Golden Beach Gas Project
Marine Environmental Impact Assessment
Technical Report

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Rev 3 – Final Report for Exhibition

AVENTUS consulting

Environmental & Safety Management for the Energy Industry

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Name	Title	Project role
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Appendices

EXECUTIVE SUMMARY

This technical report is an attachment to GB Energy's Golden Beach Gas Project Environment Effects Statement (EES). It has been used to inform the EES required for the Project.

Overview

GB Energy is an independent Australian company, headquartered in Melbourne, Victoria.

GB Energy, as operator of retention lease VIC/RL1(V) (Lease), is proposing to develop the Golden Beach Gas Field located in the Gippsland Basin approximately 3.8 kilometres offshore from the Ninety Mile Beach coastline and close to the Golden Beach township. The field was originally discovered in 1967.

The Golden Beach Gas Project (Project) has a narrow footprint, a short construction period (approximately 90 days for offshore drilling and 20 days for subsea pipeline construction), is dealing with very clean, dry gas and is being developed in an area with sparse habitation and substantial existing industrial activity. No production from the aquifer is intended and no hydrocarbon liquids will be produced.

Requirement for an EES

The Project was referred to the Minister for Planning (accepted on 7 August 2019 by the Minister) to seek advice on the need for an EES under the *Environment Effects Act* 1978 (Vic) (EE Act).

On 8 September 2019, the Minister for Planning issued his decision that an EES is required on the basis that the Project has the potential for a range of significant environmental effects on:

- Offshore marine biodiversity values;
- Aboriginal cultural heritage values; and
- Onshore biodiversity values including Lake Reeve, part of the Gippsland Lakes Ramsar site.

On 22 November 2019 under delegated authority from the Minister for the Environment, the Department of the Environment and Energy (now referred to as the Department of Agriculture, Water and the Environment (DAWE) and herein referred to as such) made a decision that the Project is a controlled action under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and as such would require assessment and a decision about whether approval should be given under the EPBC Act. The Minister considered that the Project would likely have a significant impact on the following:

- Ramsar wetlands;
- Listed threatened species and communities; and
- Listed migratory species

DAWE also confirmed the Victorian Government's advice that the Project will be assessed under a bilateral agreement under the EE Act.

The EES allows stakeholders to understand the likely environmental impacts of the GB Energy Gas Project and how they are proposed to be managed. The Minister's assessment of the EES will also inform statutory decisions that need to be made on the Project.

The EES was developed in consultation with the community and stakeholders.

Aventus Consulting Pty Ltd (Aventus) was commissioned to prepare the marine Environmental Impact Assessment (EIA) for all phases of the Project to inform the EES.

Marine Environmental Impact and Risk Assessment Context

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the Project's EES, which informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objective is relevant to the marine EIA:

- **4.2 Biodiversity and habitat** - *Avoid or minimise potential adverse effects on terrestrial, aquatic and marine biodiversity values within the Project site and its environs, including native vegetation, listed species and ecological communities, other protected species and habitat for these species.*

A summary of the key assets, values or uses potentially affected by the Project, and the associated impacts assessment are summarised below.

Existing Conditions

As presented throughout Chapter 6, the dominant seabed habitat in the Project area is sandy sediments with sparse macroalgae and sponges in water depths ranging from 10-20 m. Outside the Project area, the generally sandy seabed is interspersed with low-profile rocky reef. The recent geophysical survey undertaken for the Project confirmed the absence of highly biodiverse subtidal rocky reef habitat in the Project area, with the closest known area of rocky reef located 500 m to the west of the Project area and other reefs located more than 1 km from the Project area.

Table ES1 presents the threatened species that were identified by the EPBC Protected Matters Search Tool (PMST) and the Victorian Biodiversity Atlas (VBA) databases for the Project area.

Table ES1. Threatened species identified by the PMST and VBA databases that may be present in the Project area

Species group	EPBC Act Listing				FFG Act Listing
	Threatened status			Migratory*	Threatened*
	Critically endangered	Endangered	Vulnerable		
Shorebirds	5	4	3	15	8
Seabirds	-	4	17	17	9
Reptiles	-	2	1	3	1
Cetaceans	-	2	1	6	2
Fish	-	-	4	3	2

**Note: a single species may be listed as both migratory and threatened under the EPBC Act and FFG Act.*

Fifteen (15) species were identified for the Project area in the VBA database. The species included 14 birds and one whale species, of these species four are listed as threatened under the Flora and Fauna Guarantee (FFG) Act.

The Project area is located within the Bass Strait Area to be Avoided (ATBA), which encapsulates the Gippsland hydrocarbon province and numerous offshore petroleum installations. Commonwealth and Victorian fisheries are licensed to operate in the region with Lakes Entrance used as the closest port to the Project area, though fishing intensity in the Project area itself is low.

As demonstrated throughout Chapters 8, 9 and 10 of this report, no sensitive receptors (i.e., rocky reef, protected areas, cultural heritage sites, coastal townships, other marine users) are likely to be significantly affected by the routine impacts of the Project. Areas of sandy seabed that are likely to be disturbed by the Project (e.g., through offshore drilling, pipelay barge anchoring and pipeline installation) are very well represented in Bass Strait's shallow waters and will recover to their pre-disturbed state quickly. Commercial fishing effort is low, with only one fisher working in the waters of the Project area.

The control measures presented in Chapters 8, 9 and 10 are implemented in order to ensure the environmental compliance of the Project activities and to protect the natural environment of the Project area and its surrounds. Consideration of relevant Matters of National Environmental Significance (MNES) has been applied throughout the marine EIA and no impacts to MNES have been identified.

Key Findings

There are no residual risk ratings above 'medium' for each phase of the Project with the majority rated as 'very low' and 'low'. The mitigation and control measures that will be implemented are presented in Chapters 8, 9 and 10.

It is demonstrated through this EIA that risks during:

- Construction (drilling and pipeline installation) – are temporary, highly localised and because of the low sensitivity of the Project area, predominantly range from 'very low' to 'low' risk.
- Operations – the presence of the subsea infrastructure and the infrequent and short-duration maintenance and repair activities have risk ratings ranging from predominantly 'very low' to 'low.'

'Medium' risk is associated with the introduction of invasive marine species for each phase of the Project and for the discharge of drill cuttings and muds during the drilling phase only.

Project decommissioning will occur at the end of Project life in approximately 40 years and will involve activities similar to those outlined in this report that have been demonstrated to have 'low' environmental risks through this EIA.

Acronyms

Acronym	Definition
2D	Two-dimensional
3D	Three-dimensional
ABC	Australian Broadcasting Corporation
ABS	Australian Bureau of Statistics
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHO	Australian Hydrographic Office
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
AMON	Annulus Monitor
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
AMP	Australian Marine Park
APPEA	Australian Petroleum Production and Exploration Association
AQM	Air Quality Monitoring
A&R	Abandonment and Recovery
AS/NZS	Australian Standard/New Zealand Standard
ATBA	Area to be Avoided
AWV	Annulus Wing Valve
BGV	Blowdown Gas Volume
BHA	Bottom Hole Assembly
BHP	Bottom Hole Pressure
BIA	Biologically Important Area
BOD	Biological Oxygen Demand
BOM	Bureau of Meteorology
BOP	Blow Out Preventer
BPEM	Best Practice Environmental Management
BRAHSS	Behavioural Response of Australian Humpback Whales to Seismic Surveys
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BWMC	Ballast Water Management Certificate
BWMP	Ballast Water Management Plan
BWR	Ballast Water Report
BWRS	Ballast Water Record System

Acronym	Definition
CAMBA	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
CASA	Civil Aviation Safety Authority
CEFAS	Centres for Environment, Fisheries and Aquaculture Science
CER	Commission for Energy Regulation (UK)
CFSR	Climate Forecast System Reanalysis
CHARM	Chemical Hazard and Risk Management
CI	Corrosion Inhibitor
CI	Chemical Injection
CITV	Chemical Injection Tree Valve
CMID	Common Marine Inspection Document
CH^4	Methane
CO_2	Carbon Dioxide
CO^2-e	Carbon Dioxide Equivalent
CPS	Components Process and Services
CPUE	Catch Per Unit Effort
CRA	Corrosion Resistant Alloy
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSS	Combined Safety System
Cth	Commonwealth
CTS	Commonwealth Trawl Sector
DAFF	Department of Agriculture, Fisheries and Forestry
DAWE	Department of Agriculture, Water and the Environment
DAWR	Department of Agriculture and Water Resources (Cth)
DCS	Distributed Control System
DDR	Daily Drilling Report
DEDJTR	Victorian Department of Economic Development, Jobs, Transport and Resources (Vic) (*former*)
DELWP	Department of Environment, Land, Water and Planning (Vic)
DEWHA	Department of Environment, Water, Heritage and the Arts (Cth) *(former)*
DIIS	Department of Industry, Innovation and Science (Cth) *(former)*
DJPR	Department of Jobs, Precincts and Regions (Vic)
DMR	Daily Mud Report
DNP	Director of National Parks
DoD	Department of Defence (Cth)
DoE	Department of the Environment (Cth) (*former*)
DoEE	Department of Environment and Energy (Cth) *(former)*

Acronym	Definition
DOR	Daily Operation Report
DP	Dynamic Positioning
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities (Cth) (*former*)
EAC	East Australian Current
EARPL	Esso Australia Resources Pty Ltd
EE Act	*Environment Effects Act* 1978
EES	Environmental Effects Statement
EEZ	Exclusive Economic Zone
EFL	Electric Flying Leads
EHU	Electrical Hydraulic Umbilical
EIA	Environmental Impact Assessment
EIAPP	Engine International Air Pollution Prevention
EMBA	Environment that May Be Affected
EMD	Emergency Management Division (of DJPR)
EMV	Emergency Management Victoria
EMF	Environmental Management Framework
EMGPS	Electrolytic Marine Growth Protection system
EP	Environment Plan
EPA	Environment Protection Authority (Vic)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPO	Environmental Performance Outcome
EPS	Environmental Performance Standard
ERA	Environmental Risk Assessment
ERP	Emergency Response Plan
ERR	Earth Resources Regulation (division of DJPR)
ESD	Emergency Shutdown
ESD	Environmentally Sustainable Development
FEED	Front End Engineering Design
FFG Act	*Flora and Fauna Guarantee Act 1988* (Vic)
FFS	Fish Friendly Structure
FTU	Formazin Turbidity Units
GHG	Greenhouse Gas
G&G	Geophysical and Geotechnical
GIIP	Gas Initially In Place
GLaWAC	Gunaikurnai Land & Waters Aboriginal Corporation
GMDSS	Global Maritime Distress and Safety System
GMP	Garbage Management Plan

Acronym	Definition
GoM	Gulf of Mexico
GPS	Global Positioning System
HAZOP	Hazard and Operability Study
HDD	Horizontal Direction Drilling
HFL	Hydraulic Flying Lead
HFO	Heavy Fuel Oil
HLFL	Half Lower Flammability Level
HMCS	Harmonised Mandatory Control Scheme
HP	High Pressure
HPU	Hydraulic Power Unit
HPWH	High Pressure Wellhead
HQ	Hazard Quotient
HRV	Hyperbaric Rescue Vessel
HSE	Health, Safety and Environment
HSEMS	Health, Safety and Environment Management System
HVAC	Heating Ventilation and Air Conditioning
H_2S	Hydrogen Sulfide
IAFS	International Anti-fouling System
IAP	Incident Action Plan
IAPP	International Air Pollution Prevention
IBA	Important Bird Area
ICC	Incident Control Centre
IEE	International Energy Efficiency
ILUA	Indigenous Land Use Agreements
IMAS	Institute for Marine and Antarctic Studies
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organisation
IMP	Integrity Management Plan
IMMR	Integrity Monitoring, Maintenance and Repair
IMS	Invasive Marine Species
IMT	Incident Management Team
IOGP	International Oil & Gas Producers Association
IOPP	International Oil Pollution Prevention
IPP	International Pollution Prevention
IPIECA	International Petroleum Industry Environmental Conservation Association
IR	Infra-red
ISB	In-situ burning

Acronym	Definition
ISPP	International Sewage Pollution Prevention
ISV	Inspection Support Vessel
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for the Conservation of Nature
JAMBA	Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment
JSA	Job Safety Analysis
KEF	Key Ecological Feature
LFL	Lower Flammability Level
LiDAR	Light Detection and Ranging
LoC	Loss of Control
LoWC	Loss of Well Control
LP	Low Pressure
LPG	Liquified Petroleum Gas
LWD	Logging While Drilling
MARPOL	International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978
MARS	Maritime Arrivals Reporting System
MBES	Multibeam Echo Sounder
MCS	Master Control System
MDO	Marine Diesel Oil
MEG	Monoethylene Glycol
MGO	Marine Gas Oil
MMscfd	Million standard cubic feet per day
MMO	Marine Mammal Observer
MNES	Matter/s of National Environmental Significance
MNP	Marine National Park
MO	Marine Order
MODU	Mobile Offshore Drilling Unit
MoC	Management of Change
MSS	Marine Seismic Survey
MSV	Maritime Safety Victoria
MWD	Measurement While Drilling
NatPlan	Australian National Plan for Maritime Environmental Emergencies
NCEP	National Centre for Environmental Protection
NEBA	Net Environmental Benefit Analysis
NGER	National Greenhouse and Energy Reporting

Acronym	Definition
NIW	Nationally Important Wetland
NMSC	National Maritime Safety Committee
NNTT	National Native Title Tribunal
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Authority
NOx	Nitrous Oxides
NPWS	National Parks and Wildlife Service (NSW)
NRT	National Response Team
NSR	Non-search and Rescue
NSW	New South Wales
N^2O	Nitrous Oxide
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone-Depleting Substance
OHS	Occupational Health and Safety
OIW	Oil-in-Water
OOC	Offshore Operators Committee
OPEP	Oil Pollution Emergency Plan
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act* (Cth & Vic)
OPGGS	Offshore Petroleum and Greenhouse Gas Storage
ORCA	Oil Spill Response Company of Australia
OSMP	Oil Spill Monitoring Program
OSTM	Oil Spill Trajectory Modelling
OSPAR	Oslo-Paris Conventions
OSRA	Oil Spill Response Atlas
OSRT	Oil Spill Response Team
OWR	Oiled Wildlife Response
OWS	Oily Water Separator
P&A	Plug and Abandonment
PAH	Polyaromatic Hydrocarbon
PCBs	Polychlorinated Biphenyls
PCM	Pipeline Corrosion Monitor
PGB	Permanent Guide Base
PHG	Pre-hydrated Gel
PK-PK	Peak-to-Peak
PLEM	Pipeline End Manifold
PLET	Pipeline End Termination

Acronym	Definition
PLONOR	Poses Little or No Risk
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
PMV	Production Master Valve
POB	Persons on Board
POWBONS	Pollution of Waters by Oil and Noxious Substances
PPE	Personal Protective Equipment
PRMS	Petroleum Resources Management System
PSD	Process Shutdown
PSI	Pounds per square inch
PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift
PTW	Permit to Work
PVCs	Polyvinyl Chlorides
PWV	Production Wing Valve
P&ID	Piping and Instrumentation Diagrams
QRA	Quantitative Risk Assessment
RAMSAR	Convention on Wetlands of International Importance especially as Waterfowl Habitat
RBI	Risk-based Inspection
RGP	Raw Gas Pipeline
RO	Reverse Osmosis
ROS	Regional Outfall Sewer
ROV	Remotely Operated (underwater) Vehicle
RQ	Risk Quotient
RWP	Relief Well Plan
SA	South Australia/n
SBM	Synthetic-based Mud
SCAT	Shoreline Clean-up and Assessment Technique
SCF	Shore Crossing Facility
SCM	Subsea Control Module
SCSSV	Surface Controlled Subsurface Safety Valve
SDS	Safety Data Sheet
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SEP	Stakeholder Engagement Plan
SEPP	State Environment Protection Policy
SES	State Emergency Service (Vic)

Acronym	Definition
SESS	Southern and Eastern Scalefish and Shark
SETFIA	South-East Trawl Fishing Industry Association
SHS	Scalefish Hook Sector
SIL	Safety Integrity Level
SIMOPS	Simultaneous Operations
SIS	Safety Instrumented System
SIV	Seafood Industry Victoria
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	Short Message Service
SPCU	Subsea Power and Control Unit
SPE	Society of Petroleum Engineers
SPL	Sound Pressure Level
SPRAT	Species Profile and Threats Database
SRT	State Response Team
SSS	Side Scan Sonar
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
STP	Sewage Treatment Plant
SUTA	Subsea Umbilical Termination Assembly
TACC	Total Allowable Commercial Catch
TBM	Tunnel Boring Machine
TEC	Threatened Ecological Community
TRSCSSV	Tubing Retrievable Surface Controlled Sub Surface Safety Valve
TSS	Total Suspended Solids
TSV	Transport Safety Victoria
TTS	Temporary Threshold Shift
TUTU	Topside Umbilical Termination Unit
TVDSS	True Vertical Depth Subsea
UCH Act	Underwater Cultural Heritage Act 2018
UFL	Upper Flammability Level
UK	United Kingdom
UNEP IE	United Nations Environment Programme Industry and Environment
UT	Ultrasonic Testing
UV	Ultraviolet
VBA	Victorian Biodiversity Atlas
VFA	Victorian Fisheries Authority
VIC	Victoria
VOC	Volatile Organic Carbon

Acronym	Definition
VRFish	Victorian Recreational Fishing
VTS	Victorian Transmission System
WA	Western Australia/n
WBM	Water-based Mud
WMS	Well Management System
WOMP	Well Operations Management Plan
WWC	Wild Well Control
XMT	Christmas Tree
XOV	Cross over valve

Glossary

Term	Definition
Bass Strait Area to be Avoided (ATBA)	The ATBA is a routeing measure whereby ships in excess of 200 gross tonnage should avoid the area due to the high concentration of offshore petroleum facilities and hazard to navigation this presents.
Bathymetry	Related to water depth – a bathymetry map shows the depth of water at any location on the map.
Benthos/benthic	Relating to the seafloor and includes organisations living on/in the rocks and sediments on the seafloor.
Bioaccumulate	Refers to the amount of a substance taken up by an organism through all routes of exposure (water, diet, inhalation, epidermal).
Bioavailability	Refers to the ability of a chemical to gain entry to an organism through membranes.
Biodiversity	Refers to the level of biological diversity of the environment.
Bivalves	Molluscs that have two shells including oysters, clams and mussels.
Biota	Collective term for all the flora and fauna of a region.
Biofouling	The unwanted build-up of marine organisms on manmade structures.
Bioregion	A biogeographic region characterised by distinctive flora and fauna and made up of a group of interacting ecosystems.
Blowout	An uncontrolled flow of hydrocarbons from the reservoir to the surface.
Blowout Preventer	A series of devices used to prevent a blowout.
Casing	Steel pipe used to support a rock structure from collapsing once a hole has been drilled.
Cetaceans	Whale and dolphin species.
Commissioning	The process by which a facility is confirmed to operate as expected.
Corrosion	The process of breakdown of a metal structure from chemical or electrolytic attack (e.g., rusting).
Cuttings	Inert pieces of rock, gravel and sand removed from the well during the drilling process.

Term	Definition
Decommissioning	The process of removing infrastructure and equipment from useful service.
Demersal	Living on or near the seabed.
Directional	The ability to drill a hole and steer it to the desired location.
Ecotoxicity	A measure of the effect of a substance on one or more sectors of the environment.
Endemism	Characteristic relating to the number of species native to or confined to an area or region.
Environmental risk assessment	The overall process of environmental risk identification, analysis and evaluation.
Flaring	A process by which gas is burnt in a safe and controlled manner, usually from an elevated tower.
Pipeline	A pipe that allows flow to be contained between two places – in this case between the offshore wells and onshore facilities.
Geophysical	Concerns the use of non-intrusive techniques (e.g., acoustic surveys of rocks) for study.
Geotechnical	Relating to engineering study of the subsurface soils, involving specialised drilling, collection, and analysis techniques.
Golden Beach-2 and Golden Beach-3	The names of the offshore wells to be drilled for the Project.
Greenhouse Gas	A variety of gases that trap heat near the earth's surface, preventing its escape to space.
Grey water	Non-industrial waste water resulting from domestic activities in kitchens, showers and laundries.
Habitat	The area or environment where an organism or ecological community normally lives.
Hydrocarbon	A large class of liquid, solid or gaseous organic compounds containing only carbon and hydrogen, the basis of all petroleum products.
In situ	In its location, on-site.
Infauna	Small invertebrate animals living in the sediments of the seafloor.
Intertidal	Of or being the region between the high-water mark and the low-water mark.
Invasive species	An organism (usually transported by humans) that successfully establishes itself, and then overcomes, otherwise intact pre-existing native ecosystems.
Invertebrate	Fauna lacking a spinal column (e.g., crabs, jellyfish, sponges, corals).
Manifold	A device used to combine flow from more than one source into a single pipe.
Matters of National Environmental Significance (MNES)	Nine MNES are specifically protected under national environmental law, they are as follows: • Listed threatened species and ecological communities; • Migratory species protected under international agreements; • Ramsar wetlands of international importance; • Commonwealth marine environment; • World heritage properties;

Term	Definition
	• National heritage places; • Great Barrier Reef Marine Park; • Nuclear actions; and • A water resource in relation to coal seam gas development and large coal mining development.
Megafauna	Large animals such as whales, dolphins and seals.
Mobile Offshore Drilling Unit (MODU)	A mobile drilling unit used to drill offshore wells.
Mud	Drilling fluid used to aid the drilling of boreholes into the earth by facilitating transportation of cuttings to the surface and cooling the drill bit.
Natural gas	A highly compressible, highly expandable mixture of hydrocarbons.
Oceanographic	Data related to the physical aspects of the ocean.
Pelagic	Part of the open ocean or sea comprising the water column (i.e., all of the sea other than the nearshore and seafloor).
Plankton	Microscopic marine plants (phytoplankton) and animals (zooplankton).
Polychaete	A broad group of worms, mainly marine.
Ramsar wetland	A wetland (or site) designated for inclusion on the Ramsar List of Wetland of International Importance.
Reservoir	Zone or layer in the earth that contains hydrocarbons.
Riser	A section of flexible pipe that connects equipment on the seafloor with equipment on the surface.
Spud can	Term used for the base cones on jack-up MODUs, which are the inverted cones mounted at the base of the jack-up which provide stability to lateral forces on the rig when deployed into ocean-bed systems.
Stochastic	Occurring in a random pattern.
Subtidal	Areas close to the shore below the low water mark.
Temporary threshold shift (TSS)	In acoustics, the reversible hearing loss that results from exposure to intense impulse or continuous sound.
Well	A hole drilled into a hydrocarbon-bearing reservoir.
Wellhead	A series of valves that sit on top of a hydrocarbon production well used to control flow from the well.
Xmas tree (XMT)	The set of valves, spools and fittings, connected to the top of the well to direct and control the flow of formation fluids from the well.

1. Introduction

This report presents the outcomes of the Environmental Impact Assessment (EIA) for all phases of the Project; development (drilling, pipeline installation), production (gas production, transition and storage) and decommissioning.

1.1. Purpose of this Report

The purpose of this report is to assess the potential marine environmental impacts and risks associated with the Project to inform the preparation of the EES required for the Project.

On 8 September 2019, the Minister issued a decision confirming that an Environment Effects Statement (EES) is required for the Project due to the potential for significant environmental effects.

Similarly, the Project was referred to the Australian Government's Department of Agriculture, Water and the Environment (DAWE) and on 22 November 2019 the Project was declared a 'controlled action', requiring assessment and approval under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). DAWE also confirmed the Victorian Government's advice that the Project will be assessed under a bilateral agreement under the *Environment Effects Act* 1978 (Vic) (EE Act).

This assessment provides a detailed understanding of the marine environmental impacts and risks of the Project, informing the development of management measures in the form of construction and operational management plans within a robust Environmental Management Framework.

1.2. Why Understanding Marine Environmental Impacts and Risks is Important

The environmental impacts and risks associated with offshore petroleum activities are well documented and understood. Critical to the impact and risk assessment of the Project's offshore component is the current and future need to protect threatened species, biological diversity and to maintain essential ecological processes. It is important to develop an understanding of the existing environment, encompassing its natural, socio-economic and cultural elements, and to forecast the likely impacts and risks associated with the Project to allow for the development of appropriate mitigation measures to prevent and minimise adverse effects on the environment.

Without proper assessment of Project's impacts and risks and the implementation of appropriate mitigation measures, the proposed activities and operations for this Project may result in unacceptable impacts or risks that could result in adverse environmental consequences.

This EIA report addresses the Project's specific marine environmental matters relevant in response to the EES scoping requirements. This assessment provides evidence that the potential impacts and risks of the Project can be managed to achieve the desired outcomes outlined by the Minister for Planning.

2. EES Scoping Requirements

2.1. EES Evaluation Objectives

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the Project's EES, which informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objectives are relevant to the marine EIA:

- **4.2 Biodiversity and habitat** - Avoid or minimise potential adverse effects on terrestrial, aquatic and marine biodiversity values within the Project site and its environs, including native vegetation, listed species and ecological communities, other protected species and habitat for these species.

2.2. EES Scoping Requirements

The aspects from the Scoping Requirements relevant to the marine EIA objectives are shown in Table 2.1, as well as where these aspects have been addressed in this report. Note, the scope of this marine EIA may at times overlap with other specialist studies undertaken to support the EES (e.g., noise and vibration, visual amenity and greenhouse gas emissions).

Table 2.1. Scoping Requirements relevant to the marine EIA

Aspect	Scoping Requirement	Section addressed
1.2 – Minister's requirements for this EES	Effects of Project activities on: • The offshore marine environment and ecology; • Aboriginal cultural heritage values; • Air quality (including greenhouse gas emissions) • Visual and sound amenity of nearby sensitive receptors; and • Land-use and socio-economic values.	Characterisation of the Project area and surrounds is presented in Chapter 6. Analysis of potential effects of Project activities is presented in Chapter 8, 9 and 10.
3.1 – Matters to be addressed in the EES	In the case of potentially significant effects, analyses documented within the EES should be detailed enough to provide a good understanding of the nature of the effects including: • The potential effects on individual environmental assets —magnitude, extent and duration of change in the values of each asset— having regard to intended avoidance and mitigation measures; • The likelihood of adverse effects, including those caused indirectly or during non-routine or emergency events, as a result of proposed activities, and associated uncertainty of available predictions or estimates; • Further management measures that are proposed where avoidance and mitigation measures do not adequately address effects on environmental assets, including specific	Analysis and mitigation measures of potentially significant impacts to MNES and other environmental assets is presented throughout Chapters 8, 9 and 10.

Aspect	Scoping Requirement	Section addressed
	details of how the measures address relevant policies; • Likely residual effects, including significant residual impacts on MNES, that are likely to occur assuming the proposed measures to avoid and mitigate environmental effects are implemented; • Potential cumulative impacts (arising in conjunction with the impacts of other Projects or actions that may affect the same environmental asset or assets); • An analysis of the acceptability of impacts on all MNES; and • Proposed approach to managing and monitoring environmental performance and contingency planning.	

Section 4.2 – Biodiversity and habitat	<u>Key issues</u>
	• Direct loss of, or degradation to, habitat for flora and fauna species listed as threatened or migratory under the EPBC Act, FFG Act and/or DELWP advisory lists including but not limited to the following species identified by DAWE:
	  • Curlew sandpiper (*Calidris ferruginea*);
	  • Eastern curlew (*Numenius madagascariensis*);
	  • Australasian bittern (*Botaurus poiciloptilus*);
	  • Red knot (*Calidris canutus*);
	  • Australian painted-snipe (*Rostratula australis*);
	  • Loggerhead turtle (*Caretta caretta*);
	  • Fairy prion (southern) (*Pachyptila turtur subantarctica*);
	  • Australian fairy tern (*Sternula nereis nereis*);
	  • Hooded plover (*Thinornis rubricollis rubricollis*);
	  • Australian grayling (*Prototroctes maraena*);
	  • Great white shark (*Carcharodon Carcharias*);
	  • Green turtle (*Chelonia mydas*); and
	  • Humpback whale (*Megaptera novaeangliae*).
	• Potential for cumulative effects on biodiversity values from the Project in combination with other adjoining projects.
	• Potential for indirect effects on biodiversity values including but not limited to those effects associated with impacts on habitat features due to changes in hydrology
		Chapters 8, 9 and 10.

Aspect	Scoping Requirement	Section addressed
	(including surface water, groundwater and marine changes), water quality (i.e. on water dependent ecosystems), contaminants and pollutants, edge effects, habitat fragmentation, loss of connectivity, dust, noise, environmental weeds, pathogens and pest animals including, but not limited to declared weeds, pathogens and pest animals under the Catchment and Land Protection Act 1994. • Potential for sources of disturbance, such as noise, light, vibration and visual intrusion of people and machinery, to cause significant short and long-term impacts on terrestrial and marine biodiversity values. • Potential for significant short and long-term impacts on marine biota and habitat due to drilling (shore crossing and well drilling), construction/installation, operation and decommissioning of sub-sea infrastructure including wells and pipelines. • Potential for impacts resulting from drilling or construction activity, Project operational infrastructure and decommissioning activity on cetaceans and other large marine animals, including acoustic impacts and potential collisions. • Potential for significant impacts on the marine environment resulting from accidental or unintended leaks or spills arising from construction works, operational or decommissioning activities, including unintended introduction of exotic species (e.g. through ballast water of vessels during construction).	
Section 4.2 – Biodiversity and habitat	Existing environment • Characterise the distribution and quality of native vegetation and terrestrial, aquatic, intertidal and marine habitat and any wildlife movement in the area that could be impacted by the Project or associated works. This must include the quality and type of habitat impacted and quantification of the total impact area and areas indirectly impacted from the proposed action and must be informed as appropriate by targeted surveys undertaken in accordance with the appropriate Commonwealth and/or DELWP survey guidelines. • Identify the existing or likely presence of any protected species, and especially species listed under the EPBC Act, FFG Act and DELWP advisory lists, as well as environmental weeds, pathogens and pest animals.	Chapter 6.

Aspect	Scoping Requirement	Section addressed
	• Characterise the local status, within regional and national contexts, of listed threatened and migratory species, other protected species, ecological communities and potentially threatening processes that are likely to be present, in the Gippsland Lakes Ramsar site. • Characterise the marine environment of the Project area and surrounds that could be directly or indirectly impacted by the Project. • Identify the marine fauna and flora that could be affected directly or indirectly by the Project. • Identify exotic marine organisms that are already present or established near the Project. • Describe the existing threats to biodiversity values, including: removal of individuals or destruction of habitat; disturbance or alteration of habitat conditions (e.g. habitat fragmentation, changes to water quantity or quality, fire hazards, etc.); threats of mortality of listed threatened fauna; pressures from overbrowsing and overgrazing by native and exotic fauna; presence of or risk of introduction of any declared weeds, pathogens and pest animals within and near the Project area; and initiating or exacerbating potentially threatening processes under the EPBC Act or FFG Act. • Characterisation of the existing environment is to be consistent with Commonwealth and state survey guidelines, conservation advices and threatened species recovery plans. Where surveys do not identify a listed species or community, but past records and/or habitat analysis suggest that it may occur, a precautionary approach to the further investigation and assessment of its occurrence should be applied.	
Section 4.2 – Biodiversity and habitat	Likely effects • Assess the direct and indirect effects of the Project and feasible alternatives, on listed threatened, migratory and other protected fauna species under the EPBC Act, FFG Act and/or DELWP advisory lists. • Assess the direct and indirect effects of the Project and feasible alternatives, on the marine environment including marine biota and potential habitat. • Assess the direct and indirect effects of the Project, on biodiversity values, including: disturbance or alteration of habitat conditions (e.g. habitat fragmentation, severance of wildlife corridors or habitat linkages, displacement due to avoidance of Project infrastructure, changes to water quantity or	Chapters 8, 9 and 10.

Aspect	Scoping Requirement	Section addressed
	quality, hydrological changes to wetland function, fire hazards, etc.); the ability of wetlands, including Gippsland Lakes Ramsar site, to support listed species and communities; direct removal of individuals or destruction of habitat; threats of mortality of listed threatened fauna (including site and species specific risk-factors); and the presence and potential spread of any declared weeds, pathogens and pest animals within and in the vicinity of the Project area. • Assess the potential cumulative effects on biodiversity related values from the Project in combination with other nearby existing or proposed projects.	
Section 4.2 – Biodiversity and habitat	Mitigation measures • Identify and describe potential alternatives, proposed design options and mitigation measures and their effectiveness in avoidance or reduction of significant effects on any flora, fauna (including terrestrial, aquatic and marine) and/or ecological communities listed on the EPBC Act, FFG Act or DELWP advisory lists, other protected species or ecological character of the Ramsar site. Provide clear statements noting which avoidance or mitigation measure will be committed to.	Chapters 8, 9 and 10. Design options and Project alternatives are not considered by this report.

3. Project Description

This chapter provides a description of the marine elements of the Project, providing comprehensive details about each of its phases.

An environmental approvals process separate to the EES is also required for petroleum activities in Victorian waters under the *Offshore Petroleum and Greenhouse Gas Storage Act* 2010 (OPGGS Act) and associated OPGGS Regulations 2011. This legislation requires the preparation and approval of:

- An Environment Plan (EP) for each phase of the Project;
- A Safety Case (for drilling and pipeline installation); and
- A Well Operations Management Plan (WOMP) for drilling and well operations.

The Project description provided in this document is current as of the time of Project Front End Engineering Design (FEED), but more detail is likely to become available for the development of the documents listed previously given the continuous nature of project refinement.

3.1. Overview of the Project and Study Area

The Project encompasses the construction and operation of infrastructure to produce gas from the Golden Beach Gas Field (in Victorian waters) for provision to the Victorian Transmission System (VTS) and the east coast gas market.

The pipeline will be designed to be bi-directional, allowing for the Golden Beach gas field, when partially depleted, to be used as a gas storage facility with a 40-year design life.

The Project components are:

- Offshore drilling, testing and completion of two wells with installation of subsea wellheads;
- A subsea pipeline (or dual pipelines) from the wells (either buried or laid on the seabed) to a shore location approximately 3.8 kilometres south-west of the Golden Beach township;
- A 1.5 km shoreline crossing;
- Construction of a 21 km buried pipeline in a 30-metre-wide right of way; and
- A gas compressor station which will compress the gas and remove water entrained in the gas.

Figure 3.1 illustrates the pipeline location including the gas field within Victorian Retention Lease VIC/RL1(V).

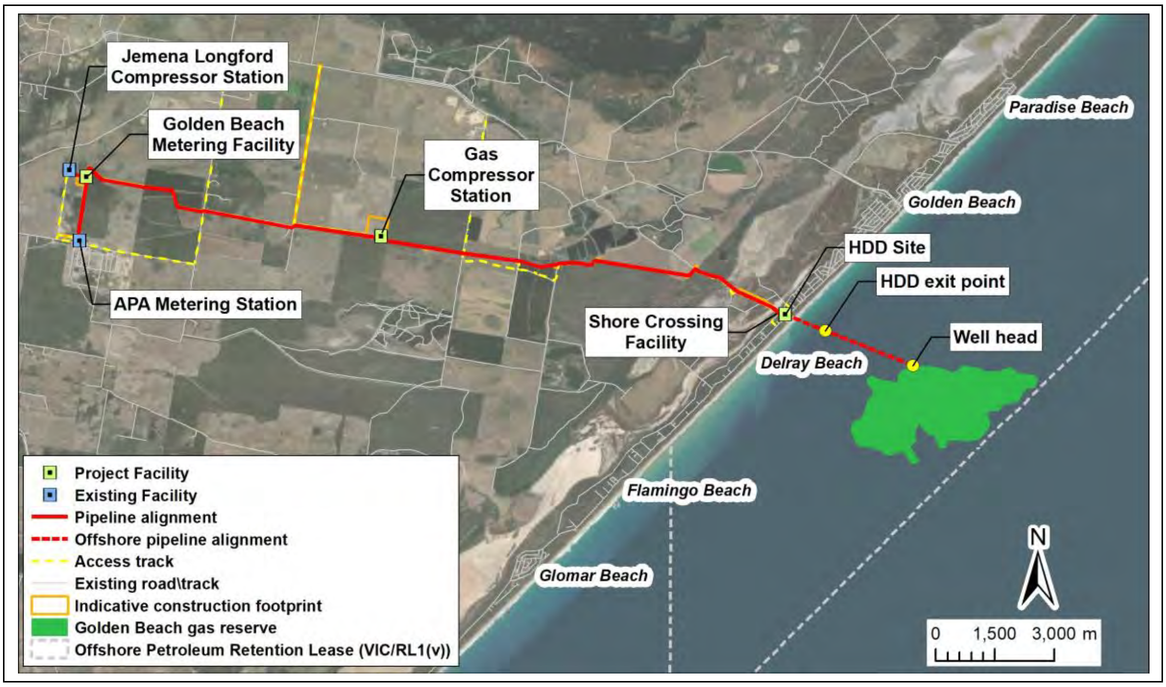


Figure 3.1. Project Overview

GB Energy, the operator of retention lease VIC/RL1(V), has progressed or completed several activities to enable Project development and definition to better inform the EES process. These include:

- Approval of an EP (PLN-001233) by Earth Resources Regulation within the Department of Jobs, Precincts and Regions (DJPR) with respect to the offshore geotechnical and geophysical investigations to be undertaken to assess seabed conditions and shallow geology for drilling rig location and offshore pipeline;
- Offshore geophysical investigation undertaken to assess seabed conditions and shallow geology for drilling rig location and offshore pipeline;
- Ongoing pipeline placement survey activities and landowner access/easement negotiations; and
- Onshore pipeline survey activities including geotechnical testing, ground proofing investigations, and ongoing field ecology and cultural heritage Investigations.

Figure 3.2 illustrates the onshore and offshore pipeline and associated infrastructure components of the Project connecting the Longford Gas Plants to the Golden Beach gas field.

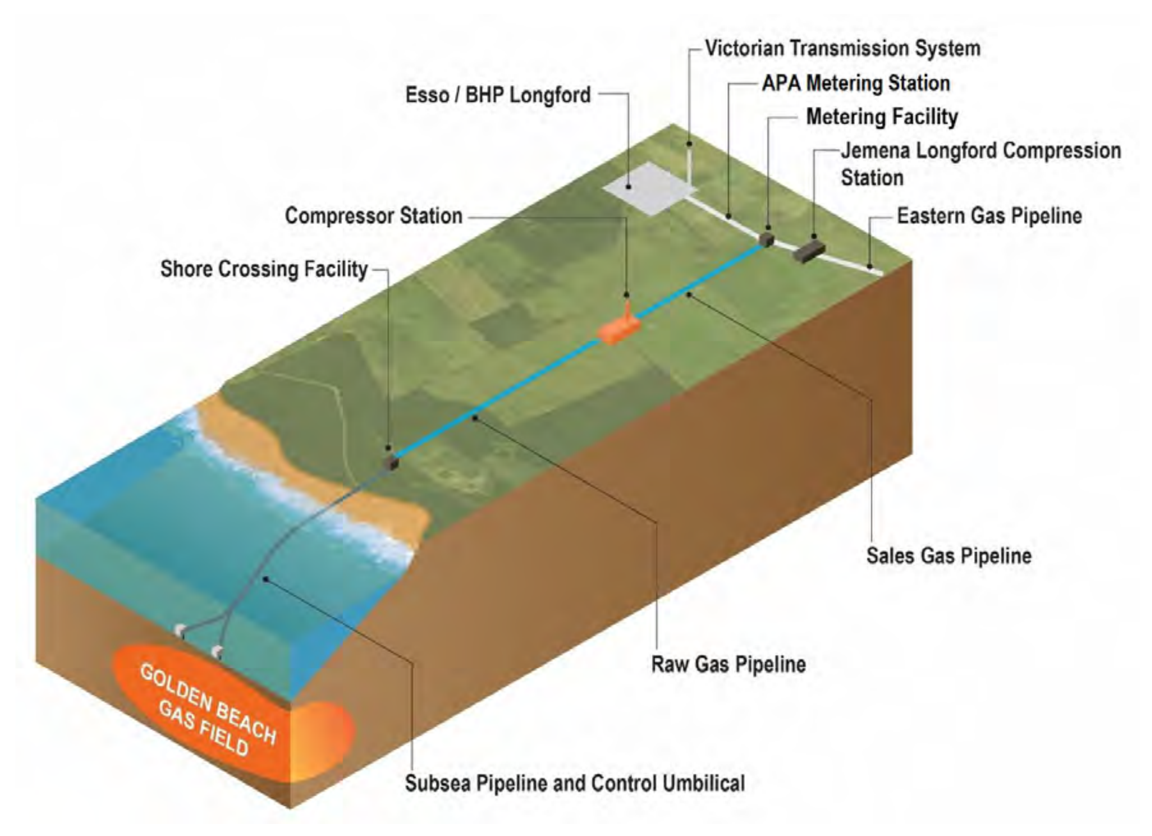


Figure 3.2. Golden Beach Gas Project schematic

3.1.1. Key Construction Activities

Key construction activities for the Project include:

- Offshore drilling of two conventional wells;
- Subsea pipeline (or dual pipelines);
- Shore crossing;
- Onshore pipeline; and
- Gas compressor station, metering station and shore crossing facility.

3.1.2. Key Operational Activities

Key operational activities for the Project include

- Production operations – Gas Extraction and Reservoir Depletion;
- Gas transmission; and
- Gas storage.

3.1.3. Key Decommissioning Activities

Key decommissioning activities for the Project may include

- Decommissioning of the infrastructure;
- Depressurisation of the pipeline;
- Capping and injection of corrosion-inhibiting water prior to its disconnection;
- Plugging and permanent capping of offshore pipeline and facilities; and
- Cutting, flushing and retrieval of equipment.

Subject to secondary use or repurposing of the site at the end of the Project's useful life, and legislation requirements at the time, these activities may be subject to change.

3.1.4. Activities Relevant to the Marine EIA

The Project comprises the following marine components:

- Drilling two offshore development wells (Golden Beach-2 and Golden Beach-3) using a jack-up Mobile Offshore Drilling Unit (MODU);
- Installation of subsea wellheads on the seabed in approximately 18 m of water using a MODU;
- Installation of a subsea pipeline (approximately 3.8 km long and 24" [72 cm] in diameter, or dual 18" (45 cm) pipelines) on the seabed to the horizontal direction drilling (HDD) exit point. Gas will flow from the wells via the subsea pipeline to shore; and
- Exit of the HDD to the seabed which will be located in approximately 12 m of water 800 m from the beach.

The marine scope of the Project will be undertaken in three phases, these being:

1. Offshore drilling and completions (i.e., installation of subsea wellheads, etc);
2. Installation of the offshore pipeline; and
3. Operations (gas production, injection and storage).

This report does not include consideration or assessment of the onshore components of the Project (i.e., HDD, onshore gas pipeline, gas processing plant, sales pipeline, etc). These are addressed by other specialists.

The following sections present the detailed description of the Project phases listed previously.

3.2. Background

GB Energy is developing the Golden Beach gas field located in the Gippsland Basin approximately 4 km offshore from the Gippsland coastline near the town of Golden Beach. The field was originally discovered in 1967.

The development will occur in two phases, with the first phase being the production of a portion (30 - 40 petajoules, PJ) of the gas currently within the reservoir. The second stage will be the conversion of the field into a gas storage facility providing an initial 250 terajoules (TJ)/day of withdrawal capacity.

The Golden Beach gas will be produced for sale at a new, stand-alone gas compression station.

Raw (native) and withdrawn (previously injected) gas will be transported from the subsea wellheads to separation, compression, dehydration and metering facilities located approximately 14 km inland.

In addition to production, the reservoir will be used in the long term for gas storage. Re-injection facilities will be provided to allow sales quality gas from the tie in point to be re-injected to the Golden Beach reservoir for later recovery.

3.3. Proposed Development Area

The marine Project area is illustrated in Figure 3.3. The Project area encompasses the HDD exit point, the proposed pipeline alignment and the drill site and a 500-m buffer around the latter two.

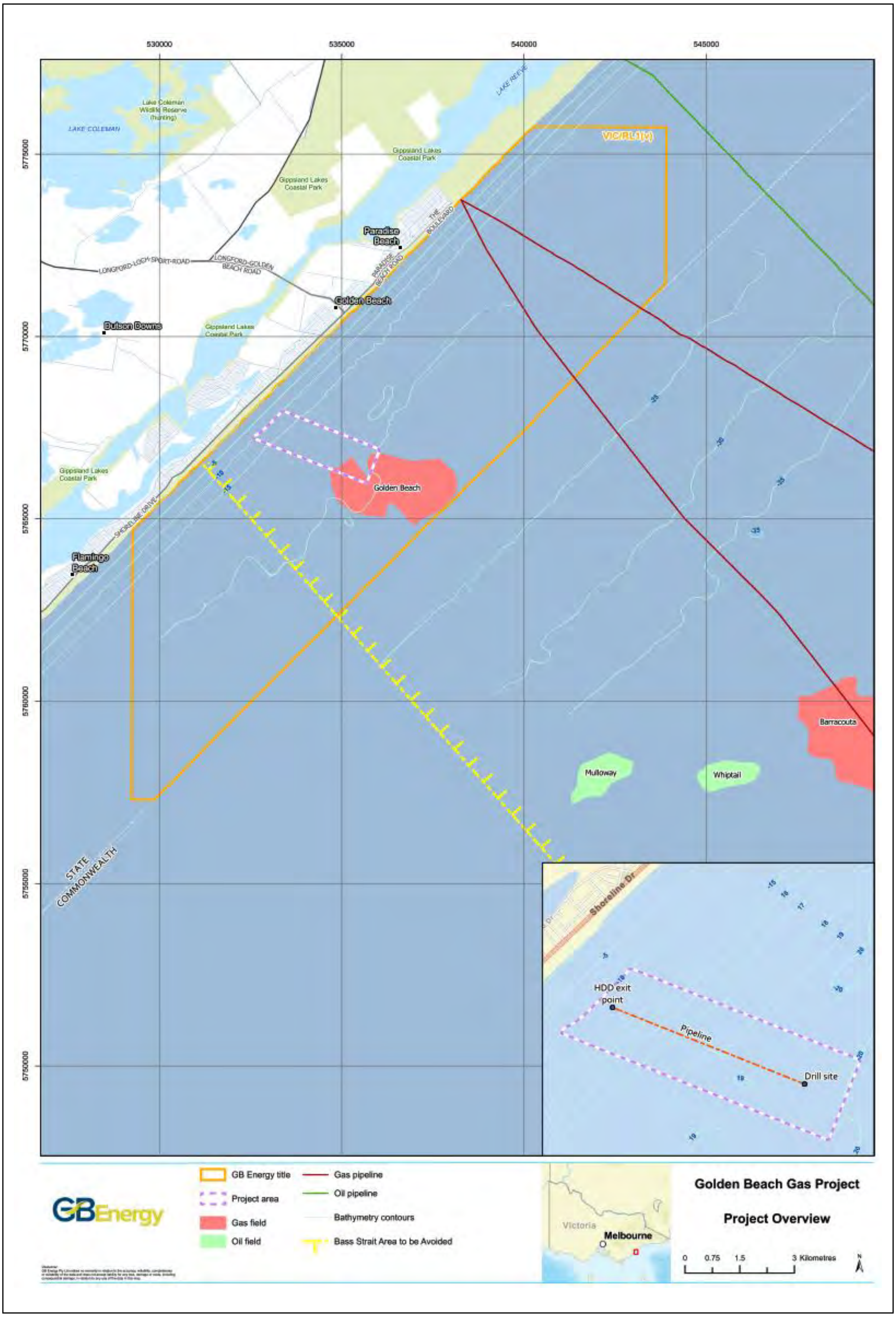


Figure 3.3 The marine Project area

3.4. Drilling

3.4.1. Objective of the Activity

The objective of the drilling activity is to drill, complete and test two (2) horizontal wells to access the targeted reservoir sands for gas production and storage purposes. It should be noted that the term “drilling” in this document covers drilling, completion and testing activities.

At this stage in the Project’s development, the drilling program continues to evolve and has not been finalised. This report presents the latest information on the drilling program, noting that more detail will be included in the Drilling EP and WOMP.

3.4.2. Project Management

GBE has an in-house drilling team comprised of highly experienced oil and gas professionals, who have progressed the design of the wells over the last two years in accordance with GBE’s Well Management System (WMS).

The purpose of the WMS is to provide a structured framework within which all GB Energy’s well engineering activities will be conducted. The system contains information that will ensure a consistent and systematic approach to the management, planning and execution of well operations. The standards have been written to define the minimum criteria that GB Energy shall apply in the design, construction, operation, maintenance, modification and abandonment of its wells.

GB Energy is committed to managing all drilling related activities in a manner that protects the health and safety of employees, contractors, the public and the environment.

3.4.3. Field Characteristics

The Golden Beach structure is a large closed anticline (“dome”), measuring approximately 10 km by 7 km, oriented east-west and containing Gippsland Basin strata of the Seaspray and Latrobe Groups. The anticline is mapped from continuous excellent quality 3D seismic surveys in the offshore domain (including the 2018 Pelican three-dimensional marine seismic survey conducted by the CarbonNet Project) and good quality reprocessed 2D seismic data onshore. Table 3.2 summarises the Gippsland Basin stratigraphy.

Two wells have already been drilled in the Golden Beach gas field, so the stratigraphy of the field is well known. Golden Beach West-1 was drilled in 1965 by Woodside Oil Company, on the onshore extension of the anticline and penetrated to what is now known as the Golden Beach Subgroup at 2,290 m MD depth. Golden Beach-1A (drilled by B.O.C of Australia in 1967) discovered the shallow top Latrobe Group gas pool, and drilled on to 2,937 m MD, also terminating in the Golden Beach Subgroup.

The Golden Beach gas occurs in the Cobia Subgroup, which is a coarse-grained quartzose sandstone at the top of the Latrobe Group. The sandstone was deposited in a marine shoreface environment and overlies the fluvial coal and sandstone sequence more common in the Latrobe Group.

The reservoir is sealed by the Lakes Entrance Formation, a marine calcareous claystone that seals all top-Latrobe fields in the Gippsland Basin. This unit grades upwards into marls and open marine facies of the Gippsland Limestone.

Table 3.2. Gippsland Basin stratigraphy

Group	Subgroup	Age	Comments
		Pleistocene	Fluvial sandstone and gravel
Seaspray Group		Early Oligocene to Pliocene	Section contains thin (<100m) shoreline sands and marls at the top but is otherwise dominated by marine carbonates and marls, including the 500 m - 2,000 m Gippsland Limestone Formation and basal 100-300 m Lakes Entrance Formation (regional seal for oil and gas fields).
Latrobe Group	Cobia Subgroup	Middle Eocene to Early Oligocene	Sandstone dominated section with excellent quality terrestrial to paralic clastic reservoirs which hosts the Golden Beach gas field as well as several giant gas fields and smaller oil fields. Meteoric aquifer with internal aquitards (seals) such as the coal-bearing Traralgon Formation T2 member.
	Halibut Subgroup	Late Cretaceous to Eocene	Good to excellent quality terrestrial to paralic clastic reservoirs with several giant oil and gas fields nearby. Divided into Upper, Middle, and Lower Halibut Subgroups. Contains a number of intra-formational seals.
	Golden Beach Subgroup	Late Cretaceous (Santonian to Campanian)	Fringing facies of generally coarse-grained terrigenous clastics and conglomerates with lower but moderate porosity and permeability.
	Emperor Subgroup	Late Cretaceous (Turonian)	Early rift phase of Latrobe Group. Contains range of facies including fringing coarse clastics.
Strzelecki Group		Early to Middle Cretaceous (Berriasian to Albian)	Poorly-sorted volcaniclastics with poor porosity and permeability. Economic basement for conventional petroleum resources but has some tight gas potential onshore.
Basement		Mesozoic	A variety of terranes with metasediments and igneous rocks underlie the basin.

The dome structure that traps the gas is closed to well below the current gas-water contact, in other words the trap is not filled to the spill-point. The sandstone below the gas water contact is water-saturated and is believed to be connected laterally with the regional aquifer system of the Gippsland Basin.

At depth below the field, the T2 member of the Traralgon coal sequence and associated smaller seams form an apparent aquitard (seal) between proposed CO_2 injection operations of CarbonNet and the Golden Beach hydrocarbon gas reservoir.

The top of the reservoir is expected to be encountered at approximately 620m below sea level. The thickness of the gas zone is known from the Golden Beach-1a. This well drilled through the gas-water contact at approximately 652.5 m below sea level, thus the gas bearing sandstone section is 32.5 m thick.

A zone of small faults divides the structure into an east and west lobe, however it is clear from detailed seismic interpretation that the small faults do not connect to create a continuous barrier across the field. It is anticipated that gas will flow unimpeded between the east and west lobes. While some internal variation and stratification in the reservoir is anticipated, the reservoir is expected to behave as one single flow unit during production and storage.

3.4.4. Reservoir and Gas Specifications

The Golden Beach-1a well tested a number of Latrobe Group targets and was terminated near the base of the prospective section. The only significant hydrocarbons intersected was the reservoir at the top of the Latrobe Group. The gas was flow tested to surface and flowed at 4.2 MMscfd from a short interval through relatively low-diameter test tools. Interpretation of the results for the well design and length of the production interval indicated the unconstrained flow capacity of the test at 22.8 MMscfd.

Samples retained from the flow were analysed and found to be predominantly methane, with some nitrogen, and small traces of other hydrocarbon gasses.

The adjacent Golden Beach West-1 well encountered small gas shows but no significant hydrocarbon volumes. The well is interpreted to be close to the limit of closure of the Golden Beach structure and intersected an equivalent porous and permeable sandstone well below the gas-water contact. There were no shows in the Cobia or Halibut Subgroups.

Aquifers and Salinity

A regional flow of fresh water is understood to occur in the Latrobe Group, from elevated intact areas onshore to discharge areas offshore. This aquifer system was originally partly artesian but with continued production of fresh water for agriculture and from co-production of oil and water in offshore fields, the standing water level in the aquifer is no longer above ground level. The pressure as measured in the Golden Beach field was measured in 1967 at 987 pounds per square inch (psi) (some uncertainty exists in this value due to hardware limitations). GB Energy estimates that current pressure in the reservoir is now approximately 900 psi, with +/- 25 psi uncertainty. Residual water salinity is unknown in the reservoir but is expected to be low (fresh) in the aquifer below the gas zone.

Unlike oil production where prolonged periods of co-production are required to drain the recoverable reserves, this Project requires no production of water. A small amount of water (in the order of 150 litres of water per gigajoule [GJ] of gas production) is expected to condense from the gas stream and be captured in the compressor station for treatment and disposal. This water is not expected to be saline.

Hydrocarbon Quality

The gas composition outlined in Table 3.3 was assayed based on bottom samples captured during the test of the gas zone in the Golden Beach-1a well. It is likely that this is a biogenic gas, similar to that seen in the Sole and Baleen fields on the northern margin of the Gippsland Basin. The gas composition is unlikely to have changed, although modern sampling and measurement will improve the level of certainty and detail.

Predicted Flow Rates

Extensive reservoir modelling has been undertaken by GB Energy and the initial production phase of the wells will be operated at 50 MMscfd per well. During this production period, various tests will be carried out on production rate and reservoir pressure support to further evaluate the production and storage capacities of the reservoir. This information will determine whether, and at what point in the production, operations can be changed to include cyclical gas storage and delivery. For current planning purposes, this point is taken to be when 50% of the total gas in place has been produced.

Injection and withdrawal rates will be determined largely by market requirements, however the project has commercial target rates of 200 MMscfd in delivery and 125 MMscfd in injection. Reservoir modelling to 250 MMscfd delivery has been undertaken.

Table 3.3. Compositional analysis of the Golden Beach-1A well

Element	GSV Lab Mole % (as measured)	Mole % (corrected for atmospheric contamination)	G&F lab Mole % (as measured) avg of two	Mole % (corrected for atmospheric contamination)
Hydrogen	Trace	Trace	0.001	0.001
Helium	Nil	Nil	0.01	0.01
Methane	93.3	94.3	93.4	94.3
Ethane	Nil	Nil	0.07	0.08
Propane and higher	Nil	Nil	0.01	<0.1
Oxygen	0.2	Nil	0.2	0
Nitrogen	6.3	5.5	6.3	5.5
Carbon dioxide	0.01	0.01	<=0.1	<0.1
TOTAL	**99.81**	**99.81**	**100.09**	**99.41**

Predicted Hydrocarbon Volume

Based on the results of the CarbonNet 2018 Pelican 3D Marine Seismic Survey (MSS) and those of the 1967 Golden Beach-1a well, GB Energy has modelled the gas in place and the portion recoverable in the Project. The gas is classified as a Contingent Resource under the Petroleum Resources Management System (PRMS) endorsed by the Society of Petroleum Engineers (SPE). The 'P' value indicates the range of uncertainty in the assessment and is analogous to a minimum (P90), most likely (P50) and maximum (P10) case. The predicted volumes are similar to previously published estimates of the gas in place and are presented in Table 3.4.

Table 3.4. Golden Beach gas field contingent resources

	P90	P50	P10
Gas initially in place (bcf)	70.1	86.2	106.1
Contingent resource (bcf)	1C	2C	3C
Total recoverable (bcf)	**49.1**	**66.8**	**88.7**

Gas, or other hydrocarbon is unlikely to be encountered in zones other than the target reservoir. This prediction is based on the absence of other significant hydrocarbon zones in the 1967 well and that there are no direct hydrocarbon indicators in the seismic data outside of the target zone, nor are there any other trapping structures interpreted.

The exploration seismic data lacks detail in the shallowest 200 m of the section. High frequency geotechnical seismic will be carried out over the drill site in preparation for siting the jack-up drill rig.

In summary:

- The section penetrated is expected to be at a normal hydrostatic gradient;

- The expected volume of gas has been interpreted by various historical operators of the permit on several vintages of seismic with broadly similar outcomes;
- There is no evidence of shallow hazards including gas, nor geological reasons to expect it or evidence of hydrocarbons in other parts of the structure; and
- The proposed well is located within the same reservoir as was tested in 1967, so the gas pressure and chemistry are known to within reasonable limits.

3.4.5. Drilling Operation

This section provides details on the drilling activity relating to the MODU, support vessels, helicopter and supply base for the Project.

The MODU

The wells will be drilled using a jack-up MODU (rig) (Photo 3.1 shows the Noble Tom Prosser, a jack-up MODU that has recently been working in Australia). Jack-up MODUs are typically used for drilling in water depths of less than 150 m. At the time of writing this document a MODU had not been contracted, although the characteristics of jack-up MODUs are generally similar, regardless of which rig is used and therefore the following points should be noted:

- The MODU will be towed into position by support vessels.
- The MODU may be 'soft pinned' (legs extended to be in contact with the seabed with no jacking load on the legs) approximately 100 m from location. At this time, the tow vessels are configured to facilitate the final positioning, which is routinely carried out to a tolerance of less than 1 m.
- Once the tow vessels have been correctly positioned, the legs of the MODU are raised clear of the seabed and the MODU is slowly moved onto the planned location.
- Once in the desired location and with the MODU stationary, the legs are lowered to be in complete contact with the seabed and the MODU raises itself approximately 15 m above the sea surface. At this point, the drilling derrick is cantilevered over the edge of the MODU in readiness for drilling. Figure 3.4 provides a simplified overview of this process.

Support Vessels

The MODU will be supported by two or more support vessels for the duration of drilling. Support vessels will be used to supply fresh water, food, fuel, bulk drilling fluid materials and equipment to the MODU. They will also remove waste from the MODU, assist in emergency response situations and monitor the 500-m radius Petroleum Safety Zone (PSZ) around the MODU (intercepting errant vessels as required). The support vessels will operate between the MODU and the most suitable port (this has not yet been determined, but could be the Port of Melbourne, Barry Beach Marine Terminal or Port of Geelong).

There will be one (1) support vessel on standby close to the MODU at all times during the Project to provide a continuous emergency response capability. In the event of personnel working overboard and during personnel transfers by helicopter, the vessel will be within the 500-m zone (but outside the helicopter approach zone). The vessels hold station using dynamic positioning (DP) and no support vessel anchoring will occur in the Project area in order to reduce the risk of anchor contact (and potential damage) to nearby rocky reefs.

Initial mobilisation of crew to the support vessels will be via port call. Refuelling of the support vessels will take place within port.

Photo 3.1. The Noble Tom Prosser jack-up MODU

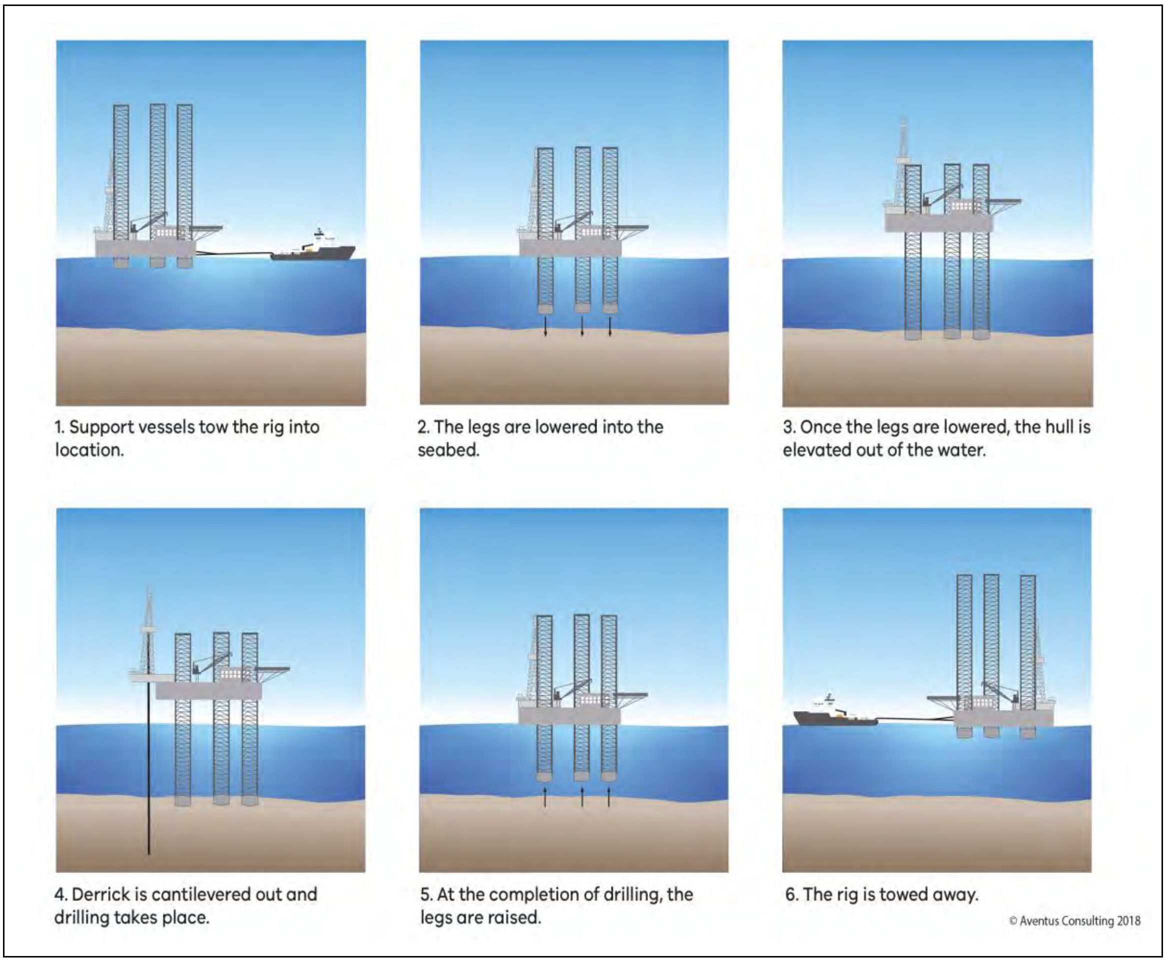


Figure 3.4. Simplified outline of the MODU positioning process

Helicopters

Helicopter operations to the MODU are planned as required but usually will be one return flight each weekday. Given the short travel distances between the nominated airport and the well location, it is unlikely that helicopter re-fuelling will be required to take place on the MODU.

A base for helicopter operations will be selected from the following heliports:

- West Sale Airport in Gippsland (located 42 km northwest of the Project area and a 15-minute flight);
- Tooradin Airport (located 173 km west-northwest of the Project area and a 45-minute flight); or
- Essendon Airport in Melbourne (located 228 km northwest of the Project area and a 60-minute flight).

<u>Supply Base</u>

Marine operations will be based out of the most suitable port, which includes either Barry Beach Marine Terminal (127 km southwest by sea), Melbourne (400 km northwest by sea) or Geelong (430 km northwest by sea).

Drilling equipment, tubulars, fluids, bulks and cement will be stored at, or transit through, this supply base and subsequently be delivered to the MODU by the support vessels. All drilling mud and cement will be mixed on the MODU. An onshore mud plant may be used for preparation and supply of completion fluids.

3.4.6. Pre-drilling Geophysical Activities

GB Energy has in place an accepted EP for geophysical and geotechnical surveys in the Project area. Some activities (such as side scan sonar) will need to be undertaken immediately prior to MODU mobilisation.

The purpose of this additional site clearance survey is to reconfirm the absence of seabed hazards and meet the warranty requirements of the MODU owner. Table 3.5 describes the types of geophysical surveys that might be required immediately preceding the drilling campaign.

Table 3.5. Pre-drilling geophysical survey requirements

Equipment	Purpose/Function	Methodology
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 'tow-fish.' The tow-fish is provided with power and digital telemetry services and towed from the vessel using a reinforced or armoured tow cable. The acoustic energy received by the SSS tow vehicle (backscatter) provides information as to the general distribution and characteristics of the surficial sediment and outcropping strata
Magnetometer	This equipment detects large and small metallic objects on or below the seabed (e.g., buried pipelines, petroleum wellheads, shipwreck debris and dropped objects such as unexploded ordinance, cables, anchors, chains) that may not be identified by acoustic means.	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. A magnetometer measures the ambient magnetic field using a specialised branch of nuclear magnetic resonance technology, applied specifically to hydrogen nuclei. No sound pulses are emitted from a magnetometer.
Multi-beam echo sounder (MBES)	The purpose of the MBES investigation is to undertake detailed measurements of water depth (bathymetry) in the Project area.	A MBES transmits a broad acoustic pulse from a transducer over a swath across 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. This acquires a wide swath (strip) of bathymetry data perpendicular to the vessel track and provides total seabed coverage with no gaps between vessel tracks

3.4.7. Drilling Program

The Golden Beach-2 and Golden Beach-3 wells will be drilled as horizontal wells from the one surface location (the cantilever deck will move 7 m further out for the second well). The first well will include a pilot hole which will be drilled to evaluate the reservoir before it is plugged back (abandoned) to drill the horizontal section. The wells will be horizontal within the top of the reservoir and will intersect up to 500 m of reservoir (Figure 3.5). The following sections describe the **preliminary** well design.

- The wells have been designed in accordance with GB Energy's Well Management System.
- Both wells have a similar casing design (Figure 3.6), with the:
  - 30" (762 mm) conductor set at 50 m below seabed;
  - Surface casing (16", 406 mm) set in Gippsland Limestone;
  - Production casing (10.75", 273 mm) set into the top Latrobe;
  - A single 9.5" (241 mm) hole section drilled to TD and completed with an open hole gravel pack comprising 6.625" base pipe; and
  - 8.625" production tubing.

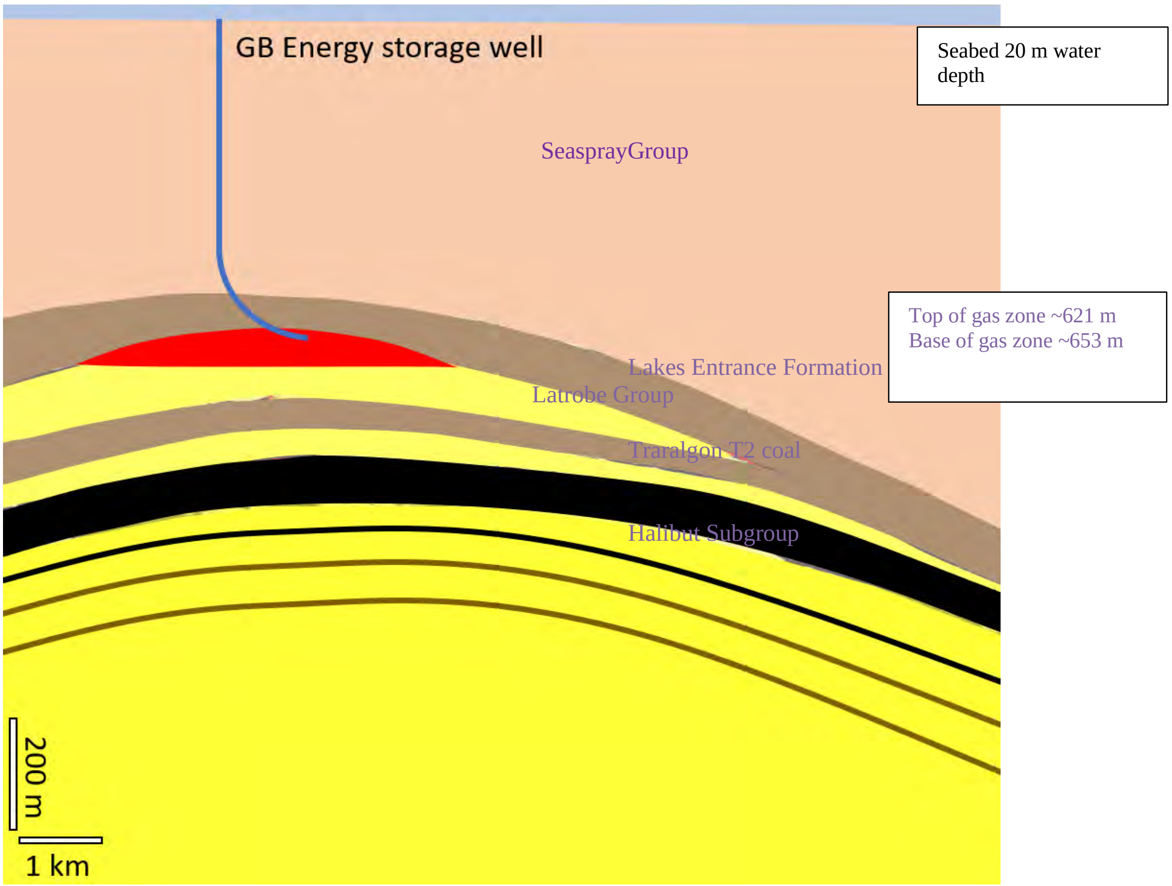


Figure 3.5. Well profile

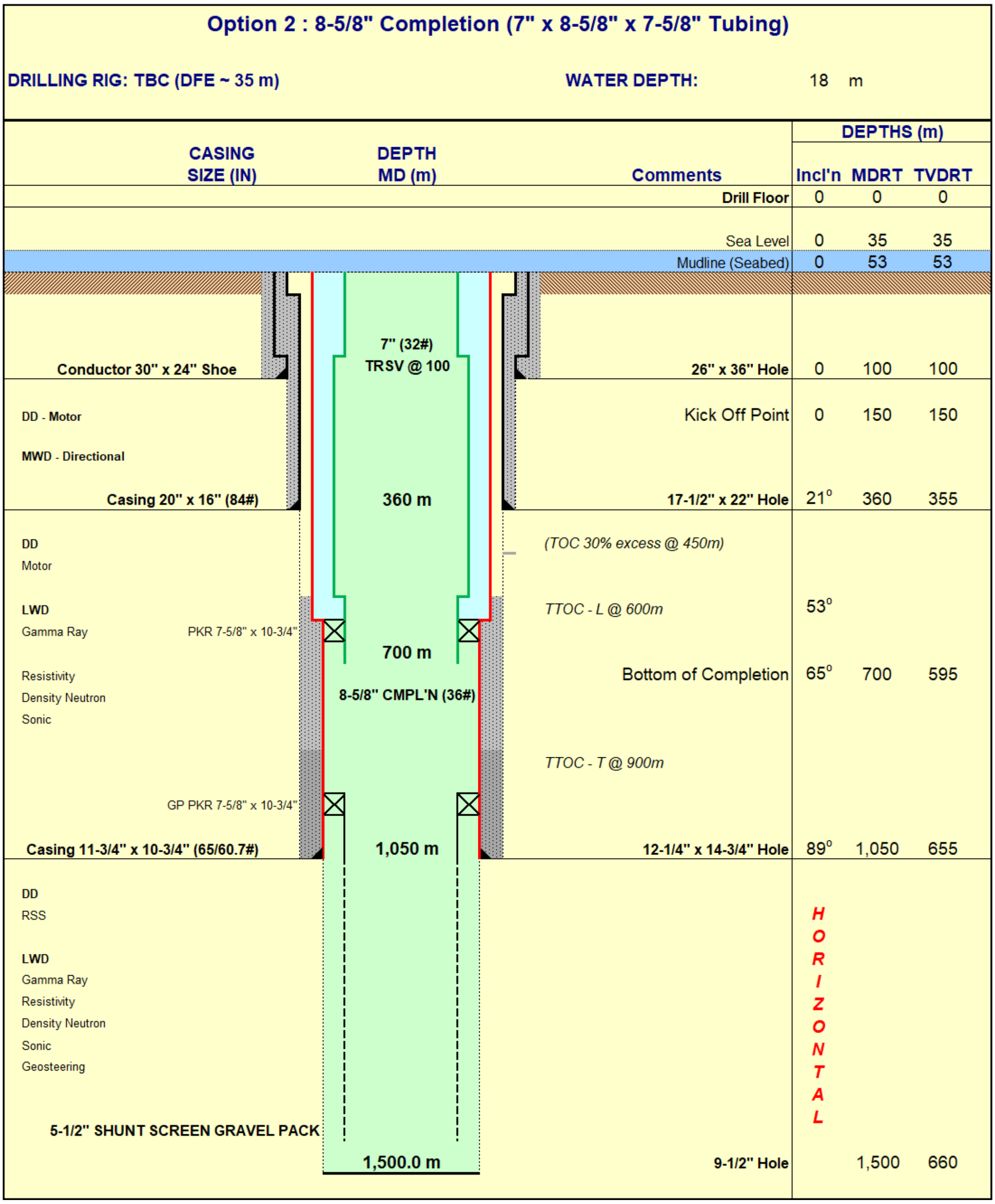


Figure 3.6. The well schematic

The casing design for the wells meet the minimum requirements of the GB Energy Casing and Tubing Standard (GB-GN-EN-STD-001) which forms part of the WMS.

The well will be spudded with a 36" (914 mm) bottom hole assembly (BHA) and drilled riserless with seawater and high viscosity sweeps (seawater viscosified by the addition of bentonite clay or polymer). Cuttings will be disposed of directly to the seabed. Upon reaching the section TD, the hole will be displaced with a high viscosity mud (containing bentonite or polymer) prior to running a 30" (762 mm) conductor casing and the low-pressure subsea wellhead housing with a Permanent Guide Base (PGB). The conductor casing will then be cemented in place with cement discharged to the seabed.

After cementing the conductor string at 17.5" (444 mm), the BHA will be run and surface hole drilled riserless, using seawater and high viscosity sweeps (cuttings and muds discharged to seabed). The well will be opened up to 22” (558 mm) with a separate BHA and a high viscosity mud (containing bentonite or polymer) will be spotted in the open hole. A 16" (406 mm) surface casing string will be run with the high pressure well head housing and cemented in place. Cement will be discharged to the seabed as an overflow from the casing cementing operations.

Once the 16” casing is cemented in place a high pressure (HP) riser and Blowout Preventer (BOP) stack will be installed and pressure tested.

The next section will consist of drilling a deviated 12.25” (311 mm) hole to land at close to horizontal in the top of reservoir. This section will be drilled using a water-based mud (WBM) system. Mud and cuttings are returned to the MODU where the returned mud will be processed to remove the drill cuttings and the mud treated to be reused. The drill cuttings will be discharged overboard. The hole will then be opened up to 14.75” (375 mm) and 10.75” (273 mm) production casing will then be run and cemented in place. This step depends upon Logging While Drilling (LWD) tool availability and associated data quality, with both options still open and under consideration.

Drilling the 12.25” section and opening it up to 14.75” or drilling 14.75” directly will depend upon LWD tool availability and the associated log data quality, along with the capability of the mud motors to achieve the desired build rate in each hole size. Both options are still open and under consideration.

Note that a pilot hole will be included following the installation of the BOP on the first well. The 8.5” (216 mm) pilot hole will be drilled at a tangent from a shallow angle (about 35 degrees) through the reservoir. It will be evaluated and plugged back (abandoned) before drilling the 12.25” section.

Finally, a 9.5” (241mm) horizontal hole section will be drilled to the well TD (approximately 625 m true vertical depth subsea [TVDSS]) with a WBM system. Mud and cuttings will then be returned to the MODU for separation and cuttings discharged overboard.

The 10.75” production casing cement bond will be evaluated prior to running the lower and upper completions.

The lower completion will consist of 6.625” (168 mm) screens which will be run in open hole and gravel packed. The upper completion will comprise 8.625” (228 mm) tubing, downhole packer and completion sub-assemblies including a 7” Tubing Retrievable Surface Controlled Sub Surface Safety Valve (TRSCSSSV).

Once the upper completion has been run and tested, the well will be made secure with downhole barriers, the BOP stack and high-pressure riser will be removed. A subsea tree and fishing friendly protective structure will be installed on the high pressure well head.

A well test will then be conducted (see Section 3.4.10) and the well suspended for future tie into the subsea pipeline.

The preliminary sequence and timing of the drilling program is summarised in Table 3.6 and Table 3.7.

Table 3.6. Preliminary sequence and timing for Golden Beach-2

Sequence and operation		Total days	Cumulative days	Drilling time (days)
1	Jack up and prepare	1.25	1.25	
2	36” hole	0.55	1.80	0.2
3	30” conductor	1.50	3.30	
4	22” hole	2.82	6.12	1.5
5	16” casing	1.29	7.40	
6	Rig up BOP and diverter	1.79	9.20	
7	14.75” hole, including pilot & core	11.27	20.46	5.0
8	10.75” casing	1.77	22.23	
9	9.5” hole	4.18	26.41	2.5
10	Cement bond log 10.75” casing	0.75	27.16	
11	Run lower completion & gravel pack	3.47	30.63	
12	Run upper completion	2.00	32.63	
13	Install XMT and FFS	2.58	35.21	
14	Well test and clean up	4.17	39.38	
15	Skid to second well	0.00	39.38	
16	Contingency	9.72	49.10	

Table 3.7. Preliminary sequence and timing for Golden Beach-3

Sequence and operation		Total days	Cumulative days	Drilling time (days)
1	Skid from first well	0.42	0.42	
2	36” hole	0.55	0.97	0.2
3	30” conductor	1.50	2.47	
4	22” hole	2.82	5.28	1.5
5	16” casing	1.29	6.57	
6	Rig up BOP and diverter	1.79	8.36	
7	14.75” hole	4.56	12.92	2.8
8	10.75” casing	1.77	14.69	
9	9.5” hole	4.18	18.87	2.5
10	Cement Bond Log 10.75" casing	0.75	19.62	
11	Run lower completion & Gravel Pack	3.47	23.09	
12	Run upper completion	2.00	25.09	
13	Install XMT and FFS	2.58	27.67	
14	Well test and clean up	4.18	31.85	
15	Demobilise rig	0.83	32.68	
16	Contingency	8.05	40.73	

Drilling Contingencies

Major contingency operations to be considered include the drilling of a wellbore side-track in the event of a mechanical problem or drilling equipment failure. A geological side-track is also possible if the reservoir penetrated does not meet the well objectives.

A blow-out relief well location will be identified (see Section 3.4.13).

3.4.8. Drilling Fluids

Function

Drilling fluids (or muds) will be used during the drilling program to provide a range of functions, including:

- Control of formation pressures (i.e., providing a hydrostatic head by managing mud density to control formation pressures and maintain well stability;
- Transport of drill cuttings out of the hole to the seabed or back to MODU for discharge;
- Act as a conduit to send real time geological and survey data from the drill bit to surface;
- Maintenance of drill bit and assembly (i.e., lubrication, cooling and support); and
- Sealing of permeable formations to prevent formation invasion.

Drilling Fluid Program

The selection of drilling fluids to be used during the drilling program is undertaken through an evaluation of the technical, safety and environmental attributes. A well-specific Drilling Fluid Program will be prepared by the drilling fluids contractor (not yet appointed) and endorsed by GB Energy prior to spud. The Drilling Fluid Program contains details of the well data, drilling fluid-related risk assessment, load out list, logistics plan, execution plan and procedures. This Drilling Fluid Program will be implemented by the wellsite mud engineers (24hr coverage).

Offset experience indicates that the Lakes Entrance formation may experience minor hole problems due to instability. Given the high angle well trajectory design through this section of the well, focus will be placed on the drilling fluid design to minimise the risk of well bore stability issues. Notionally, the following fluid systems will be used:

- <u>36” Hole Section</u> - This interval will be drilled with seawater and viscous sweeps made from pre-hydrated gel (PHG) or polymer. The PHG sweeps and drill cuttings from the well will return to the seabed.
- <u>22” Hole Section</u> - This interval will be drilled with seawater and viscous sweeps made from PHG or polymer. The PHG sweeps and drill cuttings from the well will return to the seabed.
- <u>14.75” Hole & 8.5” Pilot Hole Sections</u> – A KCl-Polymer-Glycol mud system will be used to drill these intervals. The mud will include other additives to optimise the system for wellbore stability. Lost circulation pills containing calcium carbonate and other sealing materials may be used if any downhole mud losses are encountered. The drill cuttings will be circulated to the rig and separated from the mud by the shale shakers and other separation equipment as required. The recovered mud is returned to the mud tanks for re-circulation and the cuttings discharged overboard.
- <u>9.5” Hole Section</u> - A reservoir drill-in fluid will be used for this interval. The system will be optimised for wellbore stability and prevention of reservoir damage.

The drill cuttings will be circulated to the rig and separated from the mud by the shale shakers and other separation equipment as required. The recovered mud is returned to the mud tanks for re-circulation and the cuttings discharged overboard.

- Completion - The well will be displaced to clean completion brine after drilling the reservoir section. The lower completion of sand screens will be run and gravel packed. The gravel pack operation requires pumping sized sand/proppant in a brine carrier fluid, along with other fluid additives, to create a gravel pack between the screens and open hole and preventing sand production from the reservoir. The upper completion will be run and the well filled with clean completion brine.

The calculated volumes of drill cuttings to be generated and drilling and completion fluid discharged on the two wells are outlined in Table 3.8 and Table 3.9. The data in the tables includes mud volumes discharged at the end of the well.

Table 3.8. Approximate drilling cuttings and mud discharge volumes for Golden Beach-2

Bore diameter (inches)	Well interval	Cuttings	Mud		Discharge duration (days)
		Volume discharged (m³)	Type	Volume discharged (m³)	
36”	Conductor hole	66	WBM	94	0.5
22”	Surface hole	96	WBM	231	3.0
8.5”	Pilot hole	19	WBM	210	2.0
14.75”	Intermediate hole	99	WBM	469	6.0
9.5”	Production hole	27	WBM	303	4.5
Casing & open hole	Completion & well test	Nil	N/A	88	6.0
	Total	**306**		**1,395**	**22 days**

Table 3.9. Approximate drilling cuttings and mud discharge volumes for Golden Beach-3

Bore diameter (inches)	Well interval	Cuttings	Mud		Discharge duration (days)
		Volume discharged (m³)	Type	Volume discharged (m³)	
36”	Conductor hole	66	WBM	253	0.5
22”	Surface hole	96	WBM	231	3
14.75”	Intermediate hole	99	WBM	867	6
9.5”	Production hole	27	WBM	701	4.5
Casing & open hole	Completion and well test	Nil	Brine	247	6
	Total	**287**		**2,299**	**20 days**

Note that well Golden Beach-3 discharge includes all the mud and brine carried from the previous well.

Drill Fluid Additives

Seawater or drill water is the primary constituent of drilling fluids. Inert drilling fluid additives are added to the seawater or drill water to form a WBM. Details of the fluid additives will be provided once a drilling fluid contractor has been selected. The contractor will be selected from the worldwide service providers who operate in Australia (e.g., Schlumberger, Halliburton, Baker Hughes).

Fluid Toxicity

In the absence of Australian standards regarding the suitability of drilling mud chemical additives, the Offshore Chemical Notification Scheme (OCNS) is generally used as a basis for selecting environmentally acceptable chemicals in the Australian offshore petroleum industry. The OCNS manages chemical use and discharge by the United Kingdom (UK) and Netherlands offshore petroleum industries. The scheme is regulated in the UK by the Department of Energy and Climate Change using scientific and environmental advice from the UK's Centres for Environment, Fisheries and Aquaculture Science (CEFAS) and Marine Scotland.

The OCNS uses the Harmonised Mandatory Control Scheme (HMCS) developed through the Oslo-Paris (OSPAR) Convention 1992. This ranks chemical products according to Hazard Quotient (HQ), calculated using the Chemical Hazard and Risk Management (CHARM) model. The CHARM model requires the biodegradation, bioaccumulation and toxicity data of the product to be provided.

Under the OSPAR Convention, organic-based compounds used in production, completion and workovers, drilling and cementing are subject to the CHARM model. The CHARM model calculates the ratio of the 'Predicted Effect Concentration' against the 'No Effect Concentration' expressed as a HQ, which is then used to rank the product. The HQ is converted to a colour banding to denote its environmental hazard, which is then published on the Definitive Ranked Lists of Approved Products (by the OCNS on its website, https://www.cefas.co.uk/cefas-data-hub/offshore-chemical-notification-scheme/).

Gold has the lowest hazard, followed by silver, white, blue, orange and purple (having the highest hazard).

Products not applicable to the CHARM model (i.e., inorganic substances, synthetic-based muds (SBM), hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping A – E, with 'A' having the greatest potential environmental hazard and 'E' having the least. Products that only contain substances termed PLONORs (Pose Little or No Risk to the environment) are given the OCNS 'E' grouping (Figure 3.7). Data used for the assessment includes toxicity, biodegradation and bioaccumulation.

GB Energy will specify in the drilling fluid tender that only chemicals highly ranked under the OCNS rating system (i.e., 'Gold' or 'Silver' [CHARM] and 'E' or 'D' [non-CHARM], or equivalent) may be used in the drilling fluid design. Where a chemical has not been ranked under OCNS, the drilling fluids contractor will conduct a 'pseudo rating' using toxicity and environmental data for the individual substances of a product. The rating is conducted following the hazard assessment process outlined by CEFAS for the OCNS scheme https://www.cefas.co.uk/cefas-data-hub/offshore-chemical-notification-scheme/hazard-assessment/.

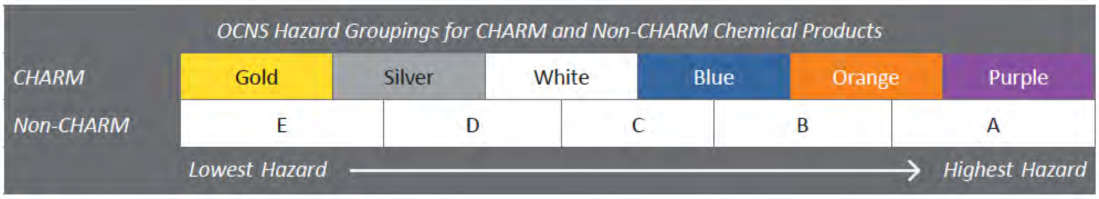


Figure 3.7. Illustration of hazard ranking bands for chemical products classified under the OCNS.

Chemical substitution

Chemicals that are hazardous to the marine environment are subject to substitution warnings under the HMCS. The UK follows and applies the OSPAR harmonised pre-screening scheme and complies with REACH recommendation to replace chemical substances identified as candidates for substitution. These substances are flagged with a substitution warning on the product template.

CEFAS recommends that during the selection of chemical products, operators consider the magnitude of their Risk Quotient (RQ) and the presence of hazardous substances and encourages operators to select products without a substitution warning.

Chemical review process

GBE will review all chemicals nominated by the drilling fluids contractor against the Definitive Ranked Lists of Approved Products (current at the time) to ensure that only 'Gold' or 'Silver' [CHARM] and 'E' or 'D' [non-CHARM] rated chemicals are nominated and that none of the chemicals nominated have a substitution warning.

Where for technical reasons a chemical doesn't meet the requirements regarding its hazard rating or has a substitution warning in place, GB Energy will review and assess the chemical proposed to ensure environmental risks are reduced to As Low As Reasonably Practicable (ALARP) and acceptable levels. This will be managed using GB Energy's Management of Change (MoC) process (described in Section 12.11).

Fluids Disposal

Any drilling and completion fluids remaining upon completion of drilling the first well will be used for the second well.

At the end of the drilling program, any drilling fluid remaining in the mud tanks will be discharged overboard (mud and brine), with quantities likely to be minimal due to the shallow nature of the well (details provided in Table 3.8 and Table 3.9). Any dry, unopened sacks of chemicals left over at the end of drilling will returned to shore.

3.4.9. Cement Program

Well integrity is a critical objective while drilling the wells.

Cement will provide one of the main barriers for isolation of the wellbore from reservoir conditions. The final cement plan will be confirmed once a cement service provider has been selected. The notional cement program is outlined below:

- 30" conductor – The conductor will be cemented to the seabed. It is planned to pump 100-200% excess while cementing the conductor in place, however the excess will be limited by stopping the cement pumping operations once cement returns are observed (using the remotely operated vehicle, ROV) at the seabed.
- 16" surface casing – The surface casing is planned to be cemented back to the seabed. It is planned that 50% excess cement will be pumped during this cement

job to account for hole washout and losses that may occur during the cementation job.

- 10.75” production casing – The production casing is planned to be cemented to a depth below the 16” surface casing shoe. It is planned that some excess cement will be pumped during this cement job to account for hole washout and losses that may occur during the cementation job. The excess will all remain within the well.
- Golden Beach-2 will include a pilot hole (Golden Beach-2P) which will be plugged back with cement for abandonment and kick-off purposes. An excess of 30% will be pumped during this operation. All the excess will remain within the well bore.

Cement Disposal

Cement is mixed as required to ensure minimal wastage. Flushing of lines and equipment is conducted at the end of each cementing operation with seawater.

There will be some excess cement discharged at the seabed during the cementing of the conductor and surface casing strings. Although cementing details are yet to be finalised, planning 50-200% excess is common for conductor and surface casing cement jobs, to account for losses and over-gauge hole conditions. Typically, once quality cement returns are observed at the seabed, cement mixing will cease and displacement will commence, with a minimal quantity of cement being deposited around the wellhead during the displacement.

It is estimated that in the order of 40 m^3 of cement slurry will be discharged for each well.

At the end of the drilling program, and assuming the MODU moves directly to another operator, the standard Portland cement may be transferred directly to them. Failing that, the cement will be discharged overboard as a slurry. All efforts will be made to minimise the quantity of cement that remains at the end of the drilling program.

3.4.10. Formation Evaluation

Evaluation of the wellbores will be carried out via LWD/Measurement While Drilling (MWD), coring (pilot hole) and wireline logging. The pilot hole will not be flow tested. Pressure measurement and fluid recoveries will be carried out in the pilot hole by wireline tools (MDT). The horizontal production wells will be evaluated by LWD and will be production tested during clean-up operations after completion.

The Formation Evaluation Program shall provide baseline geological and reservoir parameters for the reservoir such that preliminary models based on the 1967 well can be extended and updated. These models will then form the basis of production operations. Further testing of the reservoir during production will be carried out at a later date, and this data will inform the subsequent transition to gas storage.

A clean up and well test will be conducted on each well after running the completion. The well test is expected to include a 24-hour flowing period in which gas will be flared over a period of a few days.

Measurement/Logging While Drilling

As part of the drilling operation, the drilling BHA will incorporate MWD and LWD sensors. The MWD tools will provide a directional survey log of the wellbore, plus key drilling dynamics parameters while drilling.

The purpose of the LWD program will be to predict the top of the reservoir in detail such that the coring depth in the pilot hole may be selected accurately within the seal rocks above the reservoir, to accurately select the casing depths in the production wells, and to evaluate while drilling the horizontal reservoir sections.

MWD/LWD logs may include, but are not limited to:

- Direction Survey;
- Pressure, Temperature & Vibration;
- Resistivity, Gamma Ray;
- Neutron & Density; and
- Sonic response.

The purpose of the LWD program will be to predict the top of the reservoir in detail such that the coring depth in the pilot hole may be selected accurately within the seal rocks above the reservoir, to accurately select the casing depths in the production wells, and to evaluate while drilling the horizontal reservoir sections.

Wireline Logging

Conventional wireline logging operations will be conducted in the pilot hole which will be drilled at a maximum deviation of 45° from vertical. The objective of the wireline logging is to gather more detailed reservoir information than is available via LWD and carry out sampling of the gas zone. Of particular importance is the reservoir pressure, which was measured crudely in 1967 and may have changed in the intervening 50 years, clean samples for analysis, and measurements of permeability in the underlying aquifer sections

Wireline logs may include:

- Pex (resistivity, gamma ray, neutron, density);
- Image-Dipole sonic;
- Formation pressure testing and fluid sampling;
- Nuclear magnetic resonance;
- Rotary and percussion sidewall cores; and
- Cased hole - cement evaluation.

The primary objective of the cased hole logging program will be to acquire cement bond logs to confirm wellbore integrity. As a contingency, further logs may be conducted in the cased hole sections as a result of tool failures in the open hole logging operations.

Coring

Full bore cores are required to evaluate the formation at key intervals and to calibrate the responses from the various MWD/LWD and wireline tools. These conventional cores will be cut from within the top seal Lakes Entrance Formation, or as close as this may be judged in the field down to below the gas-water contact in the Latrobe Group. In addition, it is anticipated that rotary sidewall cores will be taken in any portion of this interval that was not recovered in the core barrel, and in other sections of interest in the well such as underlying aquifers and seals

The core samples will be preserved on surface and subsequently transported to a core analysis laboratory for a detailed range of experiments and analysis. In-situ formation fluids within the recovered cores will be analysed as part of the geochemical studies of the formation.

3.4.11. Well Head and Christmas Tree (XMT)

The 30" conductor and low-pressure wellhead housing provides standard features such as an internal load shoulder to support the 18.75" high pressure wellhead housing and subsequent casing strings, an external groove for the Permanent Guide Base (PGB) to lock, and side ports for drilling and cement returns.

The 18.75" high pressure wellhead housing is rated for 15,000 psi working pressure and H2S service. The wellhead housing is provided with a licensed 27" OD Vetco H4 mandrel profile for connection of the HP Riser and XMT Connectors.

The wellhead system provides 100% metal-to-metal seal capability to isolate the annuli between casing strings. Back up elastomer Annulus Seal Assemblies are also available.

The production flow path of the subsea tree (model JXT-7) is optimized to minimise pressure losses and the optimized design also eliminates the effects of swirls to mitigate effects of erosion and pressure drop.

The JXT-7 XMT includes the following features:

- Tree system is designed and manufactured to the intent of API 17D/ISO 13628-4;
- 5,000 psi rating;
- Includes electro-hydraulic controls;
- All ROV operated valves have ROV visual position indicators;
- ROV hot stab access outboard on both sides of the XMT, suited for circulation if ever required;
- Acoustic sand detector and erosion probe;
- All metal sealing surfaces and valve seat pockets inlaid with CRA materials;
- Sacrificial anodes designed for 20-year service life, with option for anodes for 40-year life selected;
- ROV installed Tree Cap Assembly;
- Diver Makeup flowline (API 9"-5K flange); and
- Cameron CC80 model choke Cv757.

Protective Structure

A protective fishing friendly structure (FFS) is to be installed on the wellhead-XMT system of each well to provide protection from fishing equipment, snag loads and dropped objects. The design of the FFS is currently ongoing.

A canopy will be installed on top of the structure to prevent snagging of fishing trawler lines and as a barrier to dropped objects. Figure 3.8 shows a preliminary layout of the wellhead, XMT and protective assembly. The height of the proposed system above seabed is approximately 6 m.

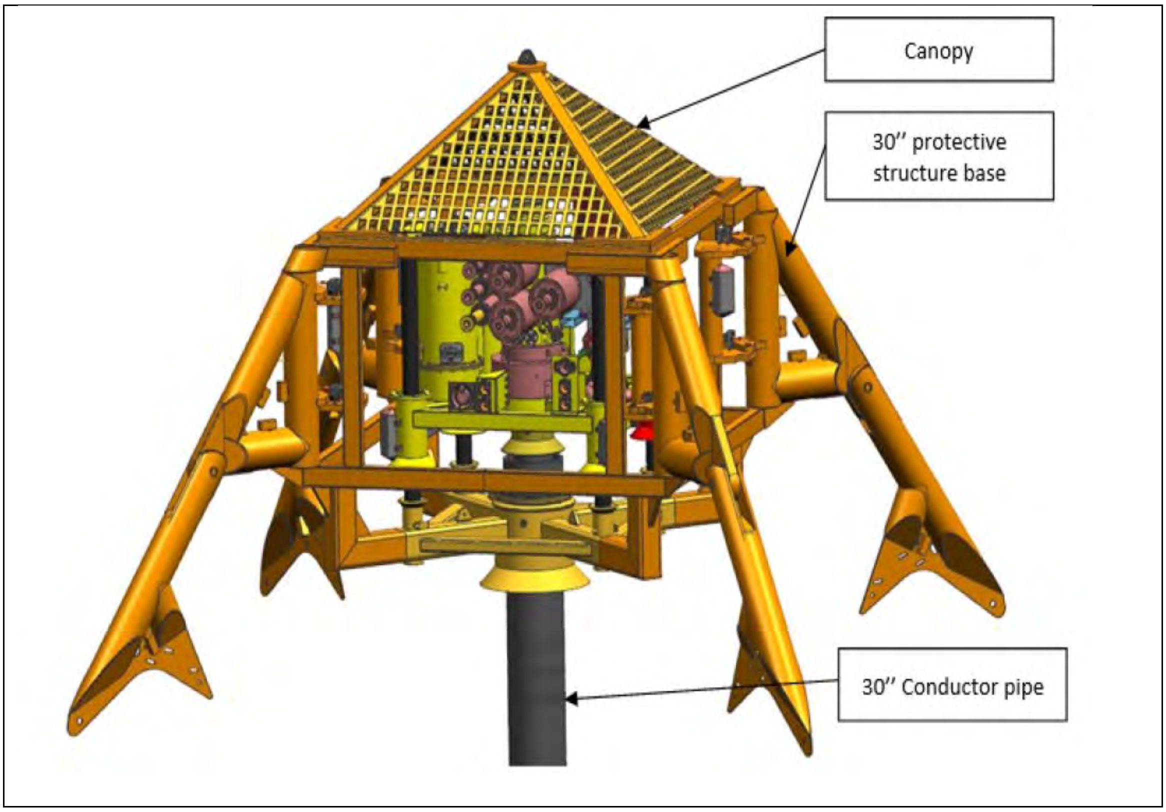


Figure 3.8. Layout of protective FFS and canopy

3.4.12. Abandonment and Suspension Options

The pilot hole will be abandoned and cemented off and the completed wells will be temporarily suspended prior to being tied into the pipeline. If for unforeseen reasons the hole sections or entire well(s) is abandoned a Plug and Abandonment (P&A) program will be undertaken.

Well Suspension

The well will be suspended as a gas producer with a subsea tree installed as shown in Figure 3.9. The tubing will remain filled with gas. The TRSCSSSV will be closed. The valves in the subsea tree will be closed and form the primary and secondary barriers to the reservoir.

Plug & Abandonment

If the decision is made to P&A the well, a possible final condition as per the schematic in Figure 3.10 is proposed. The final abandonment plan will be confirmed once the well has been drilled and logged to ensure that the barriers are located at the necessary depths. In the event the well is P&A, the wellhead will be cut and pulled back to surface and the depth of the cut will also be measured. Key considerations for P&A are outlined in Table 3.10.

Table 3.10. Potential P&A details

Barrier	Details
Plug #1 (open hole)	Abandonment of open hole with at least 30 m of good cement above and below the production casing shoe It isolates the reservoir and forms a primary barrier. Tagged and pressure tested to verify the barrier.
Plug #2 (across 16" casing shoe	Placed after cutting and retrieving the 11.75" production casing. It isolates non-hydrocarbon bearing formation from the surface and forms the secondary barrier to the reservoir. Tagged and pressure tested to verify the barrier.
Plug #3 (placed 3m below seabed)	Cut casing below BML to ensure no well protrusion above seabed. It acts as a shallow cement plug, as part of good drilling practice, though not a requirement.

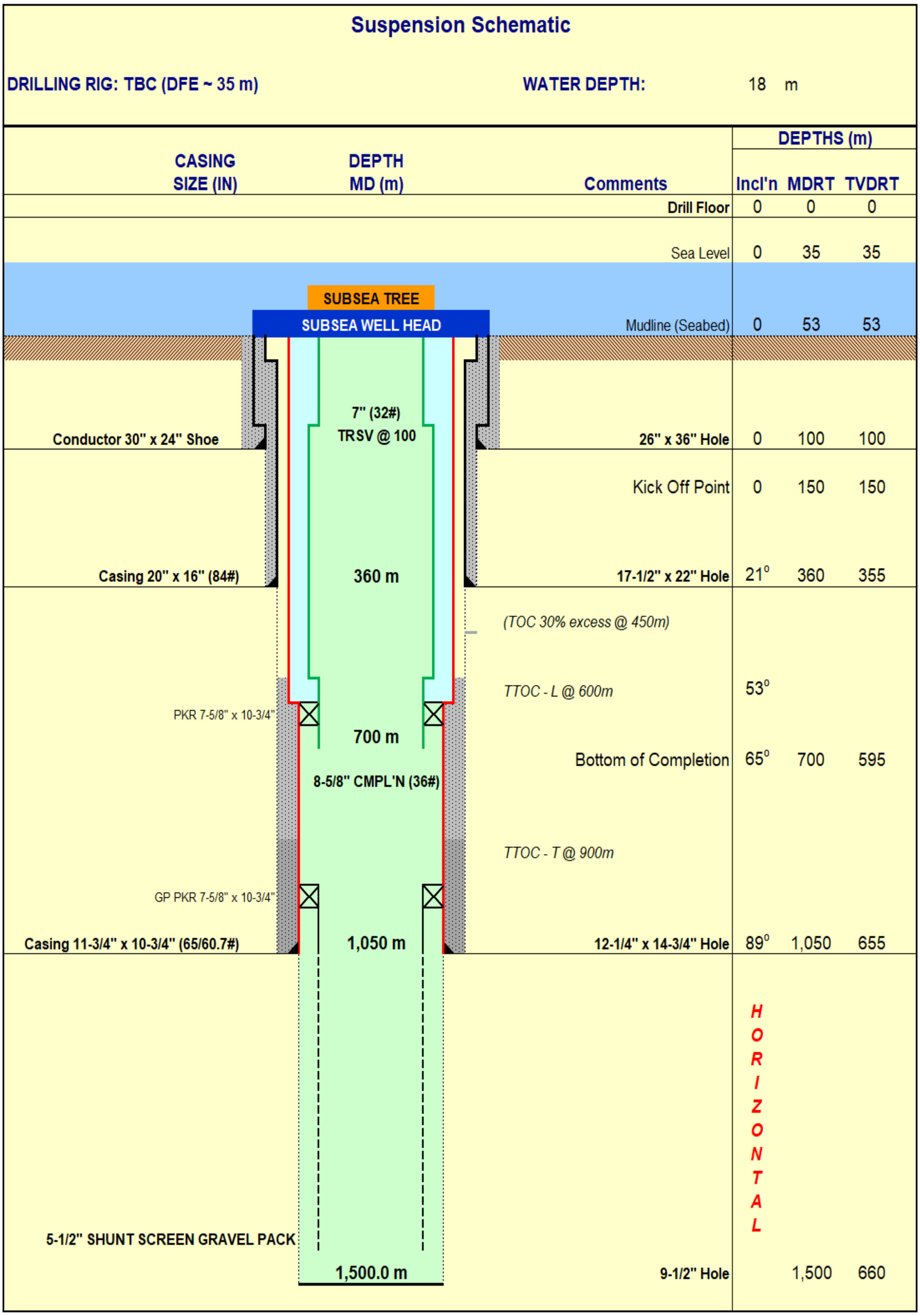


Figure 3.9. Potential suspended well schematic

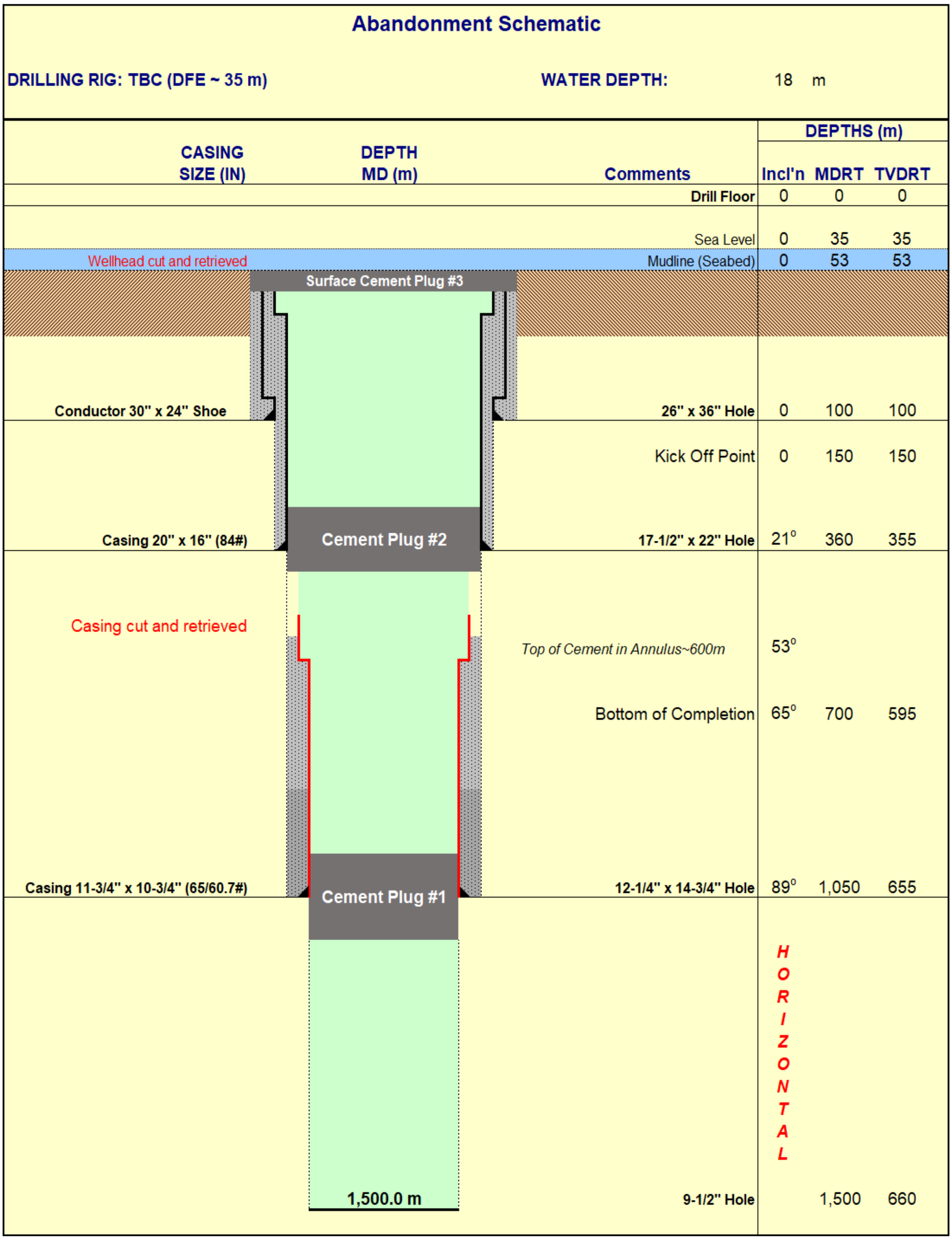


Figure 3.10. Potential P&A design

3.4.13. Well Control

Well control is the process implemented to prevent a blowout from occurring. Primary well control is provided by the hydrostatic head of the drilling fluid (density). Providing the hydrostatic head is greater than the formation pressure, the well is under control and does not flow. If primary control is lost, secondary control is applied in the form of a Blowout Preventer (BOP) that is closed to control the well.

A BOP is a mechanical device designed to seal off a well at surface when required. The system is made up of a number of different types of closing mechanisms consisting of:

- Rams (opposing pistons that move horizontally across the top of the well, creating a seal around the drill string, casing or completion tubing);
- Blind shear rams that are capable of shearing drill pipe and sealing the wellbore; and
- Annular preventers (which deploy an elastomer donut-like device) can also be used to close off the well around various sizes of pipe.

A blowout is an uncontrolled flow of formation fluids from the well after the primary control is lost and either the secondary well control has not been activated or has failed.

Blow outs are prevented during drilling operations by monitoring the well for loss of primary control, e.g. the well begins to flow indicating the formation pressure is greater than the hydrostatic head of drilling fluid in the well. In the event this is observed secondary well control activated and the BOP is closed to prevent the uncontrolled flow from the well. Primary control is then reinstated either by re applying the hydrostatic head to maintain an overbalance of pressure against the formation.

Blowout Preventer

A BOP rated to a minimum of 10,000 psi working pressure will be installed at surface and pressure tested for the well. The BOP consists of a series of hydraulically operated valves and sealing mechanisms that are open to allow the mud to circulate during drilling, but can be quickly closed if primary control is lost and well flows (a 'kick') enters the well. The following outlines the steps that would initially be taken in response to a well kick:

- If a kick occurs and secondary controls are required, an annular preventer or pipe ram is closed to prevent any further influx from the reservoir into the well if there is pipe in the hole (otherwise blind/shear rams are closed if there is no pipe in the hole).
- Lastly, the blind shear rams, which, if necessary, can shear the drill pipe and seal the well completely.

The BOP will be pressure tested prior to deployment and upon initial latch-up with the wellhead. During drilling, the BOP will be function tested and pressure tested in accordance with API Standard 53 (Blowout Prevention Equipment Systems for Drilling Wells) and the approved MODU Safety Case.

The BOP will be installed before drilling into any hydrocarbon bearing formations. The BOP will only be removed once suitable barriers are in place and are tested. This will occur:

- After running the completion and before installing the subsea tree; and
- After setting the cements plugs in the well, if the well is abandoned for any reason; and
- For any unplanned BOP maintenance or weather suspension reasons.

The BOP design is based on API standards, best practice and anticipated formation pressures. This is discussed in detail in the WOMP.

Response to a Loss of Well Control

The nature of the loss of well control leading to a hydrocarbon release will determine the type of source control activities required and the duration of the response. Source control activities can include:

- Well capping and containment;
- Relief well drilling; and
- ROV Intervention.

In the event of a blowout during drilling, reservoir modelling indicates that a maximum rate of 147 MMscf/day would be released through the 9.5” open hole for a period of time. It is assumed that there will be a pressure drop over time, though this has not been calculated.

In recent years, the global upstream petroleum industry has developed, and continues to advance innovative technologies to respond to a well blowout.

GB Energy will have a contract in place with a well control service provider that allows it to access personnel and equipment to rapidly respond to a well control response anywhere in the world.

<u>Capping and Containment</u>

A capping stack is a piece of equipment that can be placed over a blown out well and act as a cap. The purpose is to prevent the flow of hydrocarbons to the environment and thus establish a barrier to the flow of hydrocarbons to the ocean.

<u>Relief Well</u>

A relief well is a longer-term response option to stop uncontrolled flow from a well (i.e., ‘kill’ a well) and to permanently abandon the well. A relief well is drilled to intersect the well that is flowing out of control to provide a conduit to pump high density fluid into the well, and thus stop well flow. GB Energy will begin to execute its Blowout Contingency Plan which comprises a Relief Well Plan immediately after a blowout incident and in parallel with other response activities.

It is important to note that the design of the wells has taken into account the data for the offset wells, which reduces the risk of a blowout from occurring.

Preliminary Relief Well Planning

A relief well requires the mobilisation of a suitable MODU or onshore rig and the drilling of an interception well through which the failed well can be killed and made safe.

The scope of activities involved with drilling a relief well is the same as drilling a standard well, though it would be a highly deviated well due to the need to drill from outside a declared safety zone.

A relief well is typically drilled as a straight hole down to a planned kick-off point, where it is turned toward the target well using directional drilling technology and tools to get within 30-60 m of the original well. The aim is to align the two wellbores at an incident angle of 3-5° for the eventual intersect rather than aiming directly at the blowout wellbore.

The BHA is then recovered and a magnetic proximity-ranging tool is run on pipe conveyed tools to determine relative distance and bearing from the target well. Directional drilling continues to about half the distance to the planned intersection, and another magnetic ranging run is made to update relative distance and bearing.

Once the target well is penetrated, dynamic kill commences by pumping mud and/or cement downhole to seal the original well bore.

3.4.14. Drilling Summary

The drilling activity parameters are summarised in Table 3.11.

Table 3.11. Drilling phase activity parameters

Element	Details	
Location and timing		
Permit assessment area	VIC/RL1(V)	
Project area	500 m buffer zone around the pipeline and well location	
Water depths	12 - 18m	
Nearest landfall	Ninety Mile Beach – 3 km northwest	
Start date (est)	Q3 2021	
Duration of activity	Approximately 90 days	
MODU and support services		
MODU	Yet to be contracted	
Support vessels	Yet to be contracted	
Marine base	Yet to be decided, most likely from Barry Beach Marine Terminal, Melbourne or Geelong.	
Aviation support	Yet to be contracted	
Drilling details		
Well depth	Golden Beach-2 1,500 mMDRT 625 mTVDSS	Golden Beach-3 1,500 mMDRT 625 mTVDSS
Drill cuttings volume (est)	Golden Beach-2 310 m^3	Golden Beach-3 287 m^3
Drilling fluid	WBM	
Muds discharge volume (est)	Golden Beach-2 1,395 m^3	Golden Beach-3 2,299 m^3
Cement discharge volume (est)	40 m^3 per well	
VSP	Not required	

3.5. Pipeline Installation

Following the completion of drilling, the wells will be connected to the onshore facilities and sales gas pipeline. This section describes the offshore pipeline, subsea equipment and installation methodology (including the HDD section under the shoreline).

Further detail will be provided in the Pipeline Installation EP that will be prepared under the OPGGS Act.

The subsea raw gas pipeline (RGP) is considered that portion between the HDD exit point and the Pipeline End Manifold (PLEM). Impacts and risks associated with the pipeline shore crossing (which is considered the onshore pipeline) are addressed in the offshore Hazard and Risk register (GB-SS-SR-REG-001).

The installation of the subsea RGP can only take place after drilling is complete and is notionally scheduled to commence in Q1 2022, subject to the completion of drilling, vessel availability and the granting of regulatory approvals.

The construction of the subsea production system can be broken down into the following, which are addressed through this section:

- Pipeline installation;
- PLEM installation;
- Umbilical installation;
- Spool Installation;
- Hydraulic Flying Leads (HFL) and Electric Flying Leads (EFL) installation;
- Trenching or pipe anchor installation; and
- Pre-commissioning.

3.5.1. Pipeline Route

The pipeline route takes the most direct route between the HDD shore crossing and the well locations. A geophysical survey conducted in late March 2020 confirms the absence of rocky reef and other seabed obstructions along the preferred route, the preferred route is shown in Figure 3.11. The pipeline route is dominated by sands with a series of shallow (less than one meter) depressions.

3.5.2. Dimensions

The subsea RGP is 24 inches (600 mm) in diameter (with an option for dual 18” diameter pipelines, 460 mm) and 3.2 km in length from the shore crossing facility to the PLEM. The length of pipeline (excluding the shore crossing component) is approximately 2.6 km. The offshore HDD exit point is located in a water depth of approximately 10 m, with the preliminary coordinates provided in Table 3.12. A schematic of the offshore pipeline arrangement is shown in Figure 3.11.

Table 3.12. Notional HDD exit location

Location	Easting	Northing
HDD exit point	533,163	5,767,505

3.5.3. Materials and Design

The pipeline will be constructed of carbon steel and designed for sour service. The pipeline capacity is 350 TJ, which equates to three wells operating at or close to full capacity. The subsea pipeline will be stabilised initially through self-weight of the pipeline and if required via secondary stabilisation such as trenching or the use of pipe anchors. Concrete weight coating will vary between 40 mm and 110 mm thickness. The Golden Beach reservoir has a bottom hole pressure of 925 psi (approximately 6.4 kPa). Tubing head pressure (THP) maximum is 1100 psi which relates to the injection scenario. The design pressure of the subsea RGP is 9.0 MPa, so the reservoir cannot over-pressure the RGP.

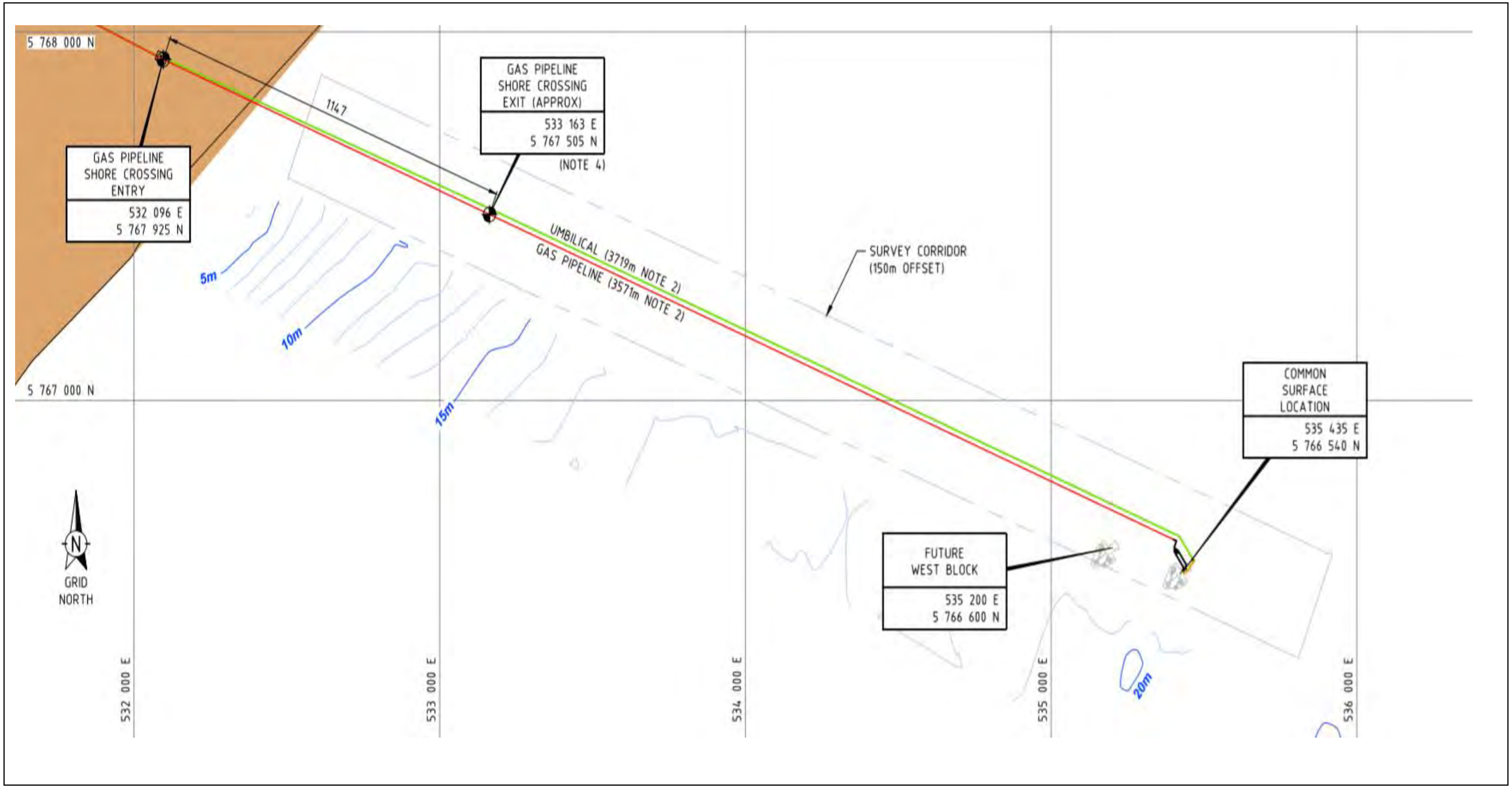


Figure 3.11. Subsea pipeline and umbilical arrangement

3.5.4. Corrosion Protection

The pipeline will be protected from external corrosion by use of anti-corrosion coating and sacrificial anodes. A fusion bonded epoxy coating of nominal 400 microns thickness will be applied externally over the entire length of the pipeline. Sacrificial anodes will be attached to the pipeline at pre-determined positions along the entire length.

3.5.5. Freespans

Where the pipeline spans across depressions in hard substrate areas, it may be necessary to place supports beneath the pipeline so that it is not suspended. Canvas grout bags will be placed under the pipeline and then filled with cement slurry grouting so that the freespan is supported as the grout bag inflates.

3.5.6. Pipeline End Manifold

The end of the pipeline will terminate in a PLEM. The PLEM serves as a collection point to bring the production flow from multiple wells into the RGP. The PLEM will be sized to accommodate the tie in of three wells (with only two being drilled in the initial drilling phase and no plans to immediately drill a third well). Tie in spools are sections of flowline which connect between a flowline and a structure laid on the seabed. Each tie in will consist of two manually operated ball valves and a bleed capability suitable to allow safe operation by divers when installing the tie-in spools. An example PLEM is shown in Photo 3.2.

Source: Offshore Oil 201 (COOEC)

Photo 3.2. An example PLEM

The tie-in spools will be constructed from Corrosion Resistant Alloy (CRA) line pipe. The spools will be 25 to 50 m in length and will be fitted with both an intrusive sand detector and an acoustic sand detector to assist with the identification and management of sand. Data from the sand detectors will be sent back to the control room via the subsea control system.

3.5.7. Subsea Control System

The subsea control system is an electro-hydraulic multiplexed system comprising a Master Control System (MCS), Subsea Power and Control Unit (SPCU), and Hydraulic Power Unit (HPU) (located at the Shore Crossing Facility (SCF)), Subsea Control Modules (SCMs) installed on each of the XMTs and an Electrical Hydraulic Umbilical (EHU) that connects the SCF to the XMTs.

The XMTs equipment will be monitored and controlled from the compressor station control room via the Distributed Control System (DCS). The subsea MCS equipment interfaces with the DCS located at the Compressor Station located onshore.

The umbilical is required to provide a supply to high pressure and low-pressure hydraulic power, electrical power, communications and chemical injection (monoethylene glycol [MEG] and corrosion inhibitor) services.

Injection of hydrate inhibitor (MEG) (non-CHARM ‘E’-rated) and continuous injection of corrosion inhibitor (Nalco EC1605A [rating unknown] or Suez ProSolv CI8071 [non-CHARM ‘E’-rated]) will be required at the wellheads, which will flow through the lines in the umbilical. Chemical injection will be metered at the shore crossing facility. MacDermid HW443 is the nominated Hydraulic fluid.

H_2S scavenger is required should concentration levels exceed 100 ppm, however based on current data, this is not expected to be the case. In the event that H_2S scavenger is used, 100% dosing availability is required. A typical EHU configuration for static use is described in Table 3.13. The design and cross section of the EHU will be confirmed during detailed design.

The umbilical will be installed via a drive system that is attached to the reel and driven to unspool the umbilical over a chute located on the side of the installation vessel, as shown in Photo 3.3. The vessel will move along the route until the umbilical is laid out. A remotely operated vehicle (ROV) will be used to monitor the touchdown of the umbilical. On completion of the lay, the subsea umbilical termination assembly is attached to the umbilical on the back deck of the vessel and then installed onto the seabed by crane. The lifting operation will be supported by a ROV or divers.

The subsea control system extends from the SCF to the well heads and consists of the elements presented in Table 3.14. Figure 3.14 provides the plan view of the subsea infrastructure to be installed for this phase of the Project.

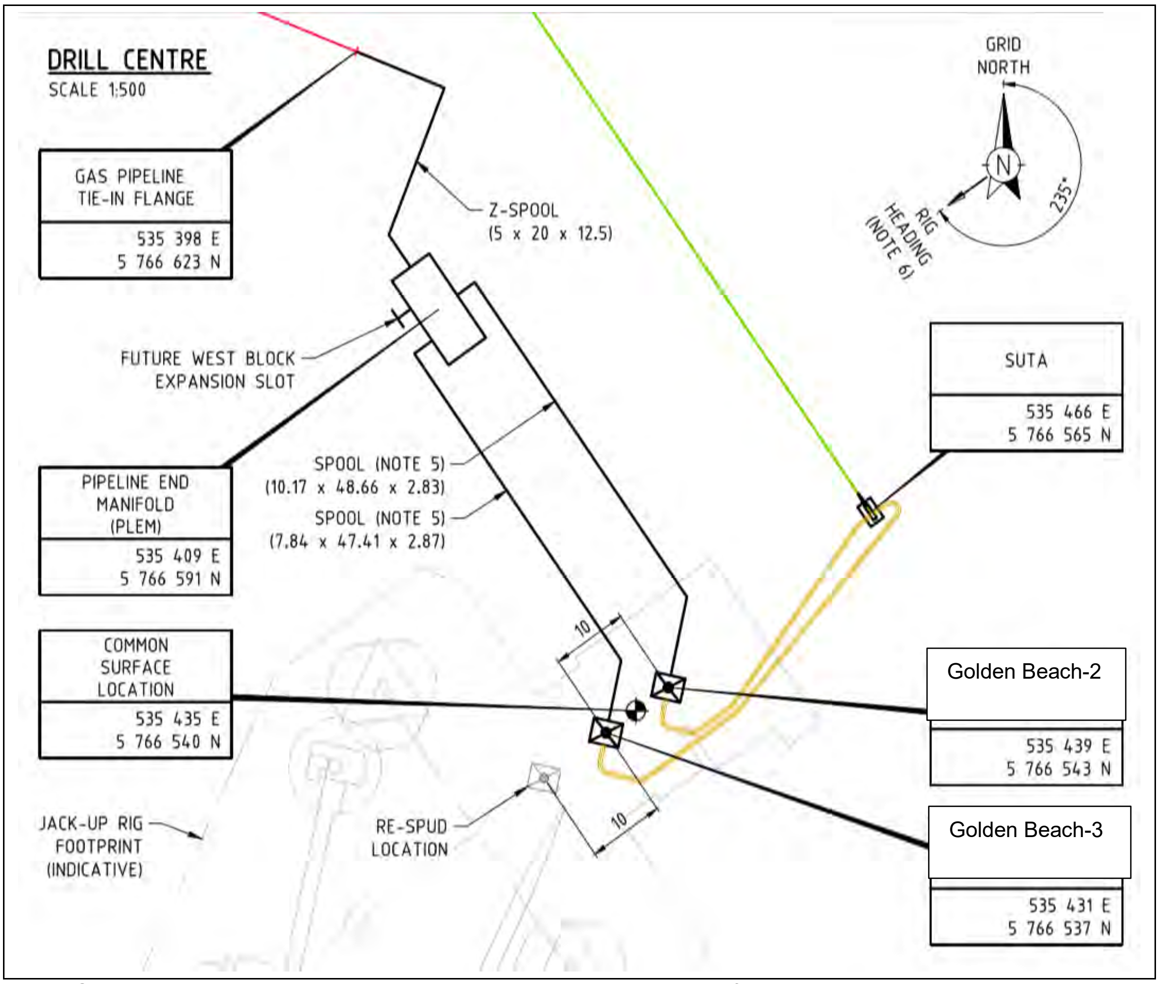
Photo 3.3. Umbilical being driven to unspool over the side of an installation vessel

Table 3.13 EHU Cores

Service	Dimensions	Max working pressure	Qty	Material
Low pressure supply	12.7 mm (internal diameter, ID)	345 (bar)	2	Thermoplastic
High pressure supply	9.5 mm (ID)	345 (bar)	2	Thermoplastic
Corrosion inhibitor	19.0 mm (ID)	345 (bar)	1	Thermoplastic
MEG	19.0 mm (ID)	345 (bar)	2	Thermoplastic
Chemical spares	19.0 mm (ID)	345 (bar)	1	Thermoplastic
Power and communications	10 mm CSA TSP	0.6 / 1 kV	2	Screened quad cables

Table 3.14 Summary of subsea control system equipment

Feature	Specification
EHU	The umbilical is approximately 4,000 m long and runs from the Onshore Topside Umbilical Termination Unit (TUTU), which is located at the SCF, to the Subsea Umbilical Termination Assembly (SUTA) located with 50m of the well centre. It provides services for hydraulic fluids, electrical power, communications, and chemical injection to the subsea development.
SUTA	The SUTA acts as a hub for the termination of the umbilical and distributes hydraulic and electrical power, MEG and corrosion inhibitor into the subsea trees via a number of HFL's and EFL's. The SUTA is located within 50m of the two XMTs.
EFL and HFL	The HFL provides the XMTs with chemical and hydraulic supply from the subsea umbilical termination assembly, whilst the EFL provides the power and signal supply. Both the HFLs and the EFLs would be lifted to the seabed on deployment frames and installed by either divers or remotely operated vehicles.



Note – Coordinates are preliminary design positions and will update as part of detailed design

Figure 3.14. Schematic of subsea installations

3.6. Subsea RGP Installation

The subsea RGP installation methodology will be undertaken to demonstrate that:

- The installation method is the most practical manner to install the shore crossing and offshore section of the pipeline and umbilical in consideration of all the site conditions;
- Installation equipment and aids, including but not limited to, installation vessels, support vessels, mooring systems, anchors, winches, pull wires, sheave blocks, buoyancy modules (and their attachments to the pipeline), pipeline roller supports, have the ability and robustness to install the pipeline and the umbilical in one uninterrupted operation irrespective of the sea state conditions which can be reasonably be expected by an experienced contractor;
- The installation method will not overstress the pipeline and umbilical materials; and
- The installation method will not cause damage to the outer surface materials of the pipeline and umbilical.

3.6.1. RGP Stabilisation Methodology

Pipelines resting on the seabed are subject to forces in both horizontal and vertical directions due to waves and currents. These forces can destabilise the pipe, leading to lateral movement if the pipeline is of insufficient weight for its size. The primary focus of a detailed design will be to select a pipeline wall thickness and concrete weight coating thickness (if required) that provide sufficient specific gravity to safely overcome the design loads and maintain stability. The design must also consider the relationship between the final weight of the pipeline and its installation ability.

If self-weight is insufficient for stability, then secondary stabilisation will be required. Secondary stabilisation could be in the form of trenching, burial or bolting to the seabed.

Trenching of subsea pipelines is widely used as a means of stability enhancement in that the pipeline is partially shielded against hydrodynamic loads. The method is also suitable for providing protection from fishing gear damage as well as thermal insulation, protective cover and to prevent upheaval buckling due to pipeline thermal expansion. Where the seabed is sand, as it is here, trenching is relatively easy to perform with more difficulty assigned to compact seafloor sediments.

Anchor piles may be used to restrain the pipeline to the seabed at predetermined spacings. A pile would be driven in either side of the pipeline and a saddle installed over the pipeline that is attached to the piles. A pile rig would be installed on the seabed and would be operated by divers. Grouting of the piles may be required depending on the substrate conditions. An example of the anchor piling stabilisation methodology is provided in Figure 3.15.

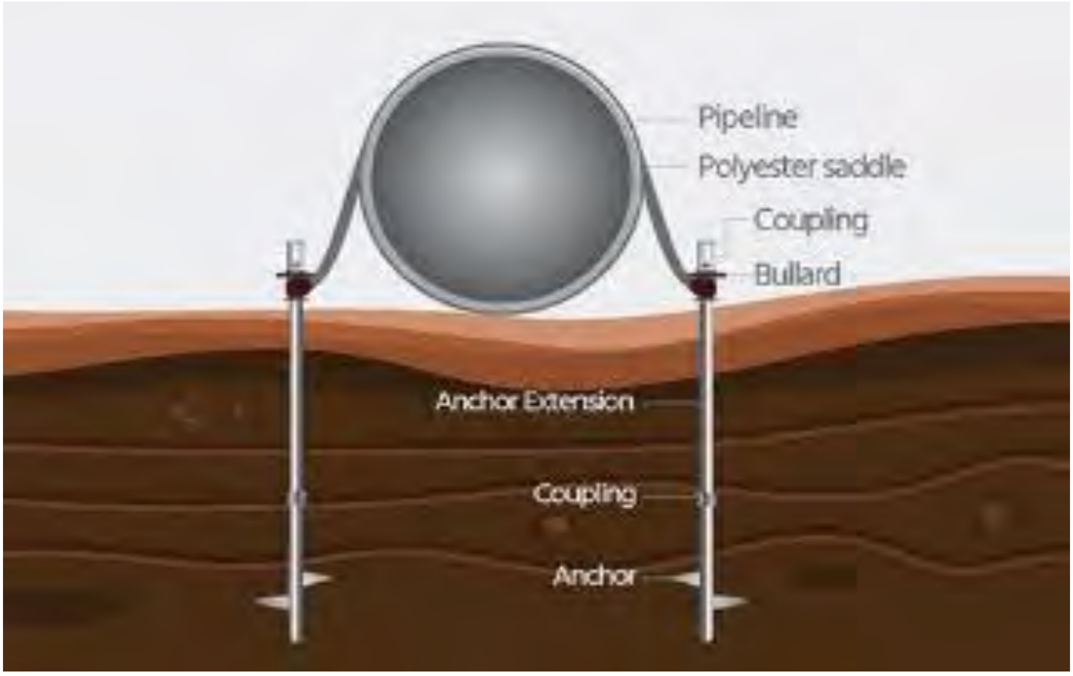
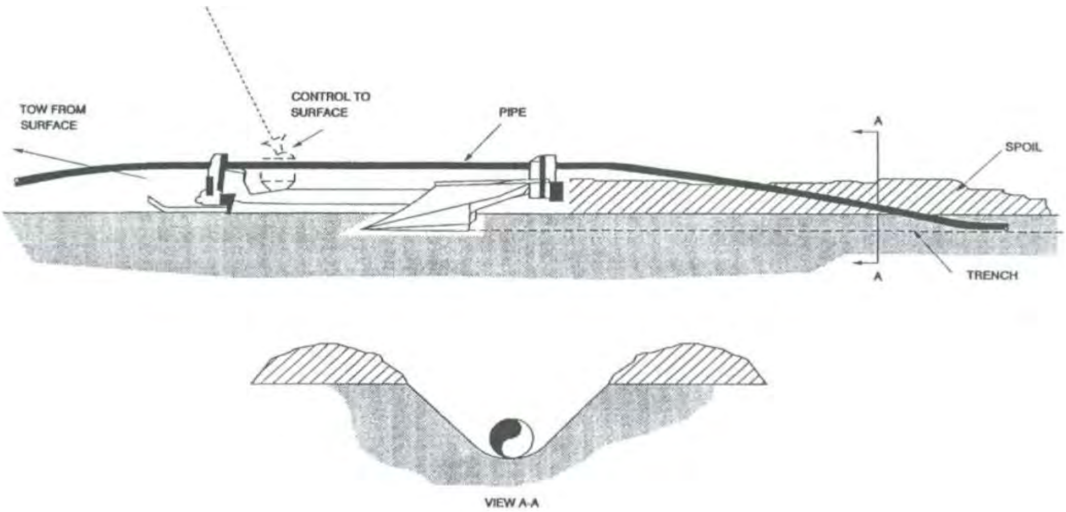


Figure 3.15. Anchor piles securing a pipeline to the seabed

If the pipeline is to be buried, possible trenching methods include the use of a plough, water jetting sled and/or water-assisted mechanical trencher. The exact stabilisation methodology will not be decided until the detailed design is available. Each of the possible burial methods is described in general here.

Pipeline Plough

The general principle of pipeline ploughing has been adapted from the technique used in agriculture to plough fields. The pipeline plough consists of a very large 'share, which the pipeline rests on top of. The pipeline is pulled along (usually by the surface vessel) and as the ploughshare passes the flowline settles in the trench. Should a backfill plough also be employed, this will reverse the process by pushing the sediments back into the trench, thereby burying the pipeline. This process is demonstrated in Figure 3.16.



Source: Bai (2005)

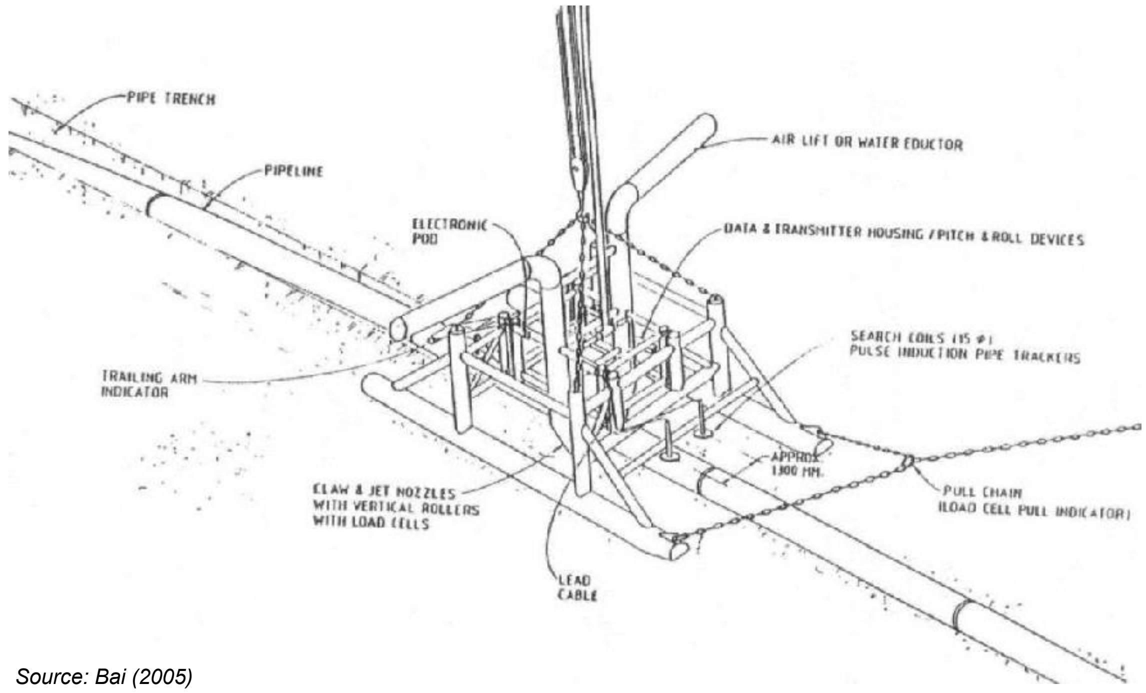
Figure 3.16. General principle of pipeline trenching using a plough

Water jetting sled

The water jetting sled works on two principles:

1. High pressure jet nozzles power water to break up the sediments
2. Air is pumped into pipes which generates lift, this lifts the broken sediments away from the location. Using these two principles a water jetting sled is able to trench.

This process is illustrated in Figure 3.17.



Source: Bai (2005)

Figure 3.17. Water jetting sled pipeline trenching method

Natural Backfill

Following trenching by one of the previously described methods, the displaced sediment piles are positioned adjacent to the trench and the pipe is then laid into the trench. Depending on the stability requirement of the pipeline, the sediment piles would either be placed back into the trench to ensure adequate cover for the pipe or natural backfill would be allowed to take place over time. This method is dependent on the hydrodynamic forces present at the installation site.

3.6.2. RGP Installation Methodology

There are three components to the installation of the RGP:

1. The shore crossing;
2. Insertion of the pipeline into the shore crossing; and
3. Installation of the pipeline offshore.

The selection of the most appropriate methodology requires a level of engineering to determine the technical and commercial feasibility of each component and their relationship to one another.

Three options for the shore crossing have been assessed:

- Open-cut trench;
- HDD (Option 1a); and
- Micro tunnelling (Option 1b).

Of the three options, the open trench option has been discarded due to the impact on the community and environment as well as for commercial reasons.

The final selection between HDD (Option 1a) and micro tunnelling (Option 1b) will be determined in consultation with the installation contractor, as the final selection would impact the success of the offshore installation. Both Option 1a and 1b are further described below. For the shore crossing, marine environment risks have generally been considered per this report, and environmental controls for the shore crossing method will be included in the onshore Environmental Management Plan (EMP) upon selection of the preferred shore crossing methodology and contractor.

The key marine environment risks associated with the shore crossing is the mud and cuttings release to the marine environment at the ‘punch through’ at the exit point on the seabed. The shore crossing ‘punch through’ has been considered and assessed per Chapters 8 and 9 of this report.

The Pipeline Installation EP will also include controls where there is cross over or marine activities are required as part of the shore crossing.

While there is an option for dual pipelines to be installed, for convenience, installation methodology refers to a single pipeline.

The insertion of the pipeline into the shore crossing would be achieved by either:

- Thrusting a pipeline string from onshore into an HDD hole (Option 2a);
- Pulling a pipeline from offshore back through a shore crossing to onshore (Option 2b); or
- Pulling a pipeline string from onshore to offshore through a micro tunnel (Option 2c).

The offshore installation has two options, these being:

- The use of a conventional lay barge (Option 3a); or
- Towing a fabricated pipe string (Option 3b).

Final details regarding the offshore pipeline installation method will be described and assessed in the Pipeline Installation EP.

Although the options for crossing the shore are described here, they are not included in the marine EIA, as other than the onshore establishment of the drill pad, the risks are subsurface. The only risks associated with the ‘punch through’ at the HDD exit point are mud and cuttings plumes, which are addressed in Chapter 9 under ‘seabed disturbance.’

Option 1a - HDD

<u>Summary</u>

Under this option, separate holes are drilled for the pipeline and umbilical. The holes are drilled from onshore using a HDD rig. The hole would be drilled out to a water depth of approximately 10 m and divers would be required to support the drilling.

The HDD hole is suitable for pipeline insertion by thrusting a pipeline string (Option 2a) or by pulling the pipeline from offshore to onshore (Option 2b).

Methodology

An HDD rig is located on a concrete foundation at the onshore entry location. A pilot hole is drilled along a pre-determined profile out to the required water depth. Reamers are then run to gradually increase the diameter of the hole to the required diameter. A mud slurry (comprising water and bentonite, a type of clay) is used to support the drilling and reaming operation.

Depending on the ground conditions and method of pipeline insertion, a liner may be installed into the hole to prevent hole collapse.

Figure 3.18 demonstrates the set up for an HDD operation.

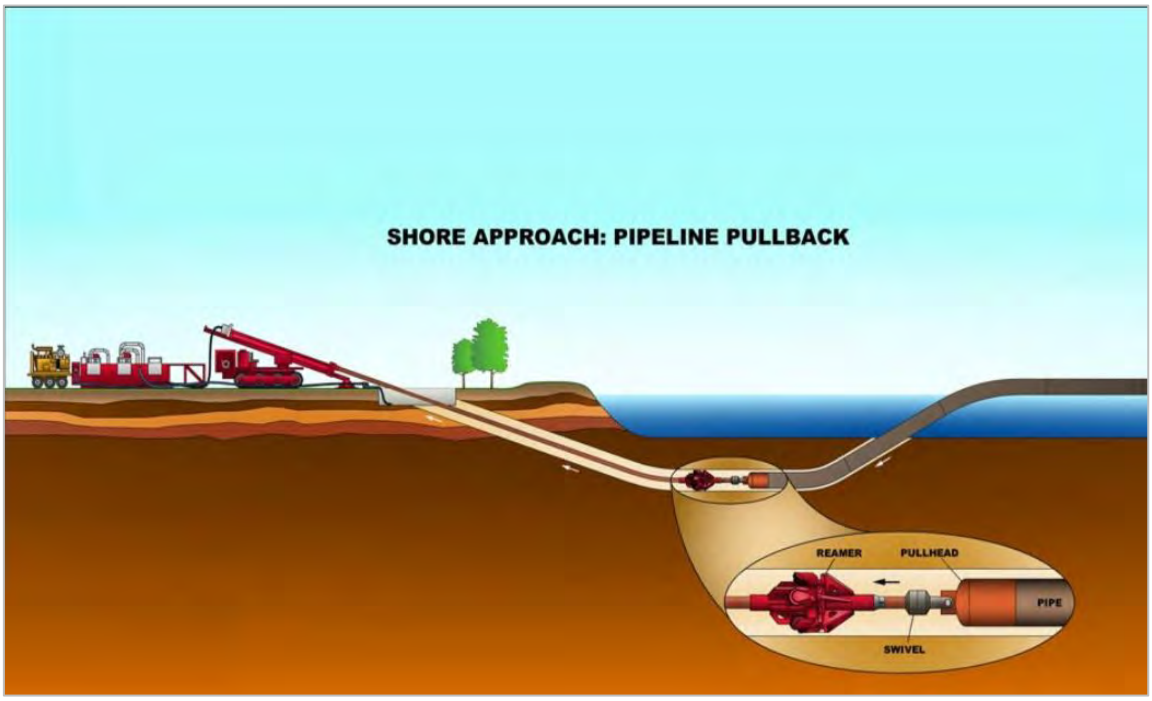


Figure 3.18. HDD and pullback of pipeline from offshore to onshore during subsea pipeline installation

Option 1b – Micro Tunnel

Summary

Under this option, a tunnel of approximately 1.1 km is drilled from shore out to a water depth of approximately 10m. The hole is drilled using a tunnel boring machine (TBM).

The tunnel diameter is sufficiently large that a bundle consisting of a pipeline, umbilical casing and buoyancy control can be inserted into the hole.

The micro tunnel is suitable for pipeline insertion by pulling the pipeline from onshore to offshore through the tunnel using offshore vessels.

Methodology

A drilling pit is installed at the onshore entry location. The soils at the exit location will be assessed to determine the suitability for receiving the tunnel boring machine, if required the soils at the exit location would be replace with an engineered soil. The tunnel is bored by the TBM and casing is inserted in sections at the entry location and thrust into the hole as the TBM progresses along the route.

Once the TBM reaches the desired location, the soils around the TBM are removed and the TBM recovered. Divers are required to support this operation.

Figure 3.19 demonstrates the set up for a micro tunnel.

Figure 3.19. Micro-tunnelling

Option 2a – Pipeline Thrust

Summary

Under this option, the pipeline string is inserted into a pre-drilled HDD hole using a thrusting rig. The string length includes sufficient length for the string to be pushed out onto the seabed far enough that will allow for the method of connection of the offshore pipeline.

The option is suitable for both offshore installation options 3a and 3b.

Methodology

The thrust rig is to be installed onto a concrete foundation at the onshore entry location.

A pipeline string is prefabricated onshore and loaded onto rollers or supported by cranes. The string is then manoeuvred to the onshore entry location where it is engaged on the thrust rig.

The pipeline is then thrusted into the pre-drilled HDD hole until it punches out at the seabed in 10 m water depth and sufficient length is laying on the seabed.

Divers are required for observing the punch out of the pipeline on the seabed.

Option 2b – Installation from Offshore

Summary

Under this option the pipeline is attached to the drill string offshore by divers and then pulled into the HDD hole by the HDD rig. Positioning of the pipeline offshore would be dependent on the method of offshore installation selected, either conventional lay barge (Option 3a) or by towing a pipe string (Option 3b).

This method of installation is limited by the pull capacity of the onshore rig.

Methodology

The shore crossing is drilled by HDD method (Option 1a). On the final reaming pass the pipeline pull head, which is positioned at the HDD exit location offshore, is attached to the reamer by divers. As the reamer is pulled back through the hole, the final diameter of the hole is achieved and the pipeline in pulled into the hole simultaneously as demonstrated in Figure 3.18.

Option 2c – Installation into a Micro Tunnel

Summary

Under this option, a pipeline bundle is fabricated onshore leading into the tunnel entry point. The bundle consists of the pipeline, a conduit for the umbilical and buoyancy modules. The buoyancy is used to reduce the weight of the pipeline and therefore the installation loads.

The length of the bundle will be dependent on the self-weight and the pull capacity of the tow vessel.

The bundle is pulled through the tunnel and along the pipeline route out to the well centre location. This would be performed in a single operation or in stages to allow pipeline string sections to be added to achieve the required pipeline length.

Methodology

Pipeline bundle will be fabricated onshore behind the entry location to the tunnel. Due to space limitations, it is likely that four 1 km long bundles will be fabricated.

On completion of the tunnel and recovery of the TBM, the seabed profile will be modified to ensure the stresses in the pipeline are not exceeded as the pipeline is pulled along the seabed profile. This work would likely be carried out by divers using suction pumps.

The first bundle string would be loaded onto rollers and the pull head attached to a pre-installed cable that runs the length of the tunnel. This cable is attached offshore to a tow vessel. The pipeline would then be pulled into the tunnel until the back end is at the onshore entry location. The second bundle string is then lifted onto the rollers and welded to the first string and the process is repeated until he full bundle length is pulled into position.

Once in position, the buoyancy is removed by divers and the pipeline flooded.

Option 3a – Conventional Lay Barge

The subsea infrastructure will be installed using the same vessel(s) used to install the pipeline where possible.

Using a pipelay vessel or barge is the more conventional method for installing subsea pipelines. The line pipe is welded, coated and checked on the vessel deck and then laid over a stinger on the back of the vessel onto the seabed as the vessel moves slowly forward. The shore crossing section can also be fabricated offshore and pulled through the HDD. Understanding the short length of the subsea pipeline and the availability of a pipeline lay vessel/barge would be a key consideration in this method being adopted.

Methodology

S-lay

The most common method of pipeline installation in shallow water is the S-lay method. In this method, the welded pipeline is supported on the rollers of the vessel and the stinger, which forms the over-bend. The pipeline is suspended in the water all the way to the seabed, forming the sag-bend. The over-bend and sag-bend form the shape of an ‘‘S.’’ The S-lay configuration is illustrated in Figure 3.20.

In this method, tensioners on the vessel/barge pull on the pipeline, keeping the whole section to the seabed in tension. The reaction of this pull is taken up by anchors installed ahead of the barge or, in the case of a dynamically positioned (DP) vessel, by thrusters. These barges/vessels are fitted with tension machines, abandonment and recovery (A&R) winches and pipe handling cranes. The firing line for welding the pipe may be placed in the centre of the barge or to one side.

Vessel

It is not yet understood at this stage of the Project design which specific vessel will be used. However, using Subsea 7's *Seven Champion* S-lay vessel as an example (refer to Photo 3.4), this vessel is 140 m in length and can accommodate up to 470 people on board.

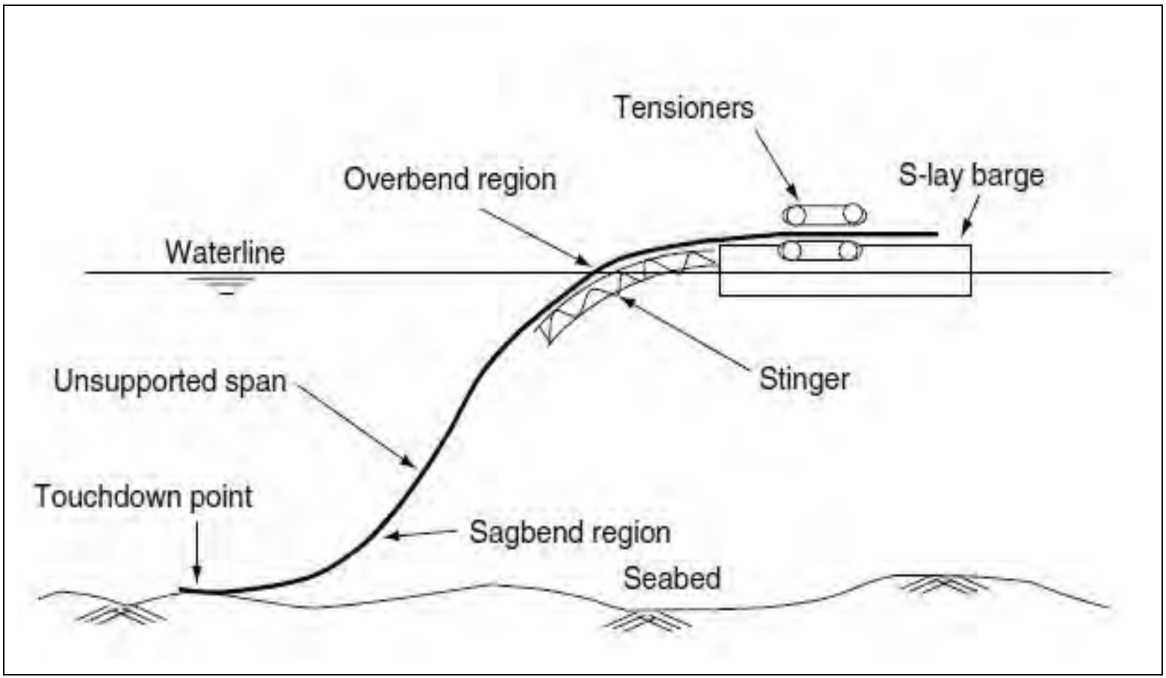


Figure 3.20. General S-lay configuration

Photo 3.4. Subsea Champion S-lay pipeline installation vessel

Option 3b – Pipeline Tow

Summary

Under this option, the pipeline would be launched by pulling the pipeline over the dunes by a vessel, then pulling the pipeline back through the HDD exit point by the HDD drill rig located onshore, which is discussed in Option 2b and demonstrated in Figure 3.18. Divers would be required to support this operation. The tow out and insertion has an estimated duration of 3 to 7 days.

The pipeline fabrication location would be determined based on technical feasibility and environmental consideration. The project would look at fabricating the pipe string at the shore crossing location against fabricating the pipe string offsite at a more accessible location along the coastline.

To fabricate the pipeline on site, support structures and an access road will be required along the pipe route down to the beach, this would require a level of disturbance to the existing sand dune and vegetation. An off-bottom tow method would be used to pull the pipeline into place.

To fabricate the pipeline offsite, the pipeline would be required to be towed to position. Due to the nearby location of the Tasmania Natural Gas Pipeline and the Basslink electricity cable, the pipe tow would need to pass over these assets. Due to the risk of damage to these assets, a mid-depth tow or surface tow method would need to be used.

Methodology

For the onsite tow, an off-bottom tow method would likely be adopted. A calculated volume of buoyancy would be added to the pipeline to achieve neutral buoyancy, thereby reducing the tow load. The pipeline would be pulled out by the tow vessel, the pipeline would be pulled along the seabed until it reaches its final position along the pipeline route. Once in place the pipeline is flooded, and the buoyancy removed.

For the offsite option, given that an off-bottom tow method is required under this option, there are two options to ensure the pipeline is not in contact with the seabed when being towed and deployed:

- Surface tow – To undertake a surface tow, buoyancy modules will be installed at designed intervals so that the pipeline floats and the top of the pipe just breaks the surface. The pipeline is towed to location where it is laid into position by releasing the buoyancy and flooding the line. This arrangement is demonstrated in Figure 3.21.
- Mid-depth tow – The pipeline is not floated with this technique, however buoyancy and chains may be required at intervals along the pipeline so that the line submerges to a pre-determined depth. While the pipeline is being towed, the pipeline is suspended in a flat catenary between two vessels and proper tension to the pipeline is maintained. The pipeline is towed to location where it is carefully laid into position. This arrangement is demonstrated in Figure 3.22.

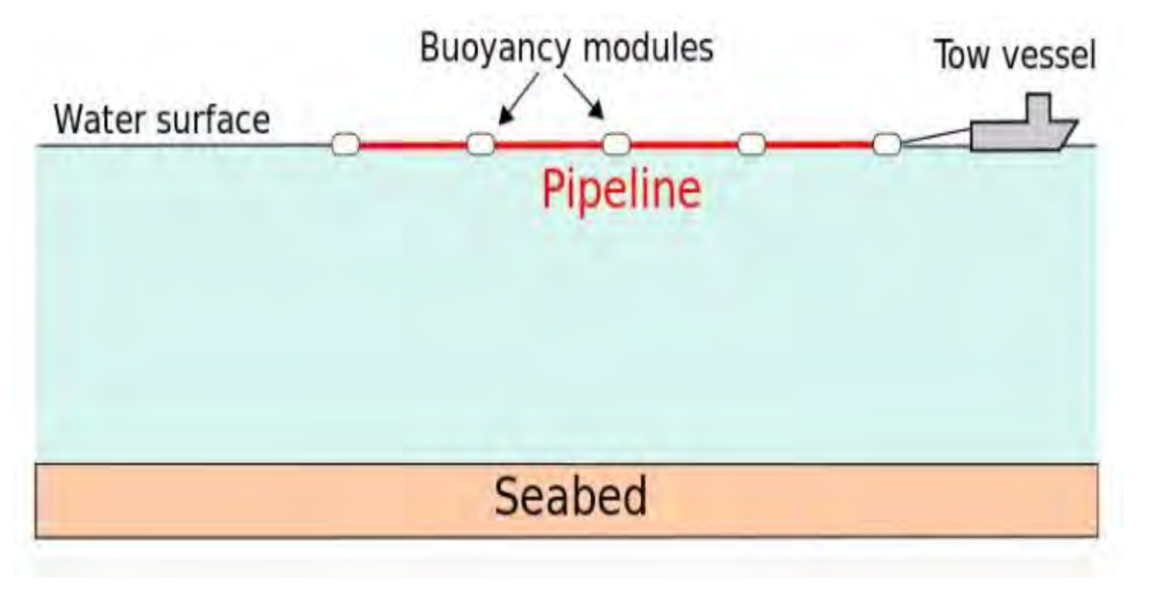


Figure 3.21. Surface tow

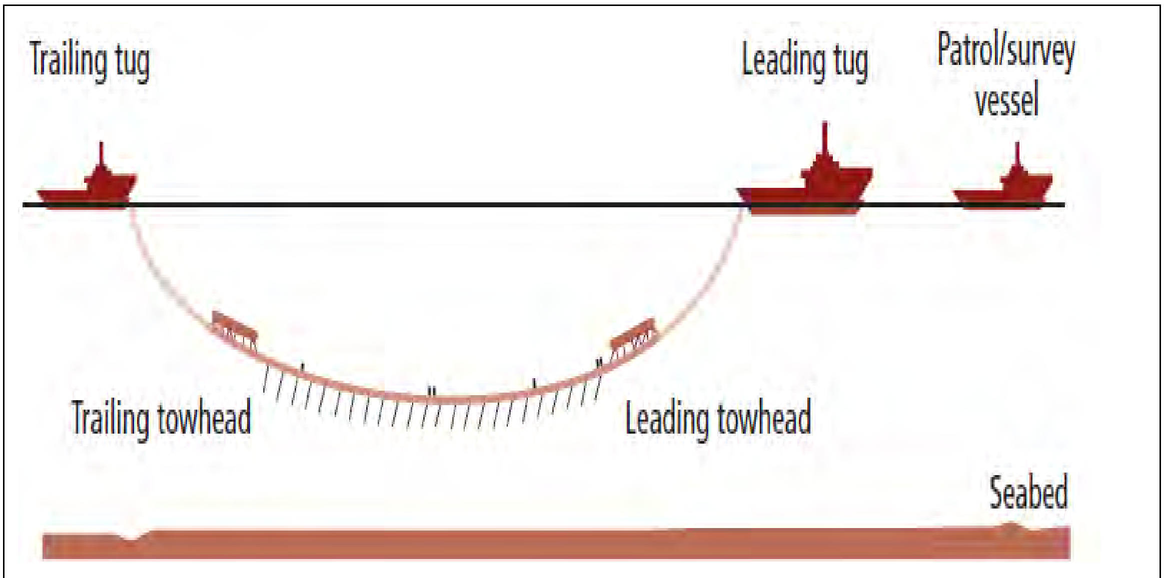


Figure 3.22. Mid-depth tow arrangement

3.6.3. RGP and Control System Pre-commissioning

Once the pipeline has been installed and subsea installation are complete, the structural integrity of the pipeline, PLEM and spools will be verified. The principle activities at this stage are:

- Mechanical completion – this involves flooding, cleaning, gauging, hydrotesting and final system leak testing;
- Pre-commissioning – this involves dewatering by displacing the water with an inert gas (typically nitrogen) leaving the infrastructure in a state ready for the start of commissioning or start-up; and
- Commissioning – this involves final system verifications and safety testing and preparations, for commencement of gas production.

ROV or divers would be required to assist with this stage of construction. The control system pre-commissioning comprises of a pressure test of the chemical and hydraulic tubes and connections, electrical test of the power and communication lines and function testing of instruments and valves. The work is performed from the shore crossing facility and supported by either divers or ROV who would monitor valve operations.

The estimated total duration of the subsea installation, excluding the shore crossing construction, is 20 days.

3.6.4. Subsea Installation Summary

A summary of the subsea installations is provided in Table 3.15.

Table 3.15. Summary of subsea installation

Feature	Description
Pipeline length	3.4 km from shore crossing facility onshore to PLEM
Pipeline diameter	24-inch single pipeline or dual 18-inch pipelines
Pipe grade and wall thickness	API 5L Grade X65. Wall thickness 17.4 mm to 25.4 mm
Umbilical diameter	6-7 inches
Pipeline installation technique	Refer to options in Section 3.5.8
Duration of subsea installation	Approximately 20 days (excluding the shore crossing)
Timing of pipeline construction	1st Quarter 2022 (preferred)
Pipelay vessel types	Pipelay Vessel Pipelay Barge Construction Support Vessel Anchor Handling Vessel Tugs
Umbilical installation method	Spooled alongside RGP from either the pipeline vessel or Construction Support Vessel
Workforce/crew number	Pipelay barge/vessel – 150 to 200 people Construction Support vessel – 110 people Anchor Handling Vessel – 60 people

3.7. Operations

3.7.1. Normal Operation

The operations phase covers the production of gas and the injection and storage of gas. The intent of this development is to ultimately sell 100% of the recoverable Gas Initially In Place (GIIP) in the reservoir. However, the GIIP will not be fully exhausted until the field no longer operates as a storage facility (estimated to be approximately 40 years into the future).

Initially, the Golden Beach gas field will be developed to facilitate the sale of gas (i.e., an initial percentage, but not all, of the total gas reserve in the reservoir will extracted and sold). This is referred to as the Blowdown Gas Volume (BGV), which is the volume of gas which can be extracted from the reservoir prior to the wells 'watering out' (when more water is extracted than gas). The gas that remains in the reservoir is the 'Cushion Gas', which facilitates the Project's transition from a production asset to a storage asset. The BGV will not be determined until the wells have been drilled and extensive pressure testing has been completed to determine the aquifer response during the first 90 to 120 days of production. It is expected that it will take 18 to 24 months to recover the BGV, which is estimated to be the equivalent of 40 to 45 PJ of sales gas.

The production from the field during the partial blowdown will be capped at 100 TJ/day and initially the plant will have the minimum compression and other equipment required to deliver this flow rate.

GB Energy has completed dynamic modelling to estimate the point at which the partial production of the field is complete. The field will then transition from production to storage at a conservative Bottom Hole Pressure (BHP) that is higher than the estimated lower limit of the storage operating pressure envelope. In order to operate efficiently as a storage facility, an amount of cushion gas will need to be retained in the reservoir to ensure water breakthrough does not occur and to ensure that the compression installed is able to meet the contractually agreed flowrates across the entire operating envelope of the reservoir at the committed reliability rate.

Following the partial blowdown of the reservoir, the Project will transition into a storage facility. As noted previously, in order to operate efficiently as a storage facility, an amount of cushion gas will need to be retained in the reservoir to ensure water breakthrough does not occur and to ensure that the compression installed is able to meet the contractually agreed flowrates across the entire operating envelope of the reservoir at the committed reliability rate. The amount of cushion gas will be determined during the initial 90-120 day production period.

For the end of life case, GB Energy will look to withdraw all of the remaining gas, including the cushion gas.

As this cushion gas is withdrawn from the reservoir, the aquifer will rise to a point at which it reaches the well and the well will draw the water into the tubing, at which point the well will water out. As there are two wells located in different locations and depths within the reservoir, it is very likely that the wells will not water out at the same time.

In order to retrieve all of the GIIP, the well which waters out first will be shut in and the second well will continue to flow until such time as it waters out.

3.7.2. Initial Production Requirements

The BGV to be produced prior to transitioning to gas storage will be calculated by testing the wells performance during the first 90 days of production and cross-referencing this actual flow data with the modelled flow data. This pipeline PLEM pressure has been selected based on the fact that GBE will not fully understand the performance of the reservoir until extensive performance testing has been completed. Once the reservoir performance is fully understood, the minimum pipeline PLEM pressure for storage (assumed to be 2,068 kPa (300 psig)) will be validated and tested.

The commercial offtake agreements in place for this phase of the development are set up for GB Energy to dictate the daily nominations to the gas purchaser, delivering gas at daily nomination flowrates of up to 100 TJ/day for the blowdown period.

It is expected that the reservoir will initially free flow gas without the requirement for compression. As the reservoir pressure decreases, the compressors will be required to deliver gas at the 100 TJ/day flowrate into the APA and Jemena pipeline network at pressures between 4,500 kPag (653 psig) and up to 6,895 kPag (1,000 psig). In order to recover the BGV, the blowdown flowrate will be curtailed to counteract the pressure loss in the reservoir.

Once the BGV has been recovered, the facility will transition into the gas storage mode.

3.7.3. Storage Withdrawal and Re-injection Requirements

In the second phase of the Project, the field will operate as a storage reservoir.

The compressors will be required to deliver gas at flowrates from 10 TJ/day up to 250 TJ/day into the APA and Jemena's pipeline networks.

During injection, the compressors will take gas at up to 125 TJ/day from the APA or Jemena Networks to deliver into the reservoir to overcome pressure drops in the system.

The commercial offtake agreements in place for the storage phase of the development are set up for the storage user to be able to inject and withdraw gas from the reservoir as follows:

- Inject gas at flowrates from 10 TJ/Day to 125 TJ/Day.
- Withdraw gas at flowrates from 10 TJ/Day to 250 TJ/Day.
- The Australian Energy Market Operator (AEMO) allows the storage user to change from injection to withdrawal or to input/change the nomination flowrate up to five times in one gas day. The gas day starts at 6 am AEST and the nominations can be revised at 10 am, 2 pm, 6 pm, and 10 pm.
- The storage operator will have a period of 2 hours to switch from withdrawal to injection or vice versa.
- The storage operator will have a period of 2 hours to alter the withdrawal or injection flowrate.

3.7.4. Injection

As the wells are expected to perform differently, the wellhead chokes are then to be manually adjusted by remote operation to meet the nomination requirements and fill the storage in a controlled manner. Adjustment of these wellhead chokes is not expected to occur on a daily basis, rather a weekly/monthly basis. Up to 1,500 litres per year of control fluid (MacDermid Oceanic HW443, non-CHARM 'D' rating) are predicted to be released to the ocean for both XMTs during valve closures.

3.7.5. Hydrogen Sulfide

Hydrogen sulfide (H_2S) content during FEED was set at <100 ppm. GB Energy does not expect any H_2S content, however wellhead, pipeline and facility materials will be suitable for service with H_2S concentrations of up to 100 ppm. The selection of materials suitable for H_2S concentrations is >5.7 mg/Sm^3 (4 ppm) as an insurance measure.

Should reservoir gas H_2S concentrations exceed this value, then suitable H_2S scavenger shall be injected at the wellhead location to reduce H_2S concentrations to below 5.7 mg/Sm^3. During the operations phase all well related activities will be conducted in accordance with the GB Energy H_2S Management Standard (GB-GN-EN-STD-010).

3.7.6. Shutdowns

The offshore shutdown system will initiate a shutdown level dependant on the severity the shutdown:

1. Emergency Shutdown (ESD); and
2. Process Shutdown (PSD).

A brief description of each level as they apply to the Golden Beach subsea development is provided here.

Emergency Shutdown

An ESD results in the complete isolation of the major sections of plant and pipeline hydrocarbon inventory. For an ESD, a timer is started (nominally 60 seconds) whereby an operator may assess the plant condition and if appropriate defeat the automatic blowdown of plant inventory to flare that would otherwise occur upon expiration of the timer.

Possible causes for this level of shutdown maybe (to be determined by quantitative risk analysis (QRA) and hazard and operability study [HAZOP]):

- A confirmed gas escape (detected by two or more line of sight gas detectors);
- A fire (detected by one or more field Ultraviolet [UV]/Infra-Red [IR] detectors);
- Selected high-priority process alarm conditions per safety integrity level (SIL) and HAZOP studies;
- Major problem with the safety instrumented system (SIS) equipment; and
- Operator initiated manual ESD button.

Furthermore, an ESD is initiated in the event of any of the following subsea conditions:

- 24V distributed control battery voltage Low-Low alarm at the SPCU;
- Loss of communications between the DCS and MCS for 12 hours;
- Loss of communications between the MCS and Subsea for 12 hours;
- Compressor station inlet pressure Hi-Hi;
- Loss of LP hydraulic supply pressure;
- Loss of HP hydraulic supply pressure; and
- Failure of production wing valve (PWV) and chemical injection (CI) valves to close during PSD.

The resulting executive actions are as follows:

- Vent down of LP hydraulic supplies;
- Close XMT production valves, production master valve (PMV) and PWV, and annulus monitor (AMON) (after 60 seconds);
- Close xmas tree annulus valves, annulus master valve (AMV), annulus wing valve (AWV) and cross over valve (XOV);
- Close xmas tree chemical injection valves; and
- Generate signal to combined safety system (CSS) when valve sequence is complete.

Process Shutdown

A process shutdown results in shutdown of the compressor station facilities only, with no likelihood of blowdown.

The philosophy for a PSD associated with the compressor station is for no action to be taken within the subsea system. The RGP will float on the wellhead flowing tubing head pressure and the well(s) remain online.

The subsea PSD is split into separate levels to reflect that certain XMT-specific initiators will shutdown only the affected XMTs.

The subsea PSD actions will be implemented by the subsea control system and as such will not constitute safety-critical functions.

A PSD for either XMT is initiated in the event of any of the following compressor station signals:

- Subsea PSD pushbutton at the compressor station control room;
- ESD occurs at the compressor station; and
- Hi-Hi alarm activation

These initiators will trigger a PSD at both XMTs.

A PSD is also initiated in the event of any of the following subsea signals:

- SCM HP header pressure Lo-Lo;
- SCM LP header pressure Lo-Lo; and
- Sand Detector Hi-Hi reading.

The resulting executive actions are as follows:

- Close XMT wing valves PWV and AWV;
- Close XMT chemical injection valves;
- Close XMT XOV valve;
- Close XMT AMON valve;
- Close XMT production choke valve after 60 seconds; and
- MCS to generate signal to CSS when valve sequence is complete.

Hydraulic supplies to subsea are not vented in event of a subsea PSD.

3.7.7. Hydrate Formation

Wet gas will form hydrates if the temperature and pressure conditions fall below the hydrate formation conditions, which among other things are a function of the gas composition. The heat and mass balance conditions do not fall within the hydrate formation range for the two gas compositions (withdrawal and blowdown phases), as all temperatures are above 20°C.

However, hydrates may form if the wells are shut in and then restarted. Two conditions were examined; restart with the pipeline at normal pressures and temperatures, and black start in winter, which assumes:

- The subsea wells are shut in for a period during winter;
- The system cools down to winter sea water temp, which is taken to be 10°C;
- The shut-in wellhead pressure is high; and
- The wells are started up again, and the large differential pressure across the choke cools the gas.

Hydrate formation may cause blockages at the choke valve. Methanol is the preferred hydrate inhibitor for this application, as opposed to glycol, which requires a comparatively higher injection rate.

Cold Start-up

Cold start-ups, in which temperatures downstream of the choke could fall below -20°C, will require continuous methanol injection upstream of the tree choke-valve. Once wellhead pressures fall sufficiently, methanol will no longer be required for start-ups.

Continuous methanol injection is necessary for about the first hour of a cold start-up (when the lowest temperatures exist) at a rate of 150 L/hr. Methanol injection can be ceased once temperatures downstream of the choke exceed -20°C. The methanol will be delivered via one ½" umbilical.

Equalisation/Blowdown

Blowdown or pressure equalisation may be required to assist in the breaking of hydrates which have formed in the subsea production system.

In the event a hydrate plug forming in any sub-sea production system (completely blocking flow) all production from the well will be stopped. The pressure differential across the plug can be reduced via the 1" blowdown / equalisation (AMON) line located within the umbilical. Methanol must be injected upstream of the choke valve at a maximum rate of 150 L/h to prevent hydrate formation in the blowdown line whilst depressurising via the XT the down the AMON line.

Following use of the AMON line it will need to be refilled with Methanol prior to production re-start to ensure it is ready for future operation. The AMON valves on the XMTs are interlocked with the XMT PMV to prevent operation of the blowdown line directly from the reservoir.

3.7.8. Testing and Monitoring Requirements

Surface Controlled Subsurface Safety Valve (SCSSV)

There is a statutory requirement for the SCSSV's of the Golden Beach installation to be function tested and leak-off tested every six months.

Master Valve and Wing Valve

There is a statutory requirement for the Master Valves and Wing Valves to be tightness tested every six months.

Annulus Pressure Monitoring

Annulus pressure monitoring (from the central control room) will be included in day to day operational activities. Annulus venting is required if the pressure in the annulus exceeds the maximum permissible limits, the cause of which can be overheating of the annulus fluids or a casing leak. The well must be shut-in to rectify the overpressure.

Sand Monitoring

Data from the erosion monitors will be assessed to determine the impact of sand break through on the subsea assets. Hi-Hi alarms will be determined during detailed design and set during construction. The Hi-Hi alarm setting shall be reviewed periodically.

On activation of a Hi-Hi alarm, well flow will be reduced or shut down well.

Corrosion Monitoring

Data from corrosion monitors located onshore and product sampling is to be analysed to determine the effectiveness of the corrosion inhibitor. The analysis results are to be used as input to the corrosion management plan.

3.7.9. Operational Integrity, Maintenance and Repair Strategy

Over the life of the Project, GB Energy will ensure asset integrity, availability and reliability at, as far as practicable, optimal life cycle cost. Given the current point of Project development, detailed and specific arrangements of the Integrity Monitoring, Maintenance and Repair (IMMR) schedule are not yet confirmed and as such are described here at a high level only. GB Energy's IMMR strategy for the Project is based on the following:

- Statutory requirements;
- Supplier's recommendations;
- Condition monitoring and inspection results;
- Criticality assessment; and
- Preventive inspection/maintenance requirements.

The IMMR required over the lifecycle of the Project is likely to involve divers, ROVs and inspection support vessels (ISVs) from which to launch these intervention methods.

All subsea operational interfaces are designed for diver and ROV intervention. Critical equipment shall be modularised for replacement using an ISV. Critical components are defined as those with high probability of failure and that can affect the integrity and/or availability of the system. A criticality analysis shall be conducted to ascertain sparing and redundancy requirements and these requirements will be included in the Sparing Philosophy. The design shall maximise component interchangeability.

Generally, a deferred maintenance approach is preferred in order to avoid mobilisation of vessels and equipment for one-off tasks, and also to maximise the use of vessels for multiple tasks once they have been mobilised. This necessitates a degree of operational flexibility or redundancy in the facilities design to maintain availability when components fail. Field proven intervention methods using divers or ROV and standard tools shall be used for IMMR activities during operations.

Vessels

ISVs and other vessels will be utilised for the transportation of personnel and equipment to offshore maintenance locations.

Preferred vessel suppliers are not selected at this stage, as they will be sourced from vessels available on the open market at the required time. They will be subject to a pre-contract selection process to ensure that the vessel/s selected will meet the environmental performance objectives, standards and measurement criteria defined in this report (and future operations Environment Plan), which will apply to the vessel/s while they are contracted to perform their duties.

Vessel selection will take into consideration the need for a Vessel Safety Case, the need is dependent on the activity to be performed from the vessel

Refuelling activities will be undertaken while in port and not at-sea. Crew changes will be undertaken while in port or in shelter waters under an approved procedure.

3.7.10. Subsea Equipment Inspections

The subsea inspections shall include inspections of the following equipment:

- XMT;
- Pipeline;
- Tie-in spools;

- PLEM;
- Secondary stabilisation;
- Flying leads (hydraulic and electric);
- Sand detectors;
- Umbilicals; and
- SUTA.

The inspection tools typically employed will include:

- ROV fitted with visual, CP and ultrasonic testing (UT) tools;
- SSS;
- Subsea Control System Diagnostics;
- Topsides HPU inspections; and
- Intelligent pigging.

No single one of these can provide all the required information, therefore an integrated inspection program that combines all necessary tools (and appropriate inspection frequency) is required.

For the single pipeline option, pigging will be run from offshore to onshore and there will be no offshore discharges associated with this activity. A pig launcher would be attached to the PLEM. A down line from the vessel will be used to launch the pig into the PLEM by injecting MEG and reservoir gas will then be used to propel the pig along the line.

For the dual pipeline option, pigging will be run from onshore to onshore. Pigs will be launched down one of the 18” lines through the pigging loop on the PLEM and return to shore down the second 18” line. There would be no offshore discharges associated with this activity.

Once sufficient operational information has been obtained after repeated prescriptive inspections, a Risk-Based Inspection (RBI) approach to inspecting the subsea system can be developed.

The inspections shall determine the condition of the subsea equipment and include corrosion and sand monitoring.

A final inspection program will be developed as part of the detailed design phase. The subsea equipment inspection activities that have been assumed at this stage include:

- Pipeline and Umbilical Inspection;
- PLEM and Subsea Tree Inspection;
- Flying Lead Inspection;
- Burial depth measurement;
- Cathodic protection survey (including inspection of coatings);
- Leak detection;
- Visual survey;
- NDT;
- Valve external condition observation; and

- ROV/Diver interface condition observation.

Note, some geophysical equipment (such as SSS) is likely to be utilised as a technique for inspection of the subsea infrastructure. Table 3.5 presents a potential list of equipment that may be utilised and its corresponding purpose and function.

3.7.11. Inspection Management System

A computer-based inspection management system will be used as the core method of managing IMMR data and activities.

Inspection intervals will be determined as part of the development of the final inspection plans, which are under development. Once sufficient operational and inspection data has been gathered in the inspection data and management system, the inspection plan can be adjusted using an RBI approach.

An RBI approach will allow the inspection effort and resources to be prioritised towards addressing the potential failure modes and damage mechanisms that present the greatest risk to the assets.

Baseline Inspections

After installation and commissioning, inspections are required to establish the baseline conditions. The first survey after installation (or at the commissioning phase) will include a full ROV inspection of the subsea system to provide a complete set of baseline data for future reference.

The baseline data will be loaded into the inspection and data management system.

Prescribed Inspections

Prescribed inspections include the baseline inspections to establish initial asset condition and, subsequently, inspections at set intervals as determined during detailed design, until sufficient information is available to adopt RBI. At this point the RBI model can be used to determine the routine inspection intervals. In addition to planned inspections, inspections may be required in exceptional circumstances where conditions have changed, or particular events have occurred.

Inspections of Opportunity

During the life of the Project, there may be several opportunities to inspect and gather information about the condition of the asset during other offshore works. For example, equipment may be in the field for the following tasks:

- MODU for workover activities (e.g., clean the well, increase production or injection rates);
- ISVs for additional tie-ins or expansions;
- Maintenance campaigns (i.e., retrievable module change outs); and
- Repair campaigns.

Event-triggered Inspections

In addition to planned inspections, inspections may be required in exceptional circumstances where conditions have changed, or particular events have occurred. The following events may trigger immediate inspection or may lead to a review of the inspection frequency and requirements for additional inspections:

- Severe weather;

- Seismic events;
- Third party interference (e.g., anchor drags, trawl boards, dropped objects, excavation impact);
- Changes in operating conditions (e.g., sand detected, additional wells brought online, changeover from pH stabilisation to film forming corrosion inhibitor);
- Accelerated corrosion rates indicated on monitoring systems;
- Future risk assessments (RBI) based on the evaluation of current operating conditions;
- Discovery of significant anomalies during an inspection, or during engineering assessments of inspection data;
- Hydraulic fluid leaks or seepage;
- Degradation or loss of electrical, communications or hydraulic function;
- Excessive hydraulic fluid consumption; and
- Suspected leaks, failures and/or performance degradation.

Subsea Control System Diagnostics

The subsea control system has in-built diagnostics that assist in detecting degradation of controls performance that can lead to failures. The diagnostics include:

- Electrical line insulation resistance monitoring;
- Communications request failures;
- Valve operation signatures and fluid usage; and
- Temperatures and pressures monitoring

In addition, the topsides HPU is regularly inspected and maintained for fluid cleanliness, fluid level, pump condition monitoring, and general security.

All information will be recorded and stored in the inspection management system.

Maintenance and diagnostics can be done via the onshore compressor station maintenance personnel, but in some cases due to its specialist nature, GB Energy may rely upon third-party services to provide this service.

3.7.12. Maintenance Strategy

Well Maintenance

The Golden Beach wells are designed for zero planned maintenance for the life of the field. However, GB Energy expects that some unplanned repairs will be required (see Section 3.7.13.

Subsea Equipment Maintenance

The subsea equipment is designed for zero planned maintenance for the design life. Typical unplanned subsea maintenance activities that may take place are as follows:

- Valve and choke override;
- Span rectification (e.g., grout bag and localised soil displacement);
- Sandbag/concrete mattress repositioning;
- Marine growth and scale removal;

- Pressure testing via hot stabs;
- Removal & parking of hydraulic & electrical jumpers;
- Pigging runs (cleaning, gauging,) from offshore to onshore; and
- Sacrificial anode replacement.

3.7.13. Repairs Strategy

Failures

The subsea wells and equipment are being designed and will be installed and operated to minimise potential repairs throughout the design life. If failure of a subsea component or system occurs, the failure will be classified as either:

- Critical; or
- Non-critical.

In the event of failure, a response plan will be developed. The plan will describe actions to be taken in accordance with safe operating practises and in compliance with statutory requirements.

The response plan will typically identify and define:

- Possible emergency scenarios;
- Responses in the form of actions;
- Roles and responsibilities;
- Communications;
- Offshore safe working practices and the permit system to be followed; and
- Interface between onshore and offshore personnel.

Critical Failures

Critical failures are those for which:

- The safety of personnel, the environment or the asset is compromised; and
- The failure substantially affects the ability to produce hydrocarbons (i.e., leak to sea, common mode control system failure, valve failed in open position).

A critical failure may require immediate intervention.

Components with a high probability of failure and that can affect the integrity and/or availability of the system should be designed to be replaceable if possible (i.e., SCM and choke insert).

A criticality analysis will be conducted to ascertain sparing and redundancy requirements. These requirements shall be stated in the Sparing Philosophy.

Spares for critical components will be held and the system will be designed with redundancy built in. Based on available spares (operational and commissioning spares and left over from installation), equipment lists will be developed for the operational phase.

Non-critical Failures

Non-critical failures are those that do not substantially affect safety or the production from the system (i.e., temperature gauge failure). The majority of interventions will be non-critical. Unscheduled (non-critical) maintenance can be programmed as ‘opportunity maintenance’ to be coincident with other planned campaign mobilisations in the region.

Repair will be carried out on an as-needed basis should equipment fail in service and may lead to change out of components.

Well Repairs

Subsea well intervention can be divided into external or internal repairs. External repairs are essentially XMT-related and involve SCM and choke insert recovery activities that can be performed with a light intervention vessel.

The internal repair (well repair/work over) can again be divided into:

- Full work over (the completion string and the XMT are recovered to surface for repair);
- Partial workover (the completion string is recovered to surface for repair); and
- Light intervention (operations that require access to the production bore without the need to disturb or recover the completion string).

For a full and partial workover, a MODU will be required, while a light intervention can be performed from both a MODU and a suitably equipped intervention support vessel.

Subsea Equipment Repairs

Repairs to subsea equipment can be carried out by modular replacement or in situ repairs. Where possible repairs will be performed in situ; if in situ repair is not possible the component will be retrieved to surface for replacement or repair. In cases where neither in situ repair or retrieval is possible, the equipment will be abandoned, and a new system installed. Subsea equipment and its associated repair methods are provided in Table 3.16.

Deferred Repairs

A deferred repair approach is preferred in order to avoid mobilisation of vessels and equipment for one-off tasks, and also to maximise the use of vessels for multiple tasks once they have been mobilised. This necessitates a degree of operational flexibility or redundancy in the facilities design to maintain availability when components fail.

Failure of chemical injection tree valves (CITVs) would generally require replacement; however, this may be deferred if injection at a single point is considered acceptable. Alternatives may also include utilising spare cores in the umbilical to allow injection of chemicals.

Table 3.16. Subsea equipment repair methods

Equipment	Repair Method
Pipeline	Leaks – Subsea repairs include clamps and weld repairs. Flange leaks – Gasket replacement, machine faces.
Tie-in spools	In situ repair using a clamp, recovery and repair or abandon and replace spool. Flange leaks – Gasket replacement, machine faces.
PLEM	Leaks – In situ repair using a clamp. Flange leaks – Gasket replacement, machine faces.

Equipment	Repair Method
Umbilical	Damage of limited extent (e.g. dropped object or anchor damage). Retrieval to surface and replacement of failed section by (e.g.) field splice. Extensive damage – comprising umbilical failure over wide areas. Replacement.
EFL, HFL	Recover to surface for repair or replace with new.
SCM, Choke insert	Recover failed unit to surface and replace with new unit.

3.8. Decommissioning

The production of sales gas from the Golden Beach reservoir is expected to last approximately 18-24 months. However, the storage capabilities of the development extends the lifespan of the Project to 40 years. Thus, decommissioning of the development assets is not likely to occur for several decades. However, in accordance with OPGGS Act (Section 621), and any other legislation relevant at the time, GB Energy will remove the subsea production equipment.

Decommissioning has two aims:

1. To return the land in a condition that is as near as practicable to pre-existing environmental conditions; and
2. To decommission the infrastructure in a manner that minimises potential impacts to the environment, land use and third parties.

The decommissioning strategy and design will be prepared in consultation with regulators prior to decommissioning and is in the preliminary stage of planning. Under the OPGGS Act, GB Energy will prepare a separate EP to cover the scope of decommissioning. At this stage, it is envisaged that decommissioning will involve:

- P&A of the wells;
- Removal of well protective structures;
- Flush and clean the subsea RGP, leave in situ flooded with sea water (subject to a risk-based assessment at the time); and
- Recovery of all other associated subsea equipment.

4. Legislation, Policy and Guidelines

4.1. Summary

Numerous legislative, policy and guidance documents were found to be relevant to this marine EIA and are discussed further in this report. The key legislation that apply to the marine EIA for the Project are summarised in Table 4.1.

Table 4.1. Key legislation

Legislation / policy	Relevance to this impact assessment
Victorian	
Offshore Petroleum and Greenhouse Gas Storage Act 2010 (& Regulations 2011)	Project is located within Victorian State waters. Victorian regulator (DJPR ERR) will assess the activity-specific EPs.
Flora and Fauna Guarantee Act 1988 (FFG Act) (& Regulations 2011)	Triggered in the unlikely event of the injury or death of an FFG Act-listed species (e.g., collision with a humpback whale) in State waters. Provides statutory protection to listed threatened species.
Heritage Act 1995 (Historical Shipwrecks) (& Regulations 2007)	May be triggered in the unlikely event of impacts to a known or previously un-located shipwreck in Victorian waters.
Environment Protection Act 1970 (& various regulations)	Triggered in the unlikely event of a Marine Diesel Oil (MDO) spill and where vessels need to discharge domestic ballast water into State waters.
Pollution of Waters by Oil and Noxious Substances Act 1986 (POWBONS Act) (& Regulations 2002)	Triggered in the unlikely event of an MDO spill in State waters that requires vessel response. Governs routine marine discharges in State waters.
Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (& Regulations 2000)	This EIA includes a description and assessment of the MNES that may be impacted by the Project (principally items 4 and 5 in the MNES list).
Australian Maritime Safety Authority Act 1990 (AMSA Act)	In the event of a Level 2 or 3 hydrocarbon spill to sea during the drilling, pipeline installation or operations phase in Commonwealth waters, AMSA may take over from GB Energy as the Combat Agency and implement the NatPlan.
Biosecurity Act 2015 (& Regulations 2016)	Relevant Project vessels sourced from foreign ports will adhere to the DAWE guidelines regarding quarantine clearance to enter Australian waters.

4.2. Legislation

4.2.1. Victorian Legislation

The Victorian legislation that applies to the marine EIA for the Project is summarised in Table 4.2.

In Victorian waters, the International Convention for the Prevention of Pollution from Ships (MARPOL) (being the key international convention relating to marine environmental matters) is given effect mainly through the *POWBONS Act* 1986. MARPOL aims to prevent and minimise pollution (routine discharges and accidents) from ships and includes six annexes. Table 4.3 lists the annexes of the Convention and identifies how they are given effect under Victorian legislation.

4.2.2. Commonwealth Legislation

The key Commonwealth legislation that applies to the marine EIA for the Project is summarised in Table 4.4.

Table 4.2. Summary of key Victorian legislation relevant to marine activities

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
Offshore Petroleum and Greenhouse Gas Storage Act 2010 (& Regulations 2011)	Addresses all licensing, health, safety and environmental issues for offshore GHG activities in Victorian coastal waters (between the low water mark and the 3 nm limit). This Act and its Regulations (Chapter 2 – Environment) are similar to the Commonwealth Act and Regulations of the same name, however have not been modified to align with most recent revisions of the Commonwealth Act and regulations and hence variations between jurisdictions exist. The preparation of an EP will satisfy this requirement of Chapter 2 of the OPGGS Regulations 2011. Section 61 of the Act (Principles of sustainable development) states that the administration of the Act should take into account the principles of sustainable development. These principles include involving the community in issues that affect them. To this extent, the stakeholder consultation undertaken for the Project (described in Chapter 24 of the EES) satisfies this requirement.	Project is located within Victorian State waters.	DJPR (ERR)
Environment Protection Act 1970 (& various regulations)	This is the key Victorian legislation that controls discharges and emissions (air, water) to the environment within Victoria (including state and territorial waters). It gives the Environment Protection Authority (EPA) powers to control marine discharges and to undertake prosecutions. Provides for the maintenance and, where necessary, restoration of appropriate environmental quality.	Triggered in the unlikely event of an MDO spill and where vessels need to discharge domestic ballast water into State waters.	Victorian EPA

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
	The State Environment Protection Policy (Waters of Victoria) designates: - Spill response responsibilities by Victorian Authorities to be undertaken in the event of spills (GB Energy) with EPA enforcement consistent with the *Environment Protection Act* 1970 and the *Pollution of Waters by Oil & Noxious Substances Act* 1986. - Requires vessels not to discharge to surface waters sewage, oil, garbage, sediment, litter or other wastes which pose an environmental risk to surface water beneficial uses. To protect Victorian State waters from marine pests introduced via domestic ballast water, ballast water management arrangements applying to all ships in State and territorial waters must be observed as per the Environment Protection (Ships' Ballast Water) Regulations 2006, Waste Management Policy (Ships' Ballast Water) and the Protocol for Environmental Management. High risk domestic ballast water (ballast water that originates from an Australian port or within the territorial sea of Australia (to 12 nm)), regardless of the source, must not be discharged into Victorian waters. Ship masters must undertake a ballast water risk assessment on a voyage by voyage basis to assess risk level, provide accurate and comprehensive information to the EPA on the status and risk of origin of ballast water contained on their ships (i.e., domestic/ international), and to manage domestic ballast water discharges with EPA written approval.		

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
Environment Protection Amendment Act 2018 *(To commence 1 July 2021)*	Provides the foundation for an overhaul of Victoria's environment protection laws and the EPA. The Act includes a new approach to environmental issues, focusing on preventing waste and pollution impacts rather than managing impacts after they've occurred. The purpose of the legislation is to enhance protection of Victoria's environment and human health through a proportionate, risk-based environment protection framework, including: • A preventative approach through a general environmental duty; • A tiered system of EPA permissions to support risk based and proportionate regulatory oversight; • Significant reforms to contaminated land and waste management; • Increased maximum penalties; • Requirements for more environmental information to be publicly available; and • Modernising and strengthening EPA's compliance and enforcement powers.	Triggered in the unlikely event of an MDO spill, and where vessels need to discharge domestic ballast water into State waters.	Victorian EPA
Emergency Management Act 2013 (& Regulations 2003)	Provides for the establishment of governance arrangements for emergency management in Victoria, including the Office of the Emergency Management Commissioner and an Inspector-General for Emergency Management. Provides for integrated and comprehensive prevention, response and recovery planning, involving preparedness, operational co-ordination and community participation, in relation to all hazards. These arrangements are outlined in the Emergency Management Manual Victoria.	Emergency response structure for managing emergency incidents within Victorian waters. Emergency management structure would be triggered in the event of a Level 2 or 3 MDO spill in Victorian waters.	Department of Justice and Regulation (Inspector General for Emergency Management)
Flora and Fauna Guarantee Act 1988 (FFG Act) (& Regulations 2011)	The purpose of this Act is to protect rare and threatened species and enable and promote the conservation of Victoria's native flora and fauna and to provide for a choice of procedures that can be used for the conservation, management or control of flora and fauna and the management of potentially threatening processes. Where a species has been listed as threatened, an Action statement is prepared setting out the actions that have been or need to be taken to conserve and manage the species and community.	Triggered in the unlikely event of the injury or death of an FFG Act-listed species (e.g., collision with a whale) in State waters.	DELWP

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
Heritage Act 1995 (& Heritage (Historical Shipwrecks) Regulations 2007)	The purpose of the Act is to provide for the protection and conservation of historic places, objects, shipwrecks and archaeological sites in state areas and waters (complementary legislation to Commonwealth legislation). Part 5 of the Act is focused on historic shipwrecks, which are defined as the remains of all ships that have been situated in Victorian waters for 75 years or more. The Act addresses, among other things, the registration of wrecks, establishment of protected zones, and the prohibition of certain activities in relation to historic shipwrecks.	May be triggered in the unlikely event of impacts to a known or previously un-located shipwreck in Victorian waters.	Heritage Victoria (DELWP)
Marine (Drug, Alcohol and Pollution Control) Act 1988 (& Regulations 2012)	This Act provides for the prohibition of masters and other persons involved in vessel operations from being under the influence of prescribed drugs or alcohol, defines prohibited discharges (refer to *Pollution of Waters by Oil and Noxious Substances Act* 1986), and allocates roles, responsibilities and liabilities to ensure that there is a capacity and obligation (i.e., Director – Transport Safety, public statutory body) to respond to marine incidents which have the potential to, or do, result in pollution. The Victorian Marine Pollution Contingency Plan (EMV, 2016) is prepared under this Act.	Applies to vessel masters, owners and crew operating vessels in Victorian State waters. Provides the Victorian Government response structure and contingency planning arrangements for marine pollution incidents in Victorian waters that must be implemented for vessel incidents.	Maritime Safety Victoria
Marine Safety Act 2010 (& Regulations 2012)	This Act provides for safe marine operations in Victoria of including imposing safety duties on owners, managers and designers of vessels, marine infrastructure and marine safety equipment; marine safety workers, masters and passengers on vessels; regulation and management of vessel use and navigation in State waters; and enforcement provisions of Police Officers and the Transport Safety Victoria staff. This Act reflects the requirements of international conventions - Convention on the International Regulations for Preventing Collisions at Sea & International Convention for the Safety of Life at Sea. The Act also defines marine incidents and the reporting of such incidents to the Victorian Director of Transport Safety.	Triggered in the unlikely event of an oil spill that extends into State waters that requires vessel response.	Maritime Safety Victoria

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
National Parks Act 1975	Established a number of different types of reserve areas onshore and offshore, including Marine National Parks and Marine Sanctuaries. A lease, licence or permit under the OPGGS Act 2010 that is either wholly or partly over land in a marine national park or marine sanctuary is subject to the *National Parks Act* 1975 and activities within these areas require Ministerial consent before activities are carried out (the GB Energy permit does not overlap any marine protected areas).	Triggered in the unlikely event of a diesel spill in a marine park in State waters.	Parks Victoria (DELWP)
Pollution of Waters by Oil and Noxious Substances Act 1986 (POWBONS Act) (& Regulations 2002)	The purpose of the POWBONS Act is to protect the sea and other waters from pollution by oil and noxious substances. This Act implements MARPOL Annex I in State waters. This Act restricts the discharge of treated oily bilge water according to vessel classification, discharge of cargo substances or mixtures, garbage disposal and packaged harmful substances, and sewage. The Act requires mandatory reporting of marine pollution incidents. See also Table 4.3 for further information.	Triggered in the unlikely event of an MDO spill in State waters that requires vessel response.	Jointly administered by DJPR and EPA
Seafood Safety Act 2003 (& Regulations 2014)	The purpose of this Act is to provide a regulatory system under which all sectors in the seafood supply chain are required to manage food safety risks.	Triggered in the unlikely event that a MDO spill results in impacts to commercial fisheries or the prevention of sale of seafood caught in waters affected by a spill.	Victorian Fisheries Authority (VFA)
Wildlife Act 1975 (& Regulations 2013)	The purpose of this Act is to promote the protection and conservation of wildlife, prevents wildlife from becoming extinct and prohibit and regulate persons authorised to engage in activities relating to wildlife (including incidents). The Wildlife (Marine Mammal) Regulations 2009 prescribe minimum distances to whales and seals/seal colonies, restrictions on feeding/touching and restriction of noise within a caution zone of a marine mammal (dolphins (150m), whales (300m) and seals (50m)).	Triggered if the unlikely event of injury or death of whales, dolphins or seals in Victorian waters (e.g., during response to an MDO spill).	DELWP

Table 4.3. Victorian legislation enacting the MARPOL Convention

Annex (entry into force in Australia)	Victorian waters (POWBONS 1986)	General requirements for operating in Victorian state waters
I Regulations for the Prevention of Pollution by Oil (1988)	Part 3, Division 2 – Prevention of pollution from ships Convention (ships carrying or using oil).	Addresses measures for preventing pollution by oil from regulated Australian vessels or foreign vessels, and specifies that: • An IOPP certificate is required; • A SMPEP is required; • An oil record book must be carried; • Oil discharge monitoring equipment must be in place; and • Incidents involving oil discharges are reported to AMSA.
II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (1988)	Part 3, Division 3 – Prevention of pollution from ships Convention (ships carrying noxious liquid substances in bulk).	Addresses measures for preventing pollution by 250 noxious liquid substances carried in bulk from regulated Australian vessels or foreign vessels, and specifies that: • An International Pollution Prevention (IPP) certificate is required; • A SMPEP is required; • A cargo record book must be carried; • Incidents involving noxious liquid substance discharges are reported to AMSA; • The discharge of residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with; and • No discharge of residues containing noxious substances is permitted within 12 nm of the nearest land.
III Prevention of Pollution by harmful Substances Carried by Sea in Packaged Form (1995)	Part 3, Division 4 – Ships carrying harmful substances.	Addresses measures for preventing pollution by packaged harmful substances (as defined in the International Marine Dangerous Goods (IMDG) code, which are dangerous goods with properties adverse to the marine environment, in that they are hazardous to marine life, impair the taste of seafood and/or accumulate pollutants in aquatic organisms) from regulated Australian vessels or foreign vessels, and specifies that: • The packing, marking, labelling and stowage of packaged harmful substances complies with Regulations 2 to 5 of MARPOL Annex III; • A copy of the vessel manifest or stowage plan is provided to the port of loading prior to departure; • Substances are only washed overboard if the Vessel Master has considered the physical, chemical and biological properties of the substance; and • Incidents involving discharges of dangerous goods are reported to AMSA.

Annex (entry into force in Australia)	Victorian waters (POWBONS 1986)	General requirements for operating in Victorian state waters
IV Prevention of Pollution by Sewage from Ships (2004)	Part 3, Division 5 – Sewage pollution prevention certificates.	Addresses measures for preventing pollution by sewage from regulated Australian vessels or foreign vessels and specifies that: • An ISPP certificate is required; • The vessel is equipped with a sewage treatment plant (STP), sewage comminuting and disinfecting system and a holding tank approved by AMSA or a recognised organisation; • The discharge of sewage into the sea is prohibited, except when an approved STP is operating or when discharging comminuted and disinfected sewage using an approved system at a distance of more than 3 nm from the nearest land; and • Sewage that is not comminuted or disinfected has to be discharged at a distance of more than 12 nm from the nearest land.
V Prevention of Pollution by Garbage from Ships (1990)	Part 2, Division 2A – Prevention of pollution by garbage.	Addresses measures for preventing pollution by garbage from regulated Australian vessels or foreign vessels, and specifies that: • Prescribed substances (as defined in the International Maritime Organisation's [IMO] 2012 Guidelines for the Implementation of MARPOL Annex V) must not be discharged to the sea; • A Garbage Management Plan must be in place; • A Garbage Record Book must be maintained; • Food waste must be comminuted or ground to particle size <25 mm while en route and no closer than 3 nm from the nearest land (or no closer than 12 nm if waste is not comminuted or ground); and • It is prohibited to discharge wastes including plastics, cooking oil, packing materials, glass and metal.
VI Prevention of Air Pollution from Ships (2007)	Indirectly through the State Environment Protection Policy (Air Quality Management) under the *Environment Protection Act* 1970:	Addresses measures for preventing air pollution from regulated Australian vessels or foreign vessels, and specifies that: • An IAPP certificate is in place; • An EIAPP certificate is in place for each marine diesel engine installed; • An IEE certificate is in place; • Specifies that incineration of waste is permitted only through a MARPOL-compliant incinerator, with no incineration of Annex I, II and III cargo residues, polychlorinated biphenyls (PCBs), garbage containing traces of heavy metals, refined petroleum products and polyvinyl chlorides (PVCs); • Marine incidents are reported to AMSA; • Sets limits on sulphur content of fuel oil (0.5% m/m);

Annex (entry into force in Australia)	Victorian waters (POWBONS 1986)	General requirements for operating in Victorian state waters
	Clause 33 (Management of Greenhouse Gases). Clause 35 (Management of ODS). Clause 36 (Management of other Mobile Sources).	• A bunker delivery note must be provided to the vessel on completion of bunkering operations, with a fuel oil sample retained; and • Emissions of ozone-depleting substances (ODS) must not take place and an ODS logbook must be maintained.

Table 4.4. Summary of key Commonwealth legislation relevant to marine activities

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (& Regulations 2000)	Protects MNES, provides for Commonwealth environmental assessment and approval processes and provides an integrated system for biodiversity conservation and management of protected areas. The nine MNES are: 1. World heritage properties; 2. National heritage places; 3. Wetlands of international importance (Ramsar wetlands); 4. Nationally threatened species and ecological communities; 5. Migratory species; 6. Commonwealth marine environment; 7. The Great Barrier Reef Marine Park; 8. Nuclear actions (including uranium mining); and 9. A water resource, in relation to coal seam gas development and large coal mining development.	This EIA includes a description and assessment of the MNES that may be impacted by the activity (principally items 4 and 5 in this list)	DAWE
Environment Protection (Sea Dumping) Act 1981 (& Regulations 1983)	Aims to prevent the deliberate disposal of wastes (loading, dumping, and incineration) at sea from vessels, aircraft, and platforms.	There will be no dumping at sea within the meaning of the legislation that would require a sea dumping permit to be obtained.	DAWE
Australian Maritime Safety Authority Act 1990 (AMSA Act)	Facilitates international cooperation and mutual assistance in preparing and responding to major oil spill incidents and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are implemented through AMSA. AMSA is the lead agency for responding to oil spills in the Commonwealth marine environment and is responsible for implementing the Australian National Plan for Maritime Environmental Emergencies (NatPlan).	In the event of a Level 2 or 3 hydrocarbon spill to sea during the drilling, pipeline installation or operations phase in Commonwealth waters, AMSA may take over from GB Energy as the Combat Agency and implement the NatPlan.	AMSA

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
Underwater Cultural Heritage Act 2018	Protects the heritage values of shipwrecks, sunken aircraft and relics (older than 75 years) in Australian Territorial waters below the low water mark to the outer edge of the continental shelf (excluding the State's internal waterways. It is an offence to interfere with a shipwreck covered by this Act.	No historic shipwrecks, sunken aircraft or relics are mapped to occur in the Project area. In the event of the discovery of, and damage to previously unrecorded wrecks, this legislation may be triggered.	DAWE
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of ozone depleting substances.	The MODU and Project vessels will manage and maintain a register of ODS.	DAWE
Protection of the Sea (Shipping Levy) Act 1981	Provides that where, at any time during a quarter when a ship with tonnage length of no less than 24 m was in an Australia port, there was on board the ship a quantity of oil in bulk weighing more than 10 tonnes, a levy is imposed in respect of the ship for the quarter.	Relevant Project vessels will adhere to the shipping levy, as required.	AMSA
Protection of the Sea (Civil Liability for Bunker Oil Pollution Damage) Act 2008	Sets up a compensation scheme for those who suffer damage caused by spills of oil that is carried as fuel in ships' bunkers. There is an obligation on ships >1,000 gross tonnes to carry insurance certificates when leaving/entering Australian ports or leaving/entering an offshore facility within Australian coastal waters.	Relevant Project vessels will hold the necessary insurance certificates, as required.	AMSA
Protection of the Sea (Harmful Antifouling Systems) Act 2006	Creates an offence for a person to engage in negligent conduct that results in a harmful anti-fouling compound being applied to a ship. Also provides that Australian ships must hold 'anti-fouling certificates', provided they meet certain criteria.	Relevant Project vessels will hold valid anti-fouling certificates, as required.	AMSA

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
Biosecurity Act 2015 (& Regulations 2016)	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. Offshore petroleum installations outside of 12 nm are located outside of Australian territory for the purposes of the Act. While these installations are not subject to biosecurity control, aircraft and vessels (not subject to biosecurity control) that leave Australian territory and are exposed to the installations are subject to biosecurity control when returning to Australian territory. When a vessel or aircraft leaves Australian territory and interacts with an installation or petroleum industry vessel it becomes an 'exposed conveyance' and is subject to biosecurity control when it returns to Australian territory unless exceptions can be met. The person in charge of an exposed conveyance carries the responsibility for pre-arrival reporting under the Act and must arrive at a first point of entry. This Act includes mandatory controls in the use of seawater as ballast in ships and the declaration of sea vessels voyaging into and out of Commonwealth waters. The regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.	Relevant Project vessels sourced from foreign ports will adhere to the DAWE guidelines regarding quarantine clearance to enter Australian waters.	DAWE

Legislation/ Regulation	Scope	Relevance to the Project	Administering Authority
Fisheries Management Act 1991 (& Regulations 2009)	This Act aims to implement efficient and cost-effective fisheries management on behalf of the Commonwealth, ensure that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of Ecologically Sustainable Development (ESD), maximise the net economic returns to the Australian community from the management of Australian fisheries, ensure accountability to the fishing industry and to the Australian community in the Australian Fisheries Management Authority's (AFMA's) management of fisheries resources, and achieve government targets in relation to the recovery of the costs of AFMA.	Provides the regulatory and other mechanisms to support any necessary fisheries management decisions in the event of a hydrocarbon spill in Commonwealth waters.	AFMA

4.3. Policy

4.3.1. Commonwealth Policy

Relevant Commonwealth government policies that have been incorporated into or taken into consideration during the preparation of this marine EIA include:

- EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance (DoE, 2013); and
- EPBC Act Policy Statement 2.1 - Interactions between Offshore Seismic Operations and Whales (DEWHA, September 2008).

4.3.2. State Policy

Relevant State government policies that have been incorporated into or taken into consideration during the preparation of this marine EIA include:

- Marine and Coastal Policy (DELWP, 2020a); and
- Protecting Victoria's Environment – Biodiversity 2037 (DELWP, 2017).

4.4. Guidelines

4.4.1. Australian Guidelines

Relevant Commonwealth government guidelines that have been incorporated into or taken into consideration during the preparation of this marine EIA include:

- Code of Environmental Practice (APPEA, 2008);
- Australian Ballast Water Requirements (DAWR, 2017);
- National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (DAFF, 2009);
- National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE, 2017);
- Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017);
- Acoustic impact evaluation and management (NOPSEMA Information Paper, N-04750-IP1765, Rev 1, September 2018a); and
- Oil pollution risk management (NOPSEMA Guidance Note GN1488, Rev 2, February 2018b).

4.4.2. International Guidelines

A number of international codes of practice and guidelines are relevant to the EIA and environmental management of the Project. While none of the codes of practice or guidelines described below have legislative force in Australia (other than MARPOL, see Table 4.3), they are considered to represent best practice environmental management (BPEM).

Relevant international guidelines and agreements that have been incorporated into or taken into consideration during the preparation of this marine EIA include:

- Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020);
- Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (International Association of Drilling Contractors, 2015);

- Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015);
- Best Practice Guidelines (International Association of Oil and Gas Producers, 2013);
- Best Practice Guidelines (International Petroleum Industry Environmental Conservation Association);
- Republic of Korea Migratory Birds Agreement 2006 (ROKAMBA);
- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA);
- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 (JAMBA);
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979; and
- Convention on Wetlands of International Important especially as Waterfowl Habitat 1971.

5. Stakeholder and Community Engagement

GB Energy has undertaken extensive consultation with the Gippsland community since October 2018. The feedback received during this process, which has included multiple information sessions and community meetings in Golden Beach, has provided an understanding of the community's concerns with the development and allowed GB Energy to design mitigation measures to alleviate those concerns wherever possible.

Stakeholders who have been consulted with regard to the marine component of the Project are listed in Table 5.1.

Table 5.1. Stakeholders with interests in marine issues

Interest/role	Stakeholder
Regulatory approvals	DJPR (ERR)
	DELWP
	DAWE
	Maritime Safety Victoria
Commercial fishing	VFA
	SETFIA
	SIV
	Mitchelson Fisheries Pty Ltd
Recreational fishing	VR Fish
	Gippsland Angling Clubs Association
	Loch Sport Angling Club
	Local residents

Table 5.2 lists the concerns specifically regarding the marine aspects of the Project. Attachment III of the EES provides a detailed report on community engagement, and a consultation plan is available on GB Energy's website at https://gbenergy.com.au/ees.

Table 5.2. Stakeholder engagement related to marine matters

Issue	Outcome	Addressed in this report
Noise from offshore construction activities.	Stakeholders were provided with Noise and Vibration Fact sheets for comment. GBE advised stakeholders that there will be no vertical seismic profiling associated with the drilling program (thereby avoiding the generation of short-term seismic pulses). Flaring from well testing will take place over 1-2 days for each of the two wells and will be loud and clearly visible.	Drilling – Section 8.2 Pipe lay – Section 9.2 Operations – Section 10.4
Impacts on amenity	Stakeholders were provided with Facts Sheets for Noise and Visual Impacts for comment.	Drilling – Sections 8.2 Pipe lay – Sections 9.2 & 9.4 Operations – Section 10.2

Issue	Outcome	Addressed in this report
	The MODU and pipelay vessel will be visible from the shoreline (and possibly homes on Shoreline Drive) for the duration of the drilling and pipe lay campaigns. During operations, there will be no visual impacts offshore, with the exception of the presence of the occasional vessel undertaking IMMR activities.	
Light pollution from the MODU during the drilling campaign.	Stakeholders were provided with fact sheets for Visual Impacts for comment. The MODU lighting will be visible at night but will have a negligible impact.	Drilling – Section 8.6
Flaring during well testing.	Stakeholders will be receiving Project updates and information in accordance to the EES Consultation Plan. Project facts sheets and Newsletters will be shared every two months.	Drilling – Sections 8.2 & 8.6
Concerns regarding oil spill risk and oil spill emergency plans.	Stakeholders will be receiving Project updates and information in accordance to the EES Consultation Plan. Project facts sheets and Newsletters will be shared with stakeholders.	Drilling – Section 8.15 Pipe lay – Section 9.13 Operations – Section 10.14
Impact of offshore activities on the fishing competition held in the region every Easter long-weekend.	Stakeholders will be receiving Project updates and information in accordance to the EES Consultation Plan. Project facts sheets and Newsletters will be shared with stakeholders.	Drilling – Section 8.2 Pipe lay – Section 9.2

6. Description of the Existing Environment

In accordance with Section 4 of the EES Scoping Requirements, this chapter characterises the existing environment to underpin the marine impact assessments for the Project. The Scoping Requirements note that the EES must characterise the distribution and quality of the marine environment in the area that could be impacted by the Project or associated works.

The focus of this chapter is the environment of the Project area. However, the 'Environment that May Be Affected' (EMBA) by the Project is also described in this section, together with its values and sensitivities. Each hazard associated with the Project (e.g., seabed disturbance and atmospheric emissions) has its own unique spatial distribution and thus EMBA. The description of the existing marine environment in this chapter has been defined by the most significant hazard and its associated EMBA, which is that relating to an MDO spill. Given the different phases of the Project and different sized vessels, there are two hydrocarbon spill scenarios that have been modelled (refer to Section 8.15.1 for modelling methodology), which in turn define the extent of the EMBA for the Project and support the risk assessment.

The first scenario is the release of 155 m^3 of MDO during drilling or operations and the second scenario is the release of 500 m^3 of MDO during pipe laying. These volumes reflect the different sized vessels required for the different phases of the Project. Due to the differing modelled volumes of spilled MDO, the EMBA for the various Project phases differs and is presented in the figures throughout this Chapter.

For the drilling and operations phases, the EMBA is defined as:

> *The combination of 100 randomly selected spill simulations delineating the extent of moderate level hydrocarbon exposure to the sea surface (10 g/m^2), moderate contact to shorelines (>100 g/m^2 or) and the extent of high exposure to hydrocarbons entrained in the water column (100 ppb) as a result of the loss of 155 m^3 of MDO over 6 hours under annualised metocean conditions from a project vessel within the Project area.*

For the pipeline installation phase, the EMBA is defined as:

> *The combination of 100 randomly selected spill simulations delineating the extent of moderate level hydrocarbon exposure to the sea surface (10 g/m^2), moderate contact to shorelines (>100 g/m^2) and the extent of high exposure to hydrocarbons entrained in the water column (100 ppb) as a result of the loss of 500 m^3 of MDO over 6 hours under annualised metocean conditions from a pipelay vessel within the Project area.*

Figure 6.1a and Figure 6.1b illustrate the two EMBAs. It is important to note that the MDO spill EMBAs do not represent the extent of an individual spill trajectory. Combining the spill simulations to present a single EMBA is for risk assessment purposes so that the range of receptors that could be impacted by a spill are understood.

Where appropriate, descriptions of the regional environment are provided for context. The 'environment' is defined as:

- Ecosystems and their constituent parts, including people and communities;
- Natural and physical resources;
- The qualities and characteristics of locations, places and areas;
- The heritage value of places; and

- The social, economic and cultural features of the matters listed previously.

Multiple data sources including desktop research, databases, field studies and scientific literature were utilised in developing the description of the environment of the Project area and EMBA. The multitude of data sources provide information that is collectively sufficient to confidently characterise the existing environment and conduct the risk assessments presented in Chapters 8, 9 and 10. Due to the sufficiency of these key information sources in determining the conditions of the Project area, no additional field study was required to be conducted for the Project area or EMBA.

The key sources of information utilised in developing this section include:

Publicly-available databases;

- EPBC Act Protected Matters Search Tool (PMST) database (DAWE, 2020a) (http://environment.gov.au/webgis-framework/apps/pmst/pmst.jsf) (**Appendix 1**).
- Victorian Biodiversity Atlas (VBA) (DELWP, 2020b) (https://www.environment.vic.gov.au/biodiversity/victorian-biodiversity-atlas) (**Appendix 2**).
- The Atlas of Living Australia (ALA) (https://spatial.ala.org.au/#) (**Appendix 3**).
- Shorebirds 2020 database (https://birdata.birdlife.org.au/) (**Appendix 4**).
- eBird database (https://ebird.org/explore) (**Appendix 5**).
- National Conservation Values Atlas (https://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf) (DAWE, 2020c).
- Species Profile and Threats Database (SPRAT) (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl) (DAWE, 2020b).
- FFG Act Threatened Species List (https://www.environment.vic.gov.au /__data/assets/pdf_file/0024/115827/20191114-FFG-Threatened-List.pdf) (DELWP, 2019).
- DELWP Threatened Species Advisory List (https://www.environment.vic.gov.au /__data/assets/pdf_file/0014/50450/Advisory-List-of-Threatened-Vertebrate-Fauna_FINAL-2013.pdf) (DSE, 2013a).
- NSW BioNet Atlas (publicly available at: https://www.environment.nsw.gov.au/ atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx).

Publicly-available literature;

- South-east Marine Region Profile (http://environment.gov.au/marine /publications/south-east-marine-region-profile) (DoE, 2015a).
- South-east Bioregional Plan (http://environment.gov.au/system/ files/resources/7a110303-f9c7-44e4-b337-00cb2e4b9fbf/files/south-east-marine-region-profile.pdf) (CoA, 2015).
- Marine Natural Areas Values Study Vol 2: Marine Protected Areas of the Flinders and Twofold Shelf Bioregions (https://www.researchgate.net/publication/ 304222509_Marine_protected_areas_of_the_Flinders_and_Twofold_Shelf_bioregions) (Barton *et al*., 2012).
- Eastern Victorian Ocean Scallop Fishery 2017-18 Abundance Survey (https://vfa.vic.gov.au/__data/assets/pdf_file/0007/423736/Copy-of-DOC-18-385073-FINAL_Vic-Ocean-Scallop-2017-18-Survey-Final-Report-1.PDF) (Fishwell Consulting/VFA, 2018a).

- Victorian Oil Spill Response Atlas (OSRA) (DEDJTR, 2017) (obtained by request from the DJPR).
- CarbonNet Project reports (parts of this project took place in the Golden Beach Gas Project area):
    - Pelican 3D Marine Seismic Survey Offshore Habitat Assessments Executive Summary (https://www.earthresources.vic.gov.au/projects/carbonnet-project/marine-seismic-survey-habitat-impact-assessment-outcomes) (CarbonNet, 2020).
    - Gular-1 Offshore Appraisal Well EP Summary (https://info.nopsema.gov.au/environment_plans/473/show_public) (CarbonNet, 2019).
    - Geophysical and Geotechnical Investigations EP Summary (https://info.nopsema.gov.au/environment_plans/479/show_public) (CarbonNet, 2018).
    - Pelican 3D Marine Seismic Survey EP Summary (https://info.nopsema.gov.au/environment_plans/405/show_public) (CarbonNet, 2018).

Project-specific;

- Geophysical survey of the Project area conducted by Fugro Australia Marine Pty Ltd (Fugro) for GB Energy in early 2020.
- CSIRO Gippsland Marine Environmental Monitoring data (raw data not publicly available) (CSIRO, 2018), including water quality, sediment quality and biological data from inside and outside the Project area. This data was not collected for the Golden Beach Gas Project, but several sample sites occur within the Project area.

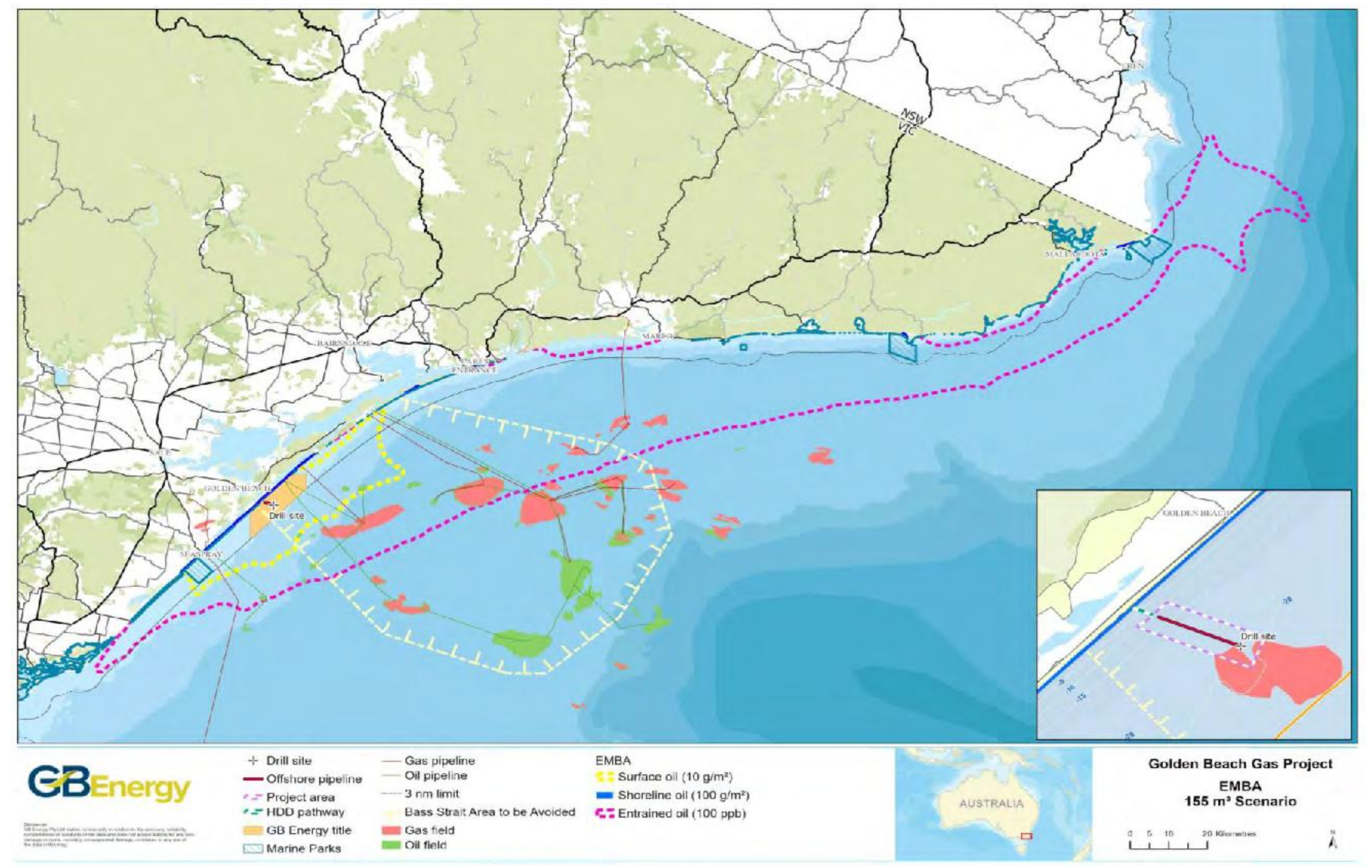


Figure 6.1a. The EMBA for the drilling and operations phases (155 m^3 MDO spill)

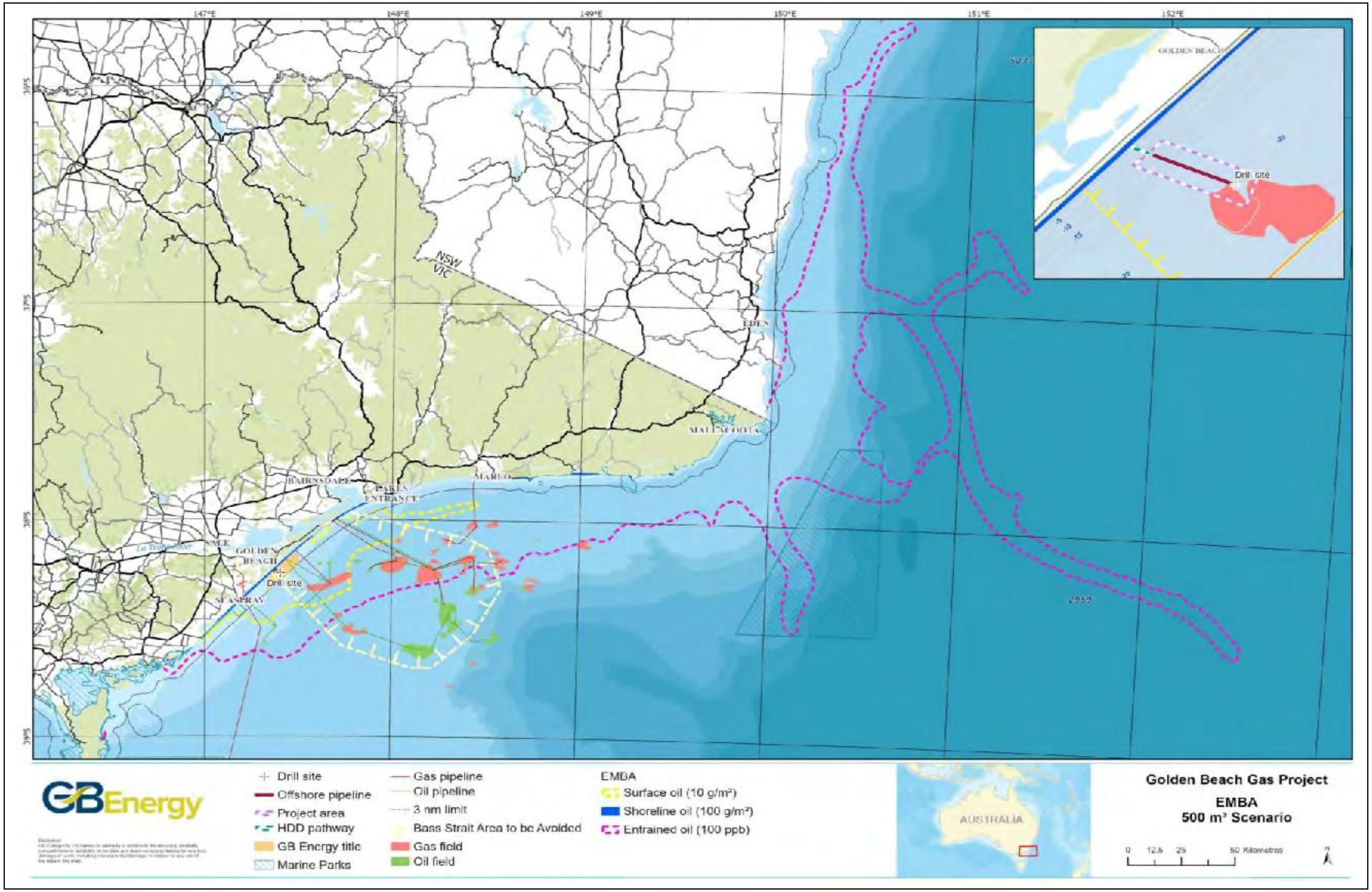


Figure 6.1b. The EMBA for the pipeline installation phase (500 m^3 MDO spill)

Table 6.1 summarises the likely presence or absence of receptors and sensitivities within the Project area and EMBAs based on the key information sources previously listed. Given the similarity between the two EMBAs, the receptors in both EMBAs are presented in Table 6.1 as a consolidated list.

Table 6.1. Presence of receptors within the Project area and EMBAs

Receptor	Project area	EMBAs
Physical		
Low profile rocky reef	No	Patchy
Sponge garden	Possible	Yes
Conservation Values		
Australian Marine Parks (AMPs)	No	Yes
World Heritage-listed properties	No	No
National Heritage-listed properties	No	No
Threatened Ecological Communities	No	Yes
Key Ecological Features	No	Yes
Nationally Important Wetlands	No	Yes
Victorian marine protected areas	No	Yes
Onshore protected areas	No	Yes
Biological Environment		
Plankton	Yes	Yes
Benthic species:	Yes	Yes
- commercial scallops	Likely to have isolated individuals	No beds that are commercially viable
- rock lobsters	No	Yes
Seagrass beds	Isolated & sparse	Yes
Fish:	Yes	Yes
- Biologically Important Area (BIA) for great white shark	Yes	Yes
Cetaceans:	Yes	Yes
- BIA for pygmy blue whale	Yes	Yes
- BIA for southern right whale	Yes	Yes
- BIA for humpback whale	No	Yes
Pinnipeds	Foraging only, no haul-out or breeding sites	Yes
Reptiles	Vagrants only	Vagrants only
Seabirds	Yes	Yes
Shorebirds	No	Yes

Receptor	Project area	EMBAs
Marine pests	Possible	Possible
Cultural Heritage Values		
Shipwrecks	No	Yes
Indigenous heritage	No	Yes
Socio-economic Environment		
Native Title	No	No
Tourism	Possible game fishing	Yes
Petroleum infrastructure	No	Yes
Commercial fishing	Shark gillnet/hook (Cth) Ocean access (Vic) Ocean purse seine (Vic)	Shark gillnet/hook (Cth) Trawl (Cth) Rock lobster (Vic) Ocean access (Vic) Ocean purse seine (Vic) Inshore trawl (Vic)
Recreational fishing	Possible game fishing	Yes
Commercial shipping	Yes	Yes

Green shading denotes presence.

6.1. Regional Context

The Project area is located within the Southeast Shelf Transition provincial bioregion within the South-east marine region (DoE, 2015a). This bioregion extends from east of Wilson's Promontory to north of Tathra (NSW) (Figure 6.2).

Victoria's marine environment has been classified into five bioregions, with the Project area located within the Twofold Shelf bioregion (Figure 6.2). These bioregions are defined based on their distinct and unique habitats and biological communities, structured by a combination of physical, chemical and biological processes (Barton *et al.*, 2012).

The coastline adjacent to the bioregions (as classified at the Commonwealth and state scales) is exposed, with long sandy beaches broken by rocky headlands and numerous coastal lagoons.

6.1.1. Climate

The region's climate is moist cool temperate (Barton *et al.*, 2012), with cool wet winters and cool summers. It is influenced by 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. 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.

Temperature and Rainfall

Average monthly air temperatures at Lakes Entrance (65 km northeast of the Project area, but the closest coastal town with a Bureau of Meteorology [BoM] weather station) range from 14.6ºC in July to 23.8ºC in February (1965 to 2006) (BoM, 2017). Mean annual rainfall is 713 mm with the rainfall fairly evenly distributed throughout the year, with a mean minimum of 41.5 mm in February and a maximum of 71 mm in November (BoM, 2017).

Winds

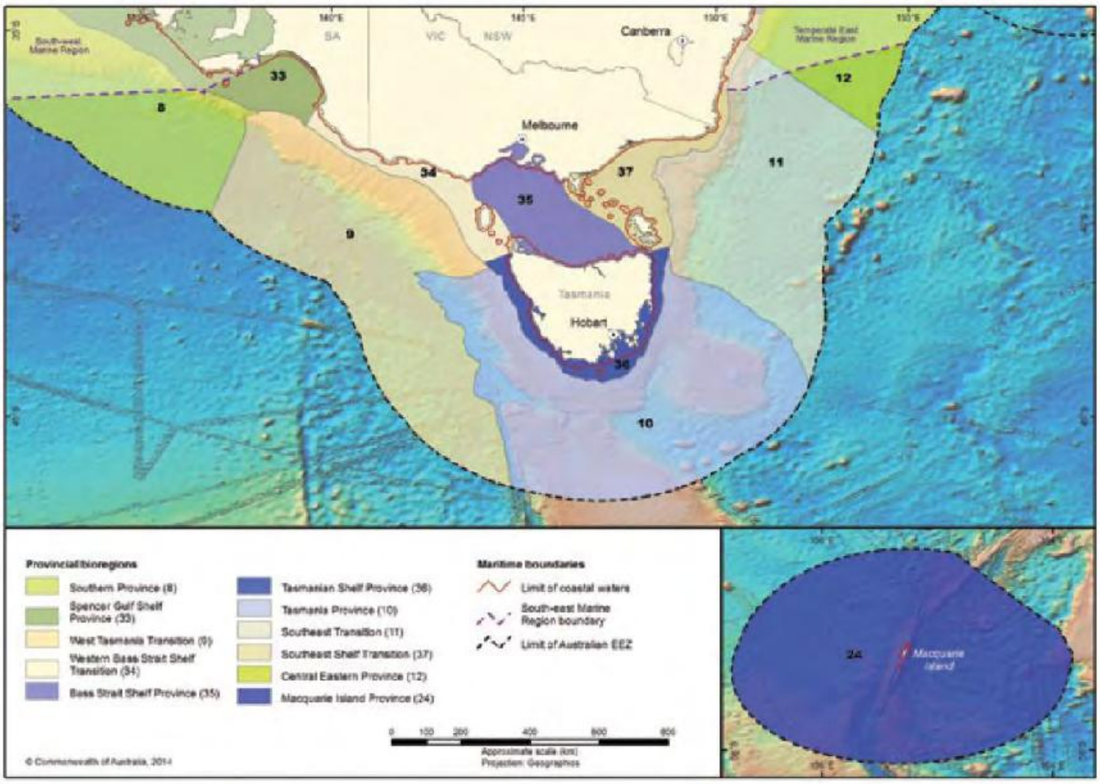
Bass Strait is located on the northern edge of the westerly wind belt known as the Roaring Forties. Occasionally, intense meso-scale low-pressure systems occur in the region, bringing very strong winds, heavy rain and high seas. These events are unpredictable in occurrence, intensity and behaviour, but are most common between September and February (McInnes and Hubbert 2003).

RPS (2020a) acquired high-resolution wind data from 2009 to 2018 (inclusive) for the Project area from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR). Table 6.2 lists the monthly average and maximum winds derived from the CFSR station located within the Project area, while Figure 6.3 illustrates the monthly wind rose distributions from 2009 to 2018 (inclusive).

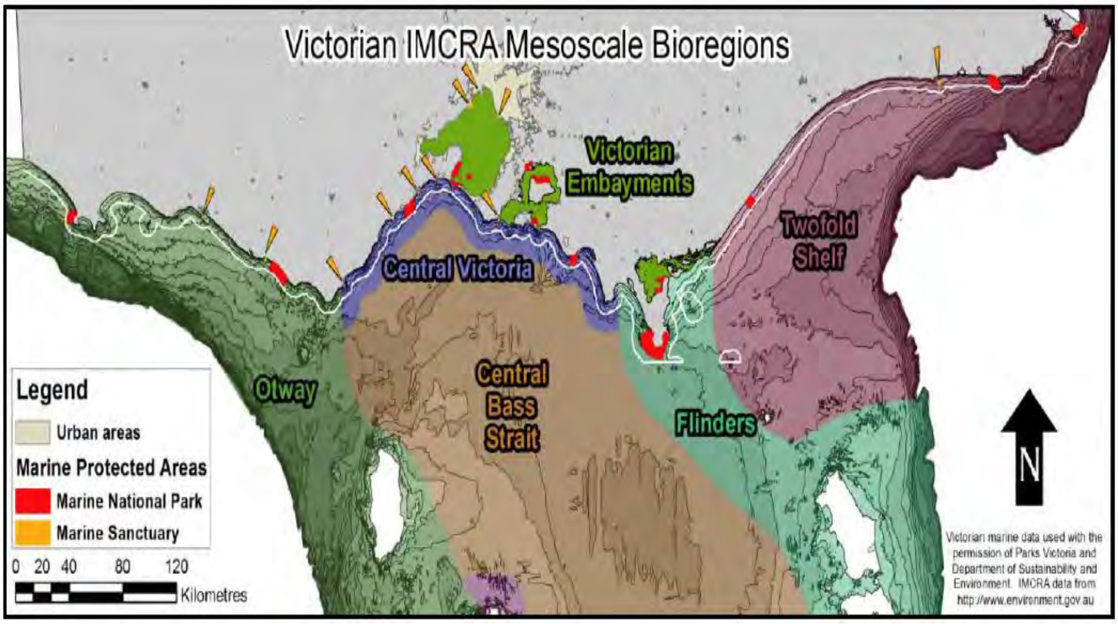
Table 6.2. Predicted average and maximum winds for the wind station within the operational area for 2009-2018 (inclusive)

Month	Average current speed (knots)	Maximum current speed (knots)	General direction
January	7	23	West-southwest - East
February	6	22	West-southwest - East
March	6	23	West-southwest - East-northeast
April	6	29	West
May	7	24	West
June	6	23	West - Northwest
July	7	22	West - Northwest
August	7	23	West - Northwest
September	7	25	West
October	7	18	West
November	6	22	West
December	7	20	West
Minimum	**6**	**18**	
Maximum	**7**	**29**	

Source: RPS (2020a).

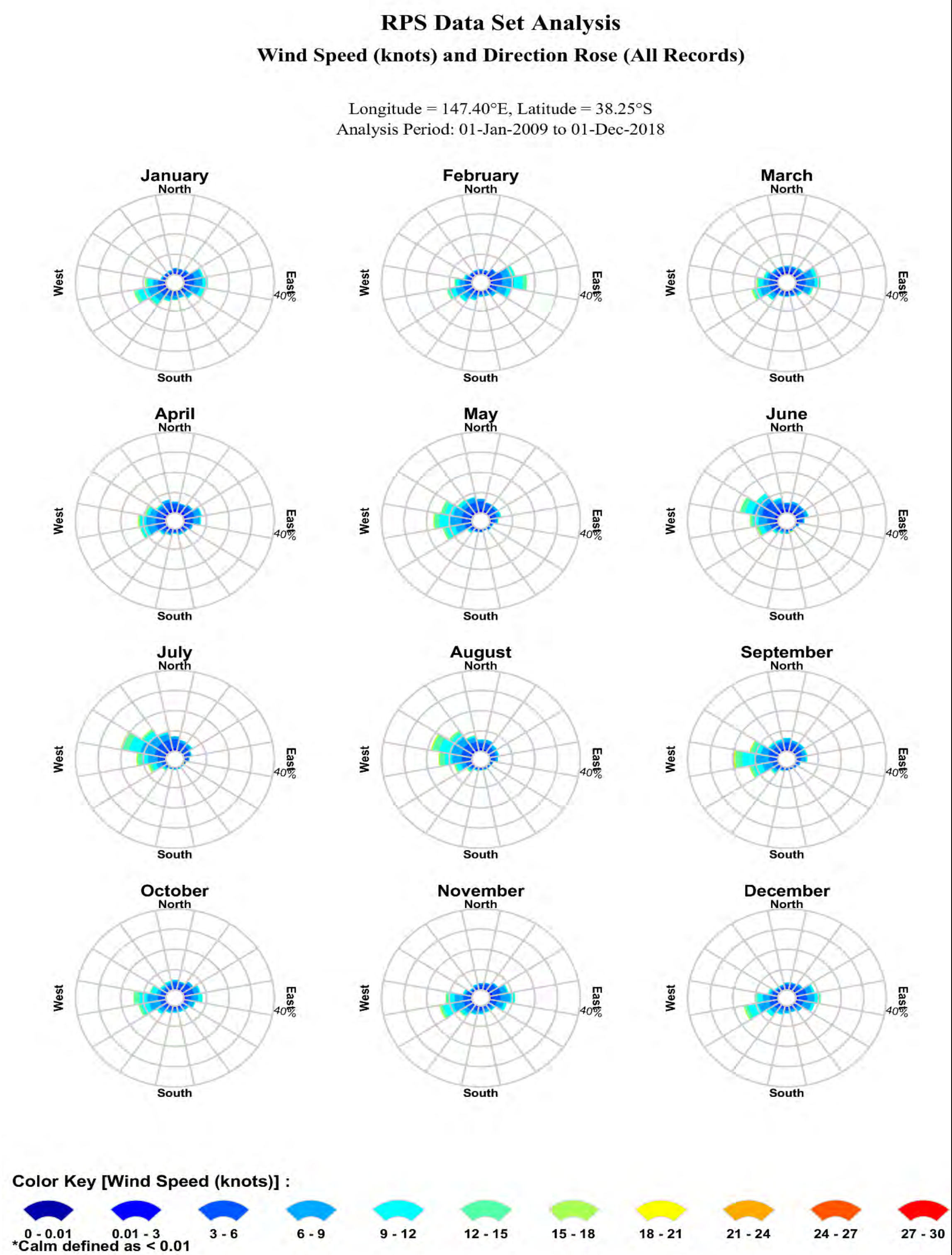


Source: DoE (2015a).



Source: Barton et al (2012).

Figure 6.2. The Southeast Shelf Transition provincial bioregion (top) and the Twofold Shelf Victorian marine bioregion (bottom)



The colour key shows the wind magnitude, the compass direction provides the direction FROM and the length of the wedge gives the percentage of the record for a particular speed and direction combination.

Source: RPS (2020a).

Figure 6.3. Modelled monthly wind rose distributions from 2009-2018 (inclusive) for the wind station adjacent to the Project area

6.1.2. Physical Environment

Seabed

Regional

Bass Strait is concave-shaped, with a shallower rim on the eastern and western entrances to the strait and a deeper centre.

The substrate across Bass Strait comprises a variety of sediment types related to tidal currents, with sediment grain size linked to wave energy, with sediments becoming progressively finer with increasing distance from the shore, consisting of fine, muddy sands in the mid-shelf regions (Harris and Heap, 2009; Wilson and Poore, 1987).

Inner shelf sediments, such as those of the Project area, generally consist of fine sands (Harris and Heap, 2009; DEDJTR, 2017), with moderate and well-sorted sands confined to the nearshore zone (Harris and Heap, 2009). Geoscience Australia's seafloor sediments database (known as MARS) classifies the Project area as having sediment grain sizes ranging in diameter from 0.2 to 0.5 mm, with isolated pockets within the EMBA having sediment diameters ups to 5 mm (Harris and Heap, 2009).

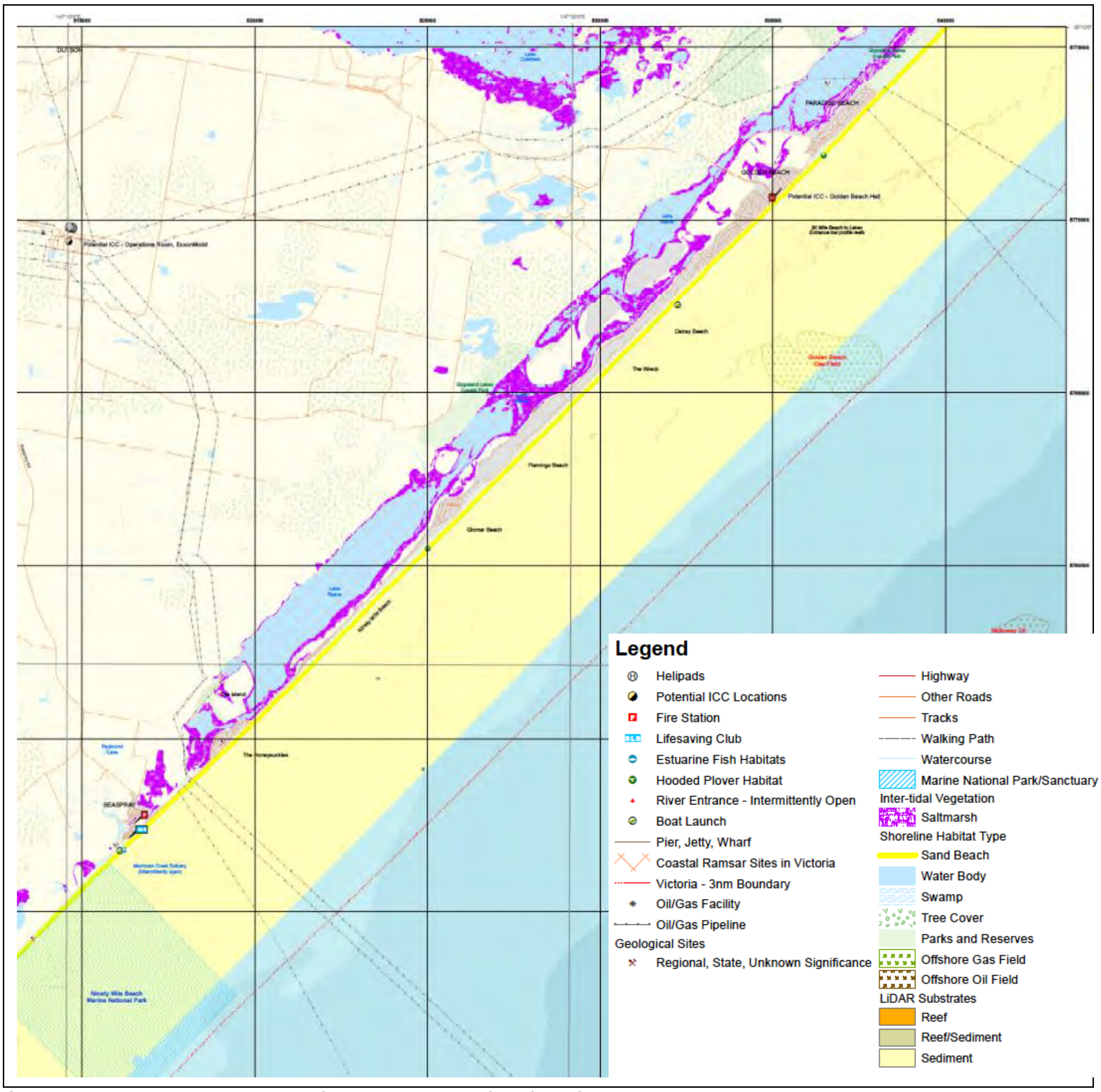
Subtidal soft sediment is recent Holocene sand (<10, 000 years ago) consisting of a mixture of fine and medium sand with some silt, gravelly sand and shell, and with a low carbonate content of 14-19% (Barton *et al*., 2012). Harris and Heap (2009) also state that that the calcium carbonate content of the sands in the Project area and the EMBA is about 10-20%. The carbonate component consists of recognisable skeletal fragments of molluscs, bryozoans and foraminifera (Harris and Heap, 2009).

Local

LiDAR (Light Detection and Ranging)-derived data on the sediments of the nearshore Victorian coastline was acquired in late 2008/early 2009 as part of the Victorian Government's Future Coasts Program. This data indicates that the majority of the seabed shoreward of the Project area comprises sandy sediments. A series of sand waves, running perpendicular to the coast, are present.

A seabed survey undertaken in 2007 for the nearby Sealion-1 drilling location (15 km to the east-northeast of the Project area) found fine to medium grained, yellow-brown unconsolidated sand with minor (<3 mm diameter sized) shell fragments (Fugro, 2007).

Intermittent and very narrow areas of low-profile reefs (about 0.5 m to 1.5 m in height above the surrounding seabed), running parallel to the coast, are scattered through the nearshore sandy sediments along the Ninety Mile Beach. These reefs comprise calcarenite and occur immediately behind the surf zone, in water depths ranging from 7 to 25 m (Barton *et al*., 2012), and are likely to be often covered by mobile sand (Figure 6.4a;b). Absence of these reefs from the Project area was confirmed with the geophysical survey undertaken in 2020.



Source: DEDJTR (2015). Note the Golden Beach gas field for reference.

Figure 6.4a. Seabed and shoreline types and sensitivities in and around the Project area from the OSRA dataset

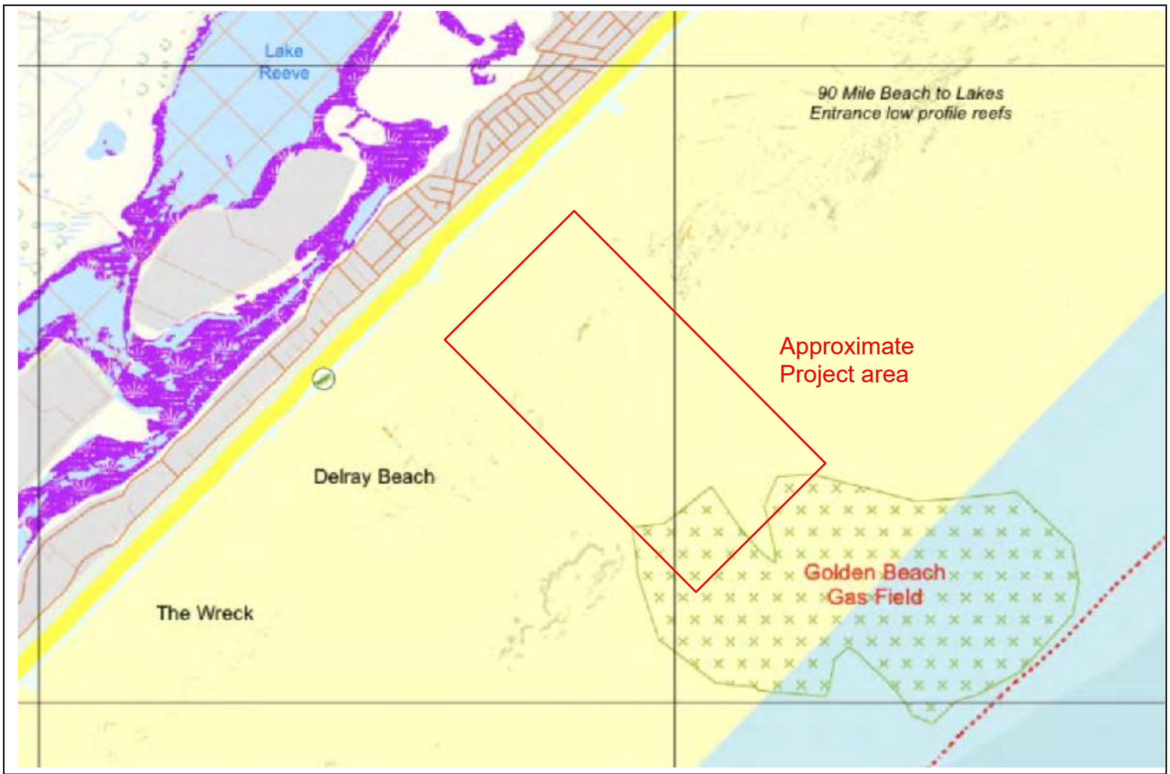


Figure 6.4b. Seabed and shoreline types and sensitivities in and around the Project area from the OSRA dataset, zoomed in to the Project area

Project Area

Fugro undertook a geophysical survey of the Project area in March 2020 for GB Energy. The survey provided an investigation and hazard assessment of the Project area, including characterisation of the seabed. Figure 6.5 presents the side scan sonar mosaic of the seabed of the Project area and Figure 6.6 presents the seabed composition. The gradient of the Project area is very flat, ranging from 0 m at the beach to 19.5 m at its deepest point at the well centre location over a distance of 3.2 km from the coast. The key observations from the survey were:

- There are elongated seabed depressions oriented northwest-southeast in the Project area;
- The proposed pipeline route passes through seabed depressions;
- The seabed at the proposed well locations is flat; and
- The seabed depression depths measured less than one metre from the surrounding seabed.

Eight grab samples from the Project area were recovered during the geophysical survey, with the location of the samples presented in Figure 6.5. As illustrated by Figure 6.4, the seabed around the Golden Beach gas field is largely homogenous, consisting primarily of sediments with some isolated patchy areas of reef. Given this homogeneity, this was determined to be an adequate number of samples required to validate the results of the side scan sonar utilised during the geophysical survey. The samples were visually inspected and logged with qualitative carbonate content checks performed in order to further characterise the seabed. The seabed samples collected indicate that the seabed of the Project area is predominantly two types of carbonate sand (Figure 6.6):

- Class 1: Low, uniform, reflectivity response interpreted as flat lying sediments including fine to medium grained carbonate sands with silts.

- Class 2: Moderate to high reflectivity response interpreted as fine to coarse carbonate sands, gravels and shells.

Table 6.3 presents a summary of the grab sample material descriptions. The grab samples that were collected assist in determining the seabed types distributed at the well site and along the pipeline corridor within the Project area. The grab samples are presented in Photo 6.1.

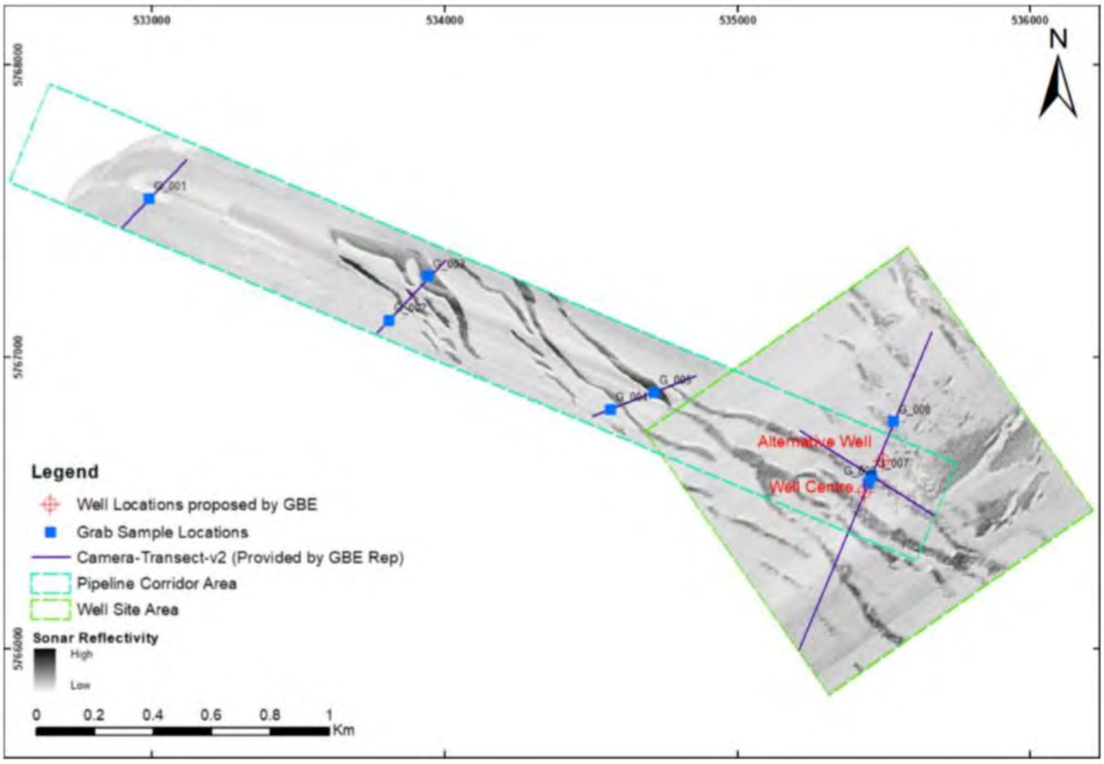


Figure 6.5. Side scan sonar mosaic of Project area seabed with grab sample locations

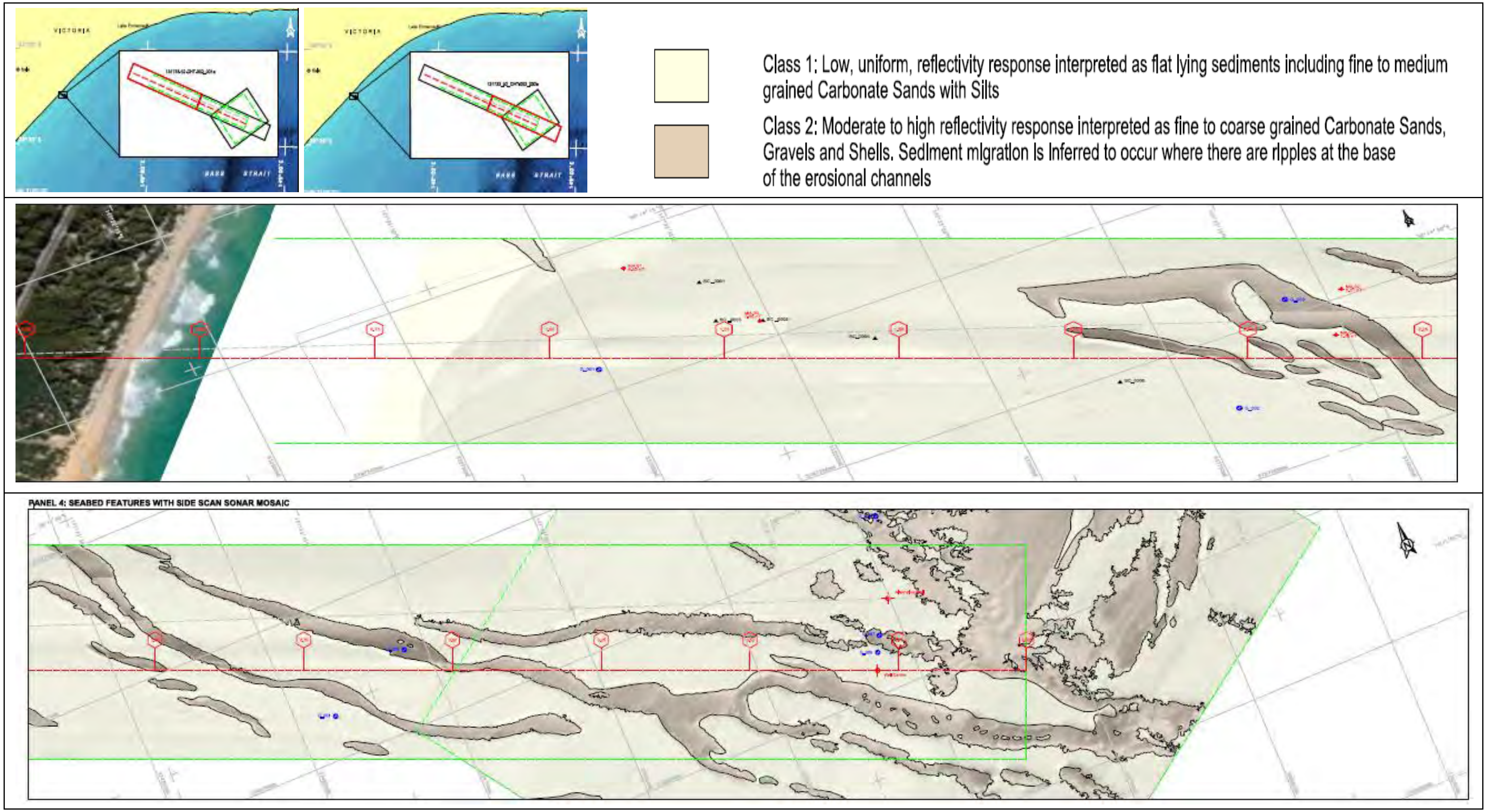


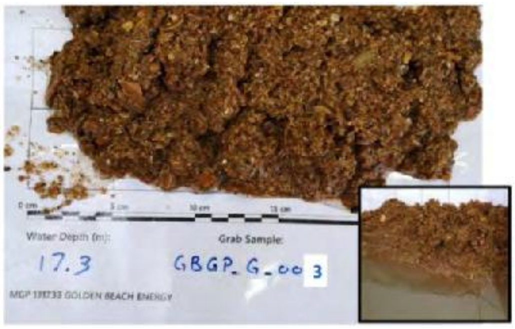
Figure 6.6 Distribution of seabed sediment types within the Project area

Table 6.3 Grab sample results of Project area

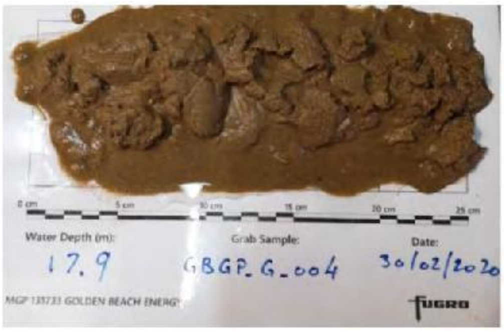
Sample ID	Location		Sample Description
	Easting (m)	Northing (m)	
Pipeline corridor			
G_001 9.6 m water depth	532,988.7	8,767,512.9	Siliceous CARBONATE SAND with silt. Sand is olive brown, fine grained and composed of mixed carbonates and siliclastics (mainly quartz), well sorted with few medium sand shell fragments and traces of coarse sand shell fragments. Some marine growth.
G_002 16.9 m water depth	533,808.4	5,767,126.3	Siliceous CARBONATE SAND with silt. Sand is olive brown, fine to medium grained and composed of mixed carbonates and siliclastics (mainly quartz), with few shell fragments and traces of coarse sand shell fragments
G_003 17.3 m water depth	533,942.1	5,767,277.3	Gravelly siliceous CARBONATE SAND. Sand is reddish to orange brown and coarse grained. Medium sand fraction composed of mainly quartz (clear and frosted) and some mixed carbonates. Coarse sand is partly shells and shell fragments With gravel composed of shells, shell fragments and traces of rock fragments
G_004 17.9 m water depth	534,565.1	5,766,820.7	Siliceous CARBONATE SAND with silt. Sand is olive brown, fine grained and composed of mixed carbonates and siliclastics (mainly quartz), well sorted with medium sand and few shell fragments and traces of coarse sand shell fragments
G_005 18.5 m water depth	534,714.6	5,766,879.2	Gravelly siliceous CARBONATE SAND. Sand is reddish to olive brown, coarse grained, and composed of mixed carbonates, particularly shells, shell fragments and probable coral fragments. Gravels of similar composition. Sample is composed for small part (10%) of fine sand
Well site			
G_006 18.6 m water depth	535,446.6	5,766,567.8	Siliceous CARBONATE SAND with silt. Sand is olive brown, fine grained and composed of mixed carbonates and siliclastics (mainly quartz), well sorted with medium sand and few shell fragments and traces of coarse sand shell fragments
G_007 18.8 m water depth	535,458.3	5,766,593.6	Gravelly siliceous CARBONATE SAND. Sand is reddish to olive brown, fine to coarse grained. Fine to medium sand fraction composed of mainly quartz (clear and frosted) and some mixed carbonates. Coarse sand is mainly shells (intact bivalves) and shell fragments with gravel shells, shell fragments (e.g. oyster shell) and traces of rock fragments
G_008 18.8 m water depth	535,532.0	5,766,779.5	Gravelly siliceous CARBONATE SAND. Sand is reddish to olive brown, fine to coarse grained. Fine to medium sand fraction composed of mainly quartz (clear and frosted) and some mixed carbonates. Coarse sand is mainly shell fragments with gravel.

G_001

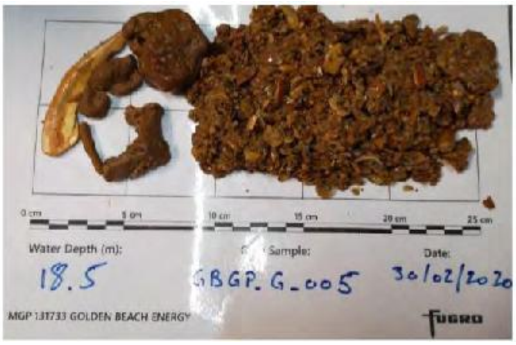
G_002



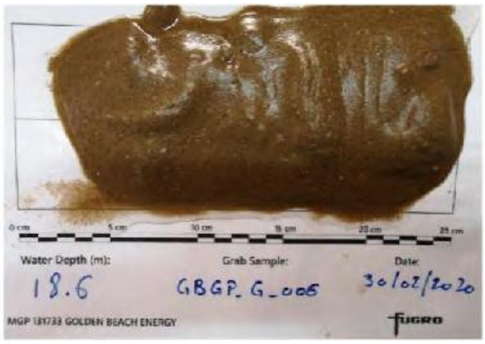
G_003



G_004



G_005



G_006

G_007

G_008

Photo 6.1. Seabed grab samples collected from the Project area

The CSIRO GipNet study (2018) includes a series of monitoring sites located in and around the Project area, as presented in Figure 6.7. These sites have been surveyed for physical properties (such as sediment grain size) and biological properties (including seabed habitat types and benthic fauna abundance).The CSIRO has shared this raw data (i.e., no consolidated study report has been made available) with GB Energy to inform the EES, with results included in this report for those sites within and immediately adjacent of the Project area.

Table 6.4 summarises the substrate types identified at the CSIRO investigation sites within the Project area (site 9, 10, 11) by towed camera footage. Photo 6.2 to Photo 6.4 present the seabed conditions at CSIRO investigation sites within the Project area. CSIRO also conducted seabed surveying using side scan sonar, which provides detailed bathymetry mapping of the seafloor in the Project area. From the bathymetry mapping presented in Figure 6.8, it is demonstrated that the seafloor of the Project area gradually increases in depth away from the coast. Areas of rocky reef outside the Project area (marked in yellow) are also visible as a rise of 0.5-1 m from the surrounding seafloor. CSIRO assessment site 17 was located within this reef (refer to Figure 6.7).

Table 6.4 Seabed conditions at CSIRO investigation sites within the Project area

CSIRO site	Distance from Project area	Seabed condition
9	Within Project area	Consists of sandy substrate sparsely interspersed with marine flora and macroalgae. No rocky reef was observed in the towed camera footage of these sites.
10		
11		

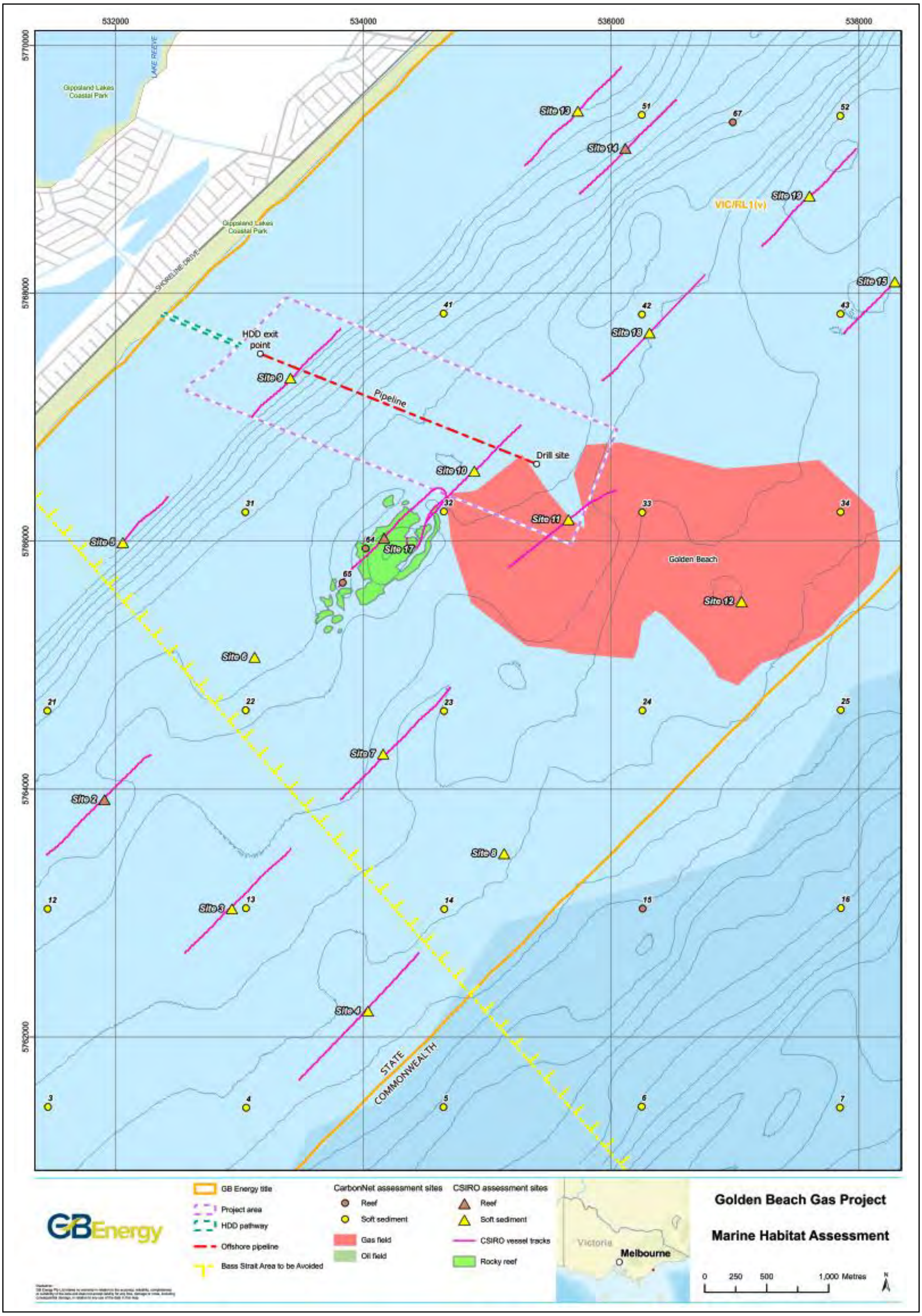


Figure 6.7. CSIRO GipNet and CarbonNet investigation sites in and around the Project area

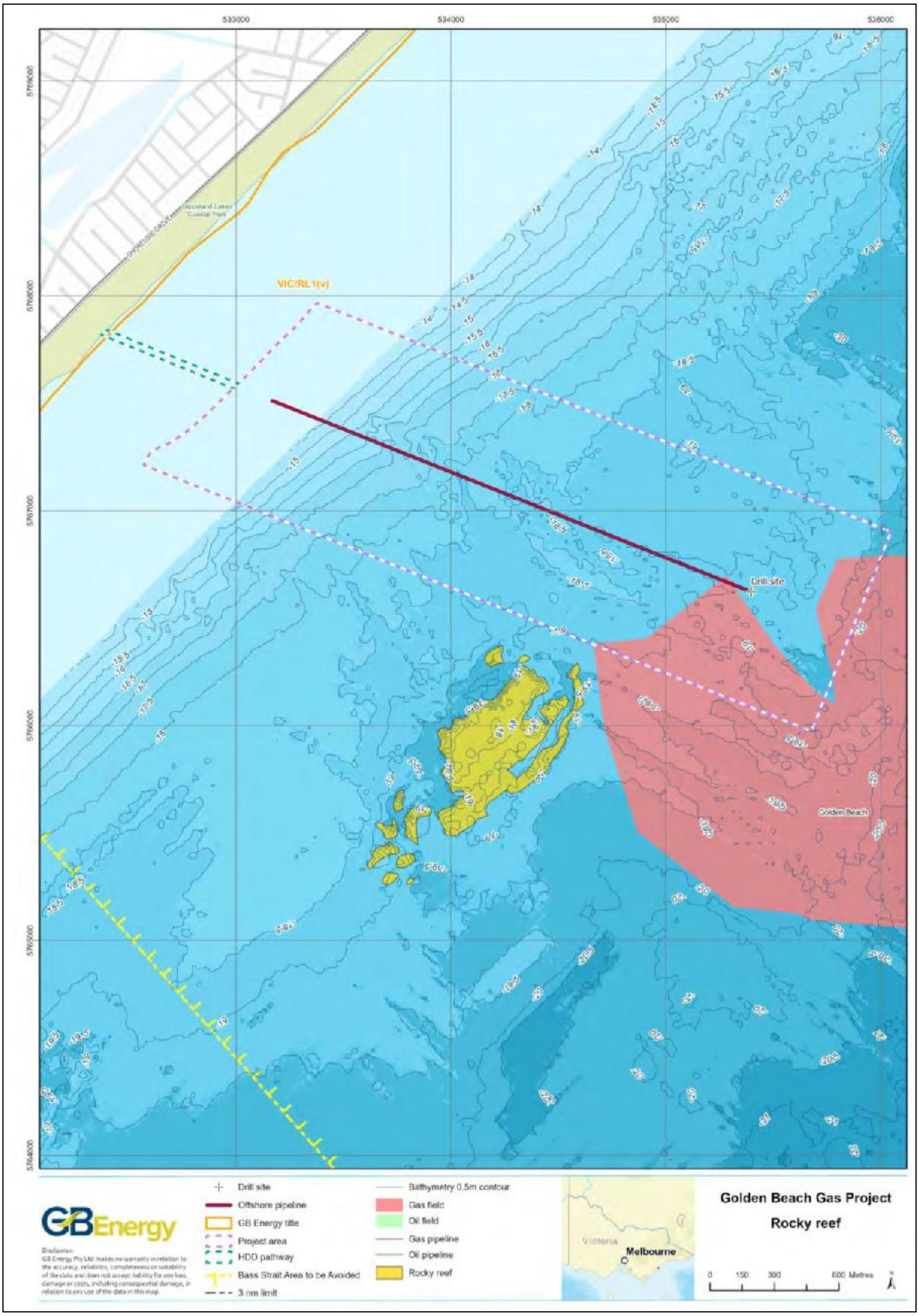


Figure 6.8. CSIRO seabed bathymetry of the Project area and known rocky reef site

Photo 6.2. Seabed conditions at CSIRO investigation site 9 (at 15 m water depth)

Photo 6.3. Seabed conditions at CSIRO investigation site 10 (at 19 m water depth)

Photo 6.4. Seabed conditions observed at CSIRO investigation site 11 (at 19 m water depth)

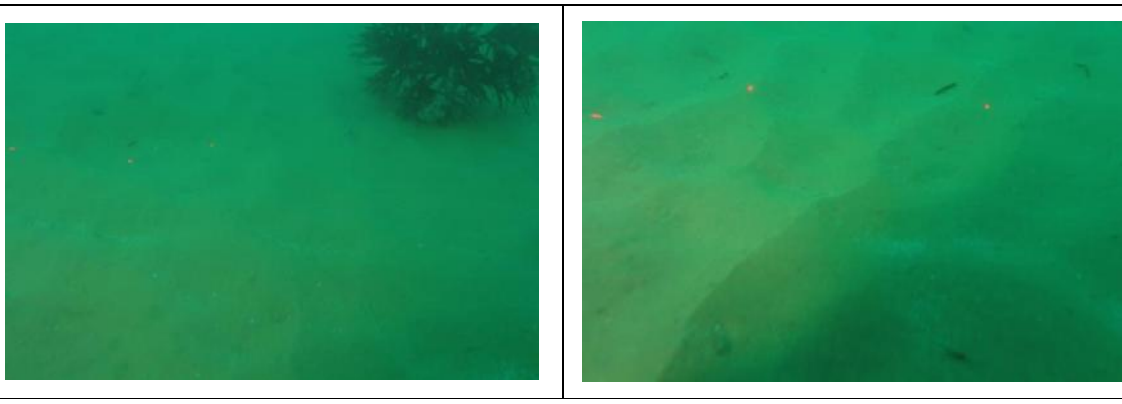
Photo 6.5 to Photo 6.13 present the seabed conditions at CSIRO investigation sites within 2.5 km of the Project area (sites 5, 6, 7, 12, 13, 14, 15, 17, 18 and 19) (CSIRO, 2018).

Table 6.5 summarises the seabed substrate types of these sites adjacent to the Project area, as identified through towed camera footage captured by CSIRO.

Table 6.5. Seabed conditions at CSIRO investigation sites adjacent the Project area

CSIRO site (water depth)	Distance from Project area	Seabed condition
5 (15 m)	1.3 km southwest	Dominated by rippled sandy sediments, no hard substrate or reefs observed.
6 (19 m)	1.8 km southwest	Dominated by rippled sandy sediments, no hard substrate or reefs observed.
7 (20 m)	2.1 km southwest	Dominated by rippled sandy sediments, no hard substrate or reefs observed.
12 (20.5 m)	450 m east	Dominated by rippled sandy substrate with some sporadic areas of seagrasses present. No hard substrate observed.
13 (15.5 m)	2.5 km northeast	Extensive areas of sandy sediments with only sporadic and interspersed areas of marine flora. Paucity of marine flora suggests lack of hard substrate present at the site.

CSIRO site (water depth)	Distance from Project area	Seabed condition
14 (17 m)	2.4 km northeast	Rocky substrate and reef communities observed, dominated by marine flora beds, minimal areas of exposed sandy sediments.
15 (20.5 m)	2.5 km northeast	Dominated by rippled sandy sediments, no hard substrate or reefs observed.
17 (18 m)	350 m south	Some areas of sandy substrate. Rocky substrate, reef communities and marine flora observed.
18 (19 m)	350 m north	Extensive areas of sandy sediments with only sporadic and interspersed areas of marine flora. Paucity of marine flora suggests lack of hard substrate present at the site.
19 (21 m)	2.5 km northeast	Dominated by rippled sandy sediments, no hard substrate or reefs observed.

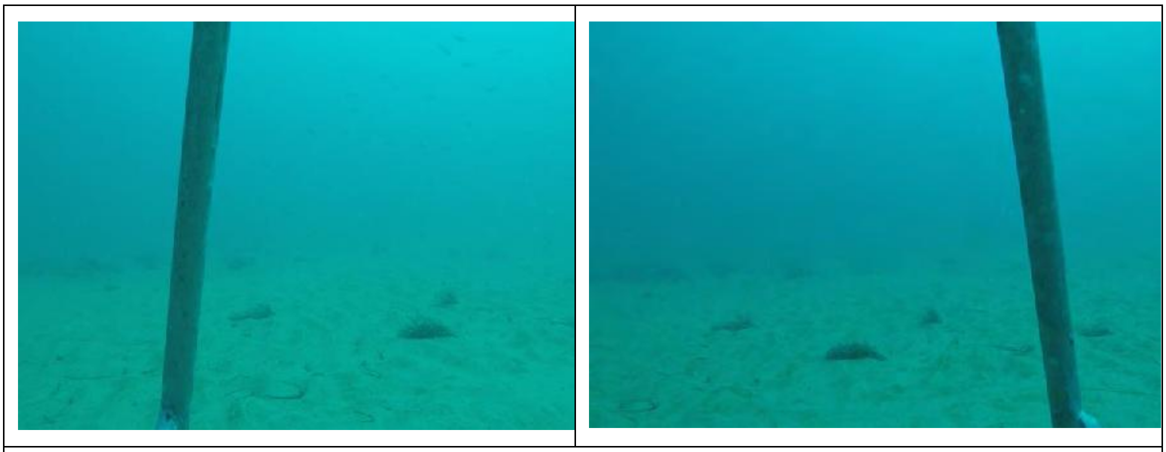


Dominated by rippled sandy sediments.

Photo 6.5. Seabed conditions at CSIRO site 5 (at 15 m water depth)

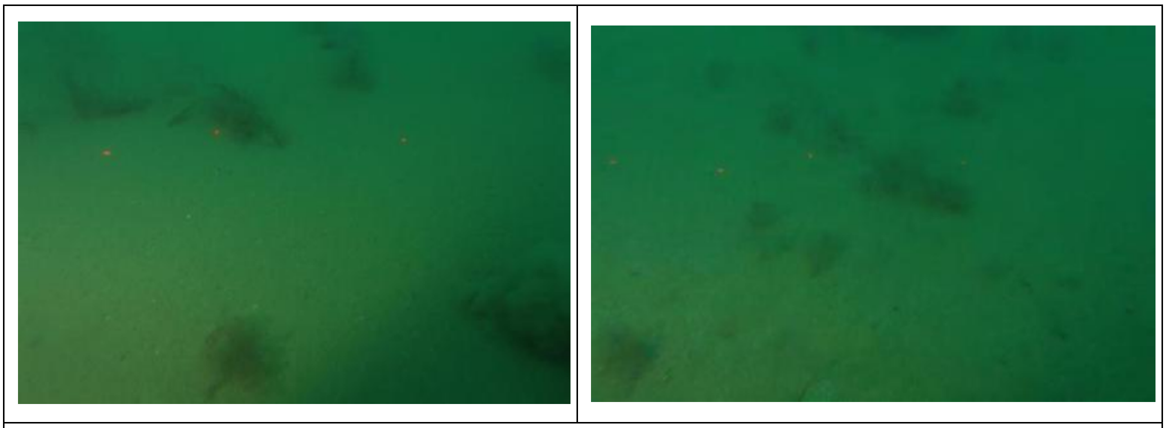
Dominated by rippled sandy sediments.

Photo 6.6. Seabed conditions at CSIRO site 6 (at 19 m water depth)



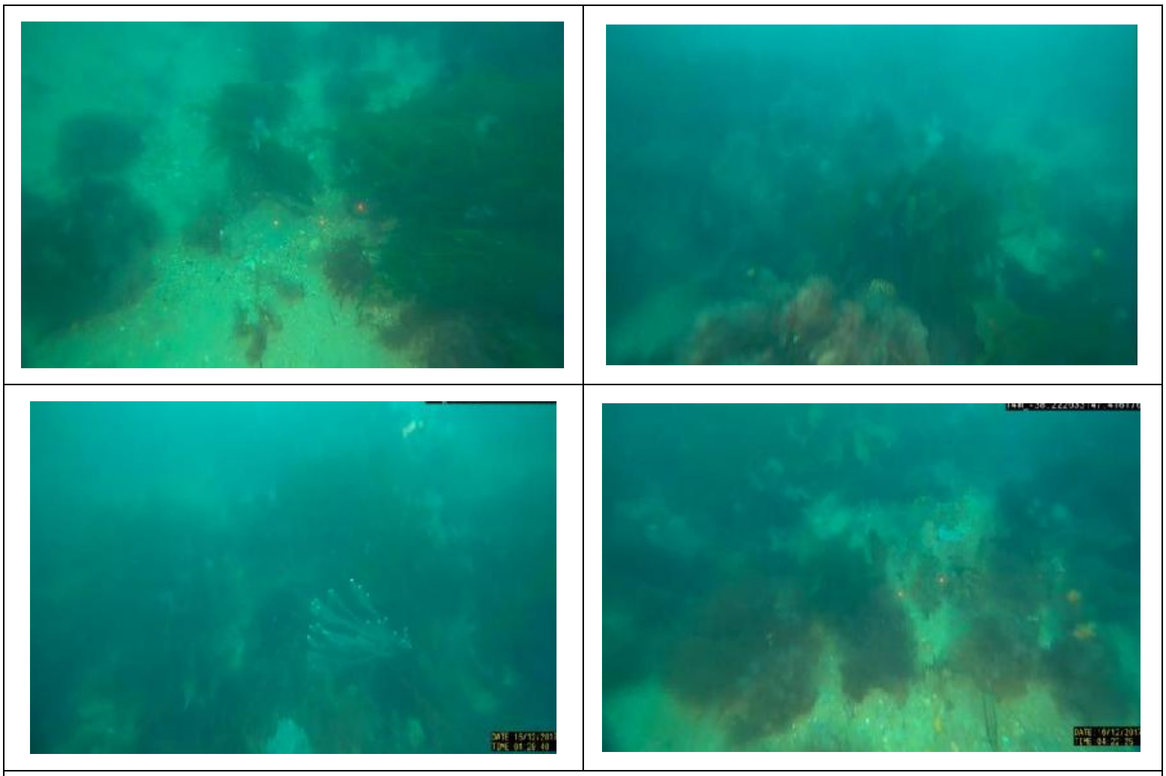
Sandy substrate with sparse marine flora, no indication of hard substrate

Photo 6.7. Seabed conditions at CSIRO site 7 (at 20 m water depth)



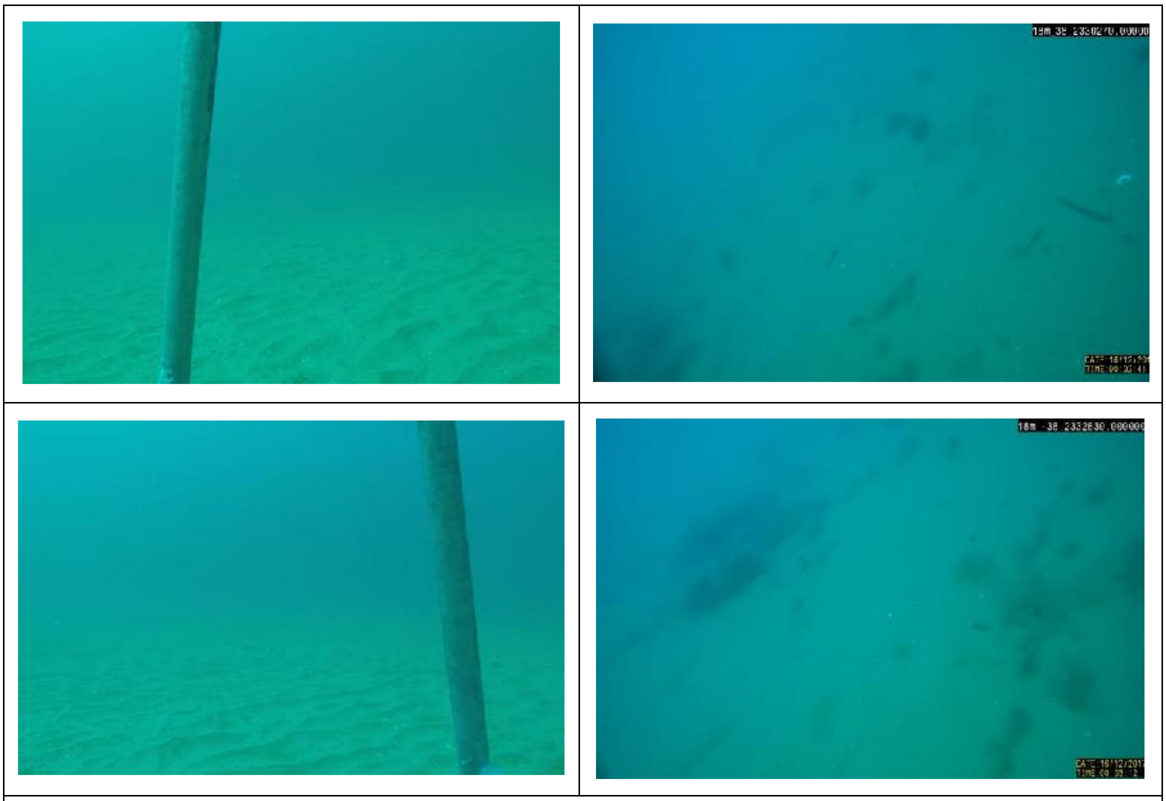
Sandy substrate with sparse marine flora, no indication of hard substrate

Photo 6.8. Seabed conditions at CSIRO site 13 (at 15.5 m water depth)



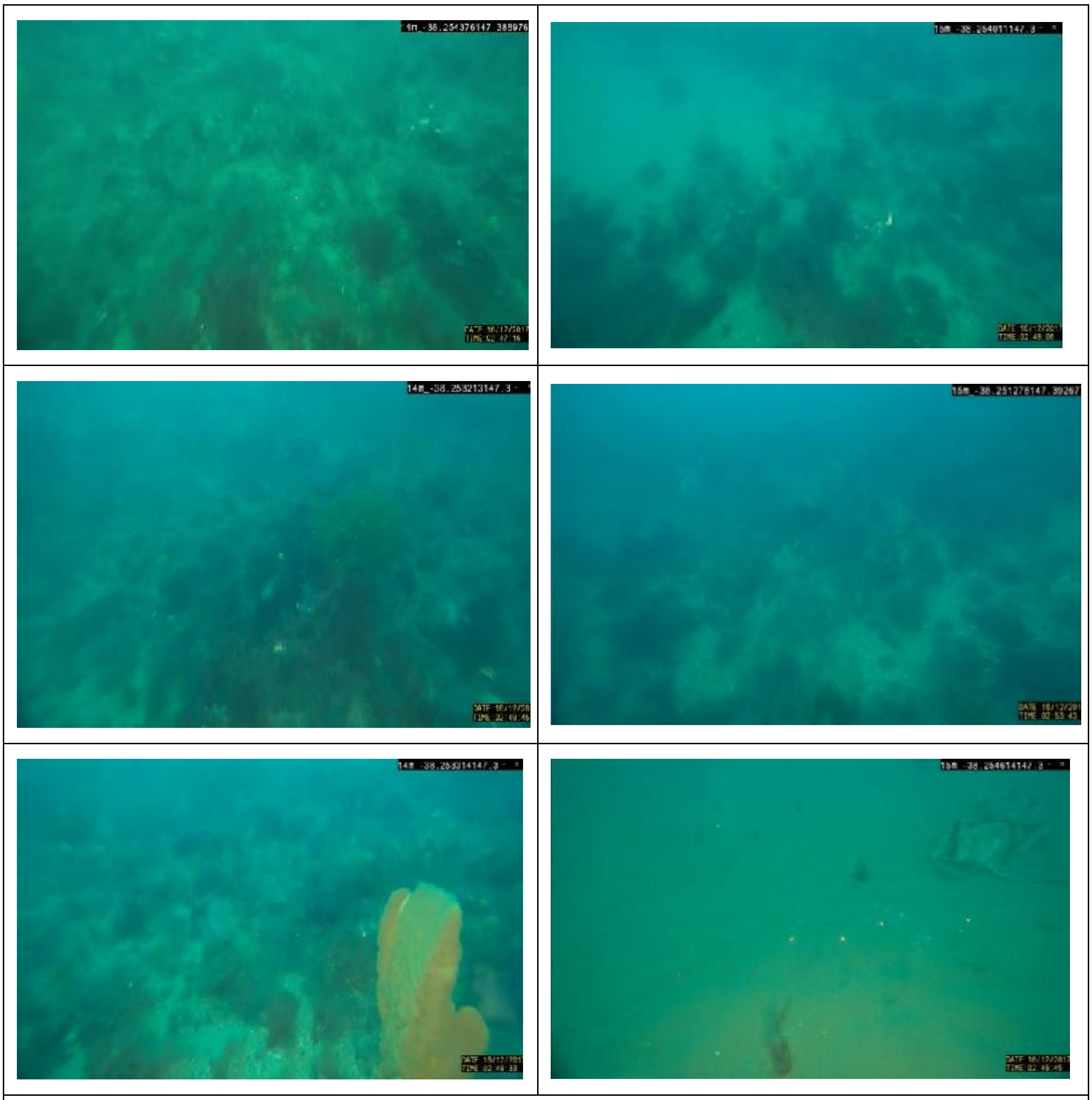
Rocky substrate and reef communities, extensive marine flora beds

Photo 6.9. Seabed conditions at CSIRO site 14 (at 17 m water depth)



Sandy substrate dominant, paucity of marine flora suggests lack of hard substrate below the sand

Photo 6.10. Seabed conditions at CSIRO site 15 (at 20.5 m water depth)



Marine flora communities dominant, some areas of sandy substrate

Photo 6.11. Seabed conditions at CSIRO site 17 (at 18 m water depth)

Sandy substrate dominant, paucity of marine flora suggests lack of hard substrate below the sand.

Photo 6.12. Seabed conditions at CSIRO Site 18 (at 19 m water depth)

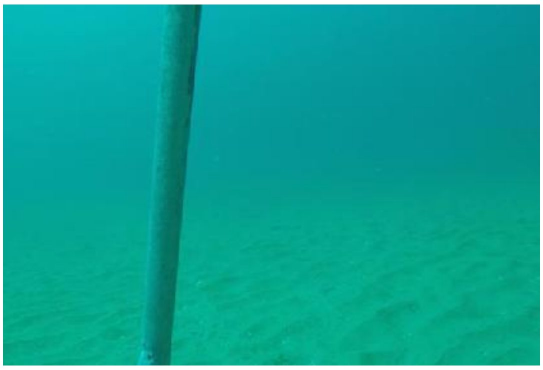
	
Sandy substrate dominant	

Photo 6.13. Seabed conditions at CSIRO Site 19 (at 21 m water depth)

Independent of the CSIRO GipNet study, a marine habitat assessment (using a non-intrusive towed camera) was commissioned by CarbonNet and conducted in early April 2017 to provide information for the CarbonNet Pelican 3DMSS. The primary aim of the assessment, among others, was to determine broad seabed substrate types of the survey area, which included the GB Energy Project area. Of the 71 sites sampled in the MSS acquisition area, eleven sites occur within 2.5 km of the Project area (sites 23, 24, 31, 32, 33, 34, 41, 42, 43, 64 and 65) (see Figure 6.7), with none of these occurring within the GB Energy Project area (CarbonNet, 2020).

Table 6.6 summarises the substrate types found at these sites based on towed camera footage (CarbonNet, 2020). The results of this sampling indicate that sand is the dominant substrate around the Project area.

Table 6.6. CarbonNet seabed habitat investigation sites summary

Site	Water depth	Distance from Project area	Seabed substrate
23	20 m	1.5 km southwest	Rippled sandy substrate
24	21 m	1.7 km southeast	Rippled sandy substrate
31	19 m	600 m southwest	Rippled sandy substrate
32	19 m	100 m southwest	Rippled sandy substrate
33	20 m	400 m southeast	Rippled sandy substrate
34	20 m	1.5 km east	Rippled sandy substrate
41	17.5 m	500 m northeast	Rippled sandy substrate
42	20 m	1 km northeast	Rippled sandy substrate
43	20 m	2 km northeast	Rippled sandy substrate

Site	Water depth	Distance from Project area	Seabed substrate
64	20 m	800 m southwest	Hard substrate, marine flora and reef communities
65	20 m	1 km southwest	Hard substrate, marine flora and reef communities

6.1.3. Oceanography

Water Depths

The Project area is located in shallow water depths ranging from 10 to 20 m in the Gippsland Basin. The bathymetry contours generally run parallel to the coast, though this pattern is less pronounced in waters deeper than 18 m (see Figure 6.8).

Water Currents

Currents within Bass Strait are primarily driven by tides, winds and density-driven flows (RPS, 2020a). The region is oceanographically complex, with sub-tropical influences from the north and sub-polar influences from the south (DoE, 2015a). There is a slow easterly flow of waters in Bass Strait and a large anti-clockwise circulation (DoE, 2015a). Three key water currents influence Bass Strait:

1. The Leeuwin Current transports warm, sub-tropical water southward along the Western Australian (WA) coast and then eastward into the Great Australian Bight (GAB), where it mixes with the cool waters from the Zeehan Current running along Tasmania's west coast (DoE, 2015a). The Leeuwin and Zeehan currents are stronger in winter than in summer, with the latter flowing into Bass Strait during winter.
2. The East Australian Current (EAC) is up to 500 m deep and 100 km wide, flows southwards adjacent to the coast of NSW and eastern Victoria, and carries with it warm equatorial waters (DoE, 2015a). The EAC is strongest in summer when it can flow at a speed of up to 5 knots, but flows more slowly (2-3 knots) in winter where it remains at higher latitudes.
3. The Bass Strait Cascade occurs during winter along the shelf break, which brings nutrient-rich waters to the surface as a result of the eastward flushing of the shallow waters of the strait over the continental shelf mixing with cooler, deeper nutrient-rich water (DoE, 2015a).

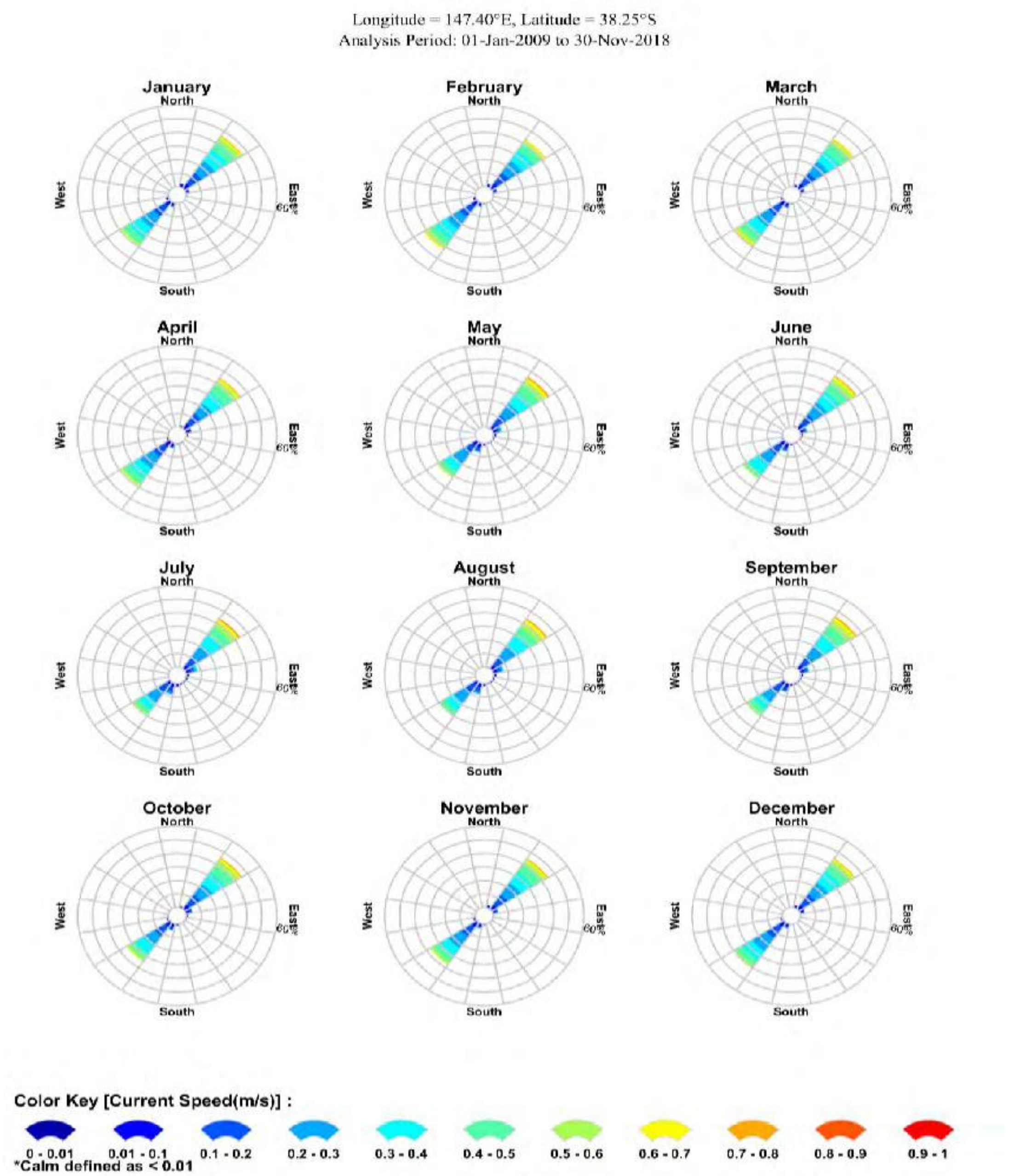
Table 6.7 provides the average and maximum combined surface current speeds (ocean plus tides) located within the Project area.

Figure 6.9 illustrates the monthly surface current rose plots located adjacent to the Project area for the five years from 2009 to 2018 (inclusive. This data indicates that surface currents flow in the northeast to southwest axis parallel with the coastline. The average monthly surface current speed was 0.30 metres per second (m/s), with the maximum surface current speeds ranging between 0.8 and 1.0 m/s. Figure 6.10 represents the major ocean currents in south-eastern Australian waters during summer and winter.

Table 6.7. Predicted average and maximum surface current speeds within the Project area from 2009-2018 (inclusive)

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction
January	0.3	0.9	Northeast/southwest
February	0.3	0.8	Northeast/southwest
March	0.3	0.9	Northeast/southwest
April	0.3	0.8	Northeast/southwest
May	0.3	0.9	Northeast/southwest
June	0.3	0.8	Northeast/southwest
July	0.3	1.0	Northeast/southwest
August	0.3	0.9	Northeast/southwest
September	0.3	0.9	Northeast/southwest
October	0.3	0.9	Northeast/southwest
November	0.3	0.9	Northeast/southwest
December	0.2	0.9	Northeast/southwest
Minimum	**0.2**	**0.8**	
Maximum	**0.3**	**1.0**	

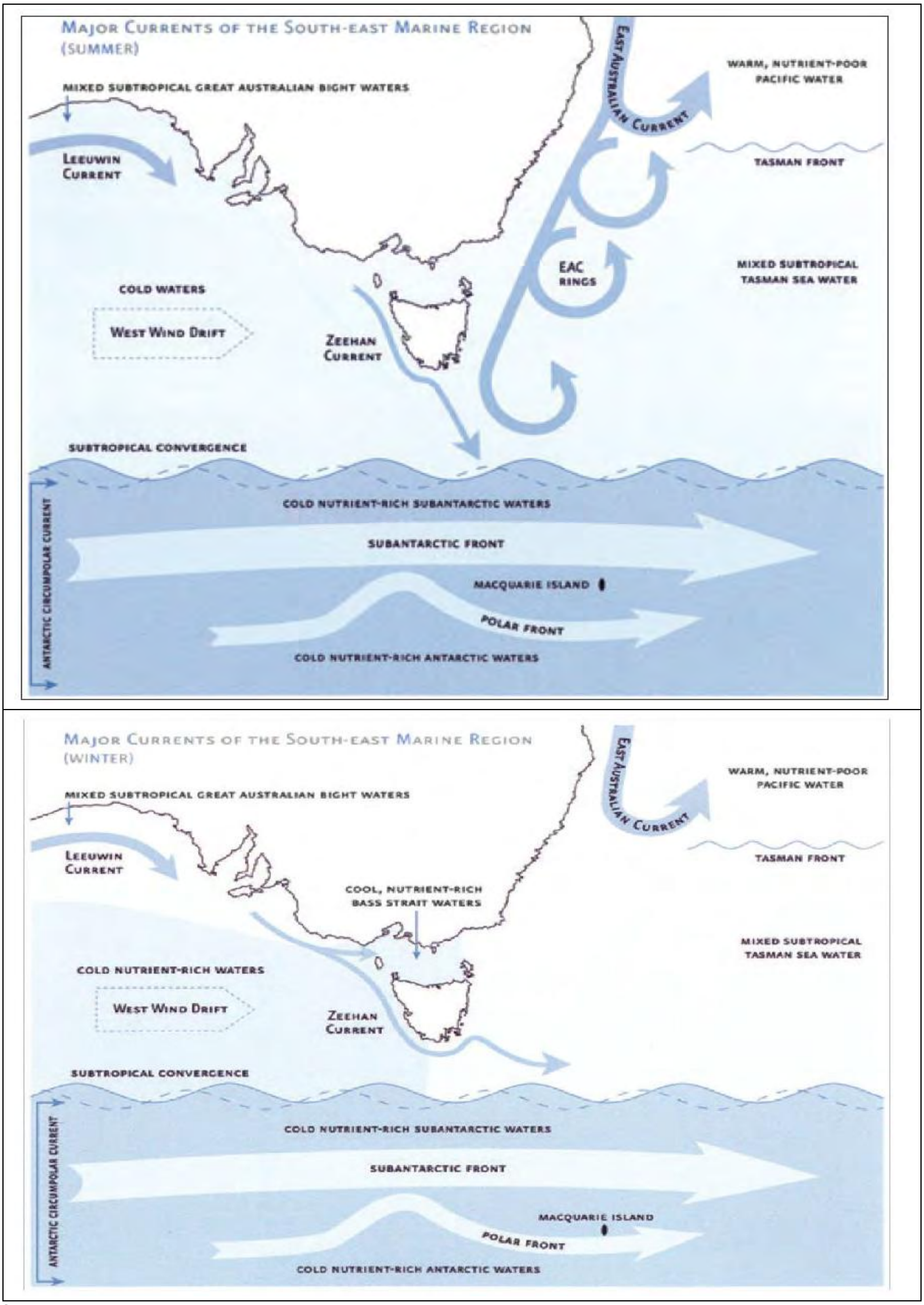
Source: RPS (2020a).



The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination.

Source: RPS (2020a).

Figure 6.9. Monthly surface current rose plots adjacent to the Project area (2009-2018 inclusive)



Source: DoE (2015a).

Figure 6.10. Major ocean currents in south-eastern Australian waters during summer (top) and winter (bottom)

Sea Temperature

The shallowness of Bass Strait means that its waters more rapidly warm in summer and cool in winter than waters of other nearby regions (DoE, 2015a). The sea surface temperatures in the area reflect the influence of warmer waters brought into Bass Strait by the EAC (IMCRA, 1998; Barton *et al*., 2012).

Waters of eastern Bass Strait are generally well mixed, but surface warming sometimes causes weak stratification in calm summer conditions. During these times, mixing and interaction between varying water masses leads to variations in horizontal water temperature and a thermocline (temperature profile) develops. The thermocline acts as a low-friction layer separating the wind-driven motions of the upper well-mixed layer of Bass Strait from the bottom well-mixed layer.

RPS (2020a) reports that sea surface temperature in the region (based on the World Ocean Atlas database produced by the National Oceanographic Data Centre) varies annually from a minimum of 14°C (August/September) to a maximum of 18°C (March). The average annual sea surface temperature is 16°C.

Salinity

Salinity in the region consistently ranges from 35-36 practical salinity units (psu) throughout the year (based on the World Ocean Atlas database) (RPS, 2020a).

Tides

Bass Strait is a relatively shallow area of the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Bass Strait has a reputation for high winds and strong tidal currents (RPS, 2020a).

Tidal currents run parallel to the coast and follow a semi-diurnal pattern (Barton *et al*., 2012), with some diurnal inequalities (Jones and Padman, 1983). Speeds of 0.5 m/s are not uncommon with maximum tidal flows of 3 m/s occurring in some areas (Fandry, 1983). Barton et al (2012) report that strong tidal currents (2 to 2.5 knots, or 1-1.3 m/s) are characteristic of the area. Tidal variation is 0.9 m for spring tides and 0.6 m for neap tides (Barton *et al*., 2012).

The main tidal components in Bass Strait vary in phase by about three to four hours from east to west. Most of this phase change occurs between Lakes Entrance and Wilson's Promontory. Tidal flows in Bass Strait come in from the east and west during a rising (flood) tide and flow out to the east and west during a falling (ebb) tide.

Waves

Bass Strait is a high-energy environment exposed to frequent storms and significant wave heights (Jones, 1980), though Barton et al (2012) report wave energy in the Twofold Shelf Bioregion as relatively low. Storms may occur several times a month resulting in wave heights of 3 to 4 m or more.

Water Quality

The Regional Outfall Sewer (ROS) has a discharge point at Delray Beach that extends into nearshore waters 350 m west of the Project area, 1.5 km from the shoreline. The mixing zone for the ROS extends 2 km northeast of the discharge point (National Outfall Database, 2020), meaning that this mixing zone extends over much of the Project area.

The last full year of water quality data collection from this site was 2018. This indicates that the monthly average outfall volume was 900 megalitres (ML) and the average monthly results for assessable pollutants were:

- Colour (Pt. Co. units) – 350.
- *E.coli* (org/100 mL) – 149.

- pH – 7.9.
- Total dissolved solids (mg/L) – 2,125.
- Total suspended solids (mg/L) – 4.8.
- Total nitrogen (mg/L) – 3.12.
- Total phosphorous (mg/L) – 0.82

Data for 2019 is available only for January to May and there is no data for 2020. The data indicates that nutrient levels in the mixing zone are elevated compared to background levels.

Ambient Ocean Sound

Physical and biological processes contribute to natural background sound. Physical processes include that of wind, waves, rain and earthquakes, whilst biological noise sources include vocalisations of marine mammals and other marine species.

Wind is a major contributor to noise between 100 Hz and 30 kHz and can reach 85-95 dB re 1µPa2/Hz under extreme conditions (WDCS, 2004). Rain may produce short periods of high underwater sound with a flat frequency spectra to levels of 80 dB re 1µPa2/Hz and magnitude 4 earthquakes have been reported to have spectral levels reaching 119 dB re 1µPa2/Hz at frequency ranges of 5-15 Hz. It is noted that earthquakes of this magnitude are relatively frequent along Australia's continental shelf in the southern margin (i.e., tens of small earthquakes per year) (McCauley & Duncan, 2001).

Turnpenny and Nedwell (1994) found that in sensitive species such as the cod, continuous ambient sound alone resulted in auditory masking, and that sound had to be 20 dB above ambient sound to be audible. Table 6.8 presents a comparison of biological and anthropological sounds in the marine environment.

Table 6.8. Sound intensity and pressure (dB re 1µPa @ 1 m from source) for some common marine sources

Source	Sound intensity (dB re 1 µPa)	Frequency (Hz)	Reference
Natural sound			
Ambient sea sound	80-120	Varied	2
Undersea earthquake	272	50	2
Seafloor volcanic eruption	255+	Varied	2
Lightning strike on sea surface	250	Varied	2
Iceberg calving, shoaling and disintegration	220-245	Varied	5, 6
Bottlenose dolphin click	Up to 229	Up to 120,000	2
Breaching whale	200	20	2
Blue whale vocalisations	190	12 – 400 (16 – 25 dominant)	2
Blue whale moans	188	12 – 390 (16 - 25 dominant)	1
Southern right whale vocalisations	172-186	30 – 2,200 (50 – 500 dominant)	1

Source	Sound intensity (dB re 1 μPa)	Frequency (Hz)	Reference
Humpback whale vocalisations	144-174	30 – 8,000 (song) (120 – 4,000 dominant) 50 – 10,000 (social calls)	1, 3
Sperm whale clicks	Up to 235	100 – 30,000	2
Anthropogenic sound			
Seismic acoustic source (32 guns)	178-210	Most energy 5 to 200 Hz	1
Ship sound (close to hull)	200	10 - 100	2
Survey vessel	110-135 (without thrusters) 121-146 (with thrusters)	20-1,000	4
Fishing trawler	158	100	3
7 m outboard motorboat	156	630	3
Tanker (179 m)	180	60	3
Supertanker (340 m)	190	7	3
Containership (274 m)	181	8	3
Navigation transponders	180 – 200	7,000 – 60,000	3
SSS	220 – 230	50,000 – 500,000	3
Bottom profilers	200 – 230	400 – 30,000	3
Helicopter flyover (Bell 212)	142 – 155	162	1, 3
Drill rig (*Ocean Bounty* semi-submersible)	145 maximum (>120 for 1% of time at 5.1 km)	20 – 1,000 (15-30 dominant)	7
FPSO (maximum at *Griffin Venture*)	176	10 – 500 (up to 2,000)	8
References			
1 – Richardson et al (1995).	*3 – WDCS (2004).*	*5 – Chapp et al (2005).*	
2 – APPEA (2006).	*4 – Total (2004).*	*6 – Matsumoto et al (2014).*	
7 – Woodside (2003).	*8 – Apache Energy (2008).*		

Ambient underwater sound characterisation of the Pelican 3DMSS acquisition area (which took place over the Project area) was undertaken in February 2018 (CarbonNet, 2018). The study involved four deployment locations, with site1 being the closest to the Project area (3.6 km to the east in a water depth of 19 m). The three other sound loggers were located in water depths of 26, 27 and 39 m, with the next closest site (site 2) located 5.5 km southeast of the Project area.

The sound loggers recorded data that indicates the ambient underwater soundscape of the Golden Beach region was contributed to strongly by weather events (wind and wave noise correlated with tidal state), with low levels of shipping and biological sound. Both Stations 3 and 4 (in water depths of 27 m and 39 m, respectively) show the presence of snapping shrimp, with elevated power spectral density levels above 1.5 kHz due to their contributions at night. Biological sources are primarily evident in recordings from Station 3 in the 1-10 kHz and 10-32 kHz bands as elevated night time levels, which are likely linked to increased biological activity at the nearshore reef, as they are not evident at Station 4.

Increased noise levels in the 10-100 Hz band (primarily at Station 3) occur on a 6-hourly cycle, aligning with the tidal cycle. The highest levels occur as the tide rises from low to high at night early in the week, with similar noise levels for all tidal cycles at the end of the week as the moon approached the last-quarter on the 8th of February 2018. The tidal cycles are more noticeable at Station 3 as it is in shallower water than Station 4, and also because it is closer to the coast, and the sound levels are more influenced by wave action on the beach. The daily sound exposure level (SEL) ambient underwater sound values varied between a minimum of 162.5 dB re 1 $\mu Pa^2 \cdot s$ and maximum of 163.7 dB 1 $\mu Pa^2 \cdot s$ at Station 3, and a minimum of 158.3 dB 1 $\mu Pa^2 \cdot s$ and a maximum of 163.6 dB 1 $\mu Pa^2 \cdot s$ at Station 4 (CarbonNet, 2018).

6.2. Coastal Environment

The physical coastal environment described in this section is defined by the potential extent of dispersion of moderate threshold entrained hydrocarbons predicted under the 500 m^3 scenario (it also encompasses the 155 m^3 spill scenario), which stretches from the east coast of Wilsons Promontory in Victoria to Eden in NSW.

The environmental features of the coast immediately adjacent to the Project area are dominated by sandy sediment with sparse reef (low-profile carbonate reef, see Section 6.1). The Wellington Shire coast is dominated by Ninety Mile Beach, which is entirely sandy beach and provides important hooded plover (*Thinornis rubricollis*) nesting habitat. East of Cape Conran, in the East Gippsland Shire coast section, rocky headlands intertidal shore platforms become interspersed among sections of sandy beach, though sandy beach remains the dominant coastal feature.

The presence or absence of environmental sensitivities along the coastline of the EMBA is presented in Table 6.9.

Table 6.9. Coastal sensitivities within the EMBAs

Environmental receptor	Wellington Coast	East Gippsland Coast
Shoreline types		
Sandy beach	Yes	Yes
Mixed sand beach/shore platform	No	Yes
Intertidal shore platform	No	Yes
Nearshore substrates		
Intertidal sand flat	Yes	Yes
Subtidal sand flat	Yes	Yes
Subtidal low-profile patch reef	Yes	Yes
Rocky reef	Yes	Yes
Species presence		

Environmental receptor	Wellington Coast	East Gippsland Coast
Australian fur-seal haul-out sites	No	Yes
Australian fur-seal breeding colony	No	Yes
New Zealand fur-seal colony	No	Yes
Little penguin colony	No	Yes
Estuarine fish habitat	Yes	Yes
Hooded plover habitat	Yes	Yes
Tern nesting sites	Yes	Yes
Shorebird roosting sites	Yes	Yes

6.2.1. Shoreline Types

The western part of the coastline within the EMBA is dominated by the Ninety Mile Beach, a 90-mile (145 km) long stretch of sandy beach on the seaward side of a narrow, tall, vegetated sand dune system. These sand dunes provide important habitat for hooded plovers (see Section 6.3.8) and roosting sites for other shorebird species. From Cape Conran until the eastern most extent of the EMBA in NSW, the shoreline is interspersed with intertidal shore platform, sandy beaches and rocky cliffs.

There are no estuaries immediately adjacent to the Project area, but there are 22 estuaries along the coastline of the EMBA. Moving from west to east, these are:

- Jack Smith Lake estuary – intermittently open;
- Lake Dennison estuary – intermittently open;
- Merriman Creek estuary – intermittently open;
- Lakes Entrance – permanently open;
- Bunga River – intermittently open;
- Lake Tyers – intermittently open;
- Snowy River – permanently open;
- Yeerung River – intermittently open;
- Sydenham Inlet – intermittently open;
- Tamboon Inlet – intermittently open;
- Thurra River – intermittently open;
- Mueller River – intermittently open;
- Wingan Inlet – permanently open;
- Easby Creek – intermittently open;
- Red River – intermittently open;
- Benadore River – intermittently open;
- Seal Creek – intermittently open;
- Shipwreck Creek – intermittently open;

- Betka River – intermittently open;
- Davis Creek – intermittently open;
- Mallacoota Inlet – permanently open; and
- Wonboyn River – permanently open.

6.2.2. Intertidal Habitats

Sand is the dominant intertidal substrate within the EMBA, with intertidal shore platforms intermittently found along the coastline to the east of the Project area from Cape Conran to Eden in NSW. Intertidal and subtidal rock reefs are also intermittently found further east along the coastline, appearing just east of the Snowy River estuary. Rocky reef substrates are also found further east of the EMBA, starting just west of Cape Conran.

6.3. Biological Environment

The sources listed at the start of this chapter have been used in the preparation of this section.

Additionally, BIAs are identified for those species that may occur within the Project area and EMBA. BIAs are spatially defined areas, defined by the DAWE based on expert scientific knowledge, where aggregations of individuals of a species are known, or likely, to display biologically important behaviour such as breeding, foraging, resting or migration (DAWE, 2020c). The BIAs do not represent a species' full distribution range.

6.3.1. Benthic Assemblages

Regional Knowledge

The seascape of the region is composed of a series of massive sediment flats, interspersed with small patches of reef, bedrock and consolidated sediment (Wilson and Poore, 1987). OSRA mapping for the Ninety Mile Beach indicates that there is an abundance of sandy sediments with few areas of emergent reefs in the region (see Figure 6.4).

The sediment flats are generally devoid of emergent fauna but benthic invertebrates such as polychaetes, bivalves, molluscs and echinoderms are present (Wilson and Poore, 1987). There are also a number of burrowing species that inhabit the soft seabed, including tubeworms, small crustaceans, nematodes, nemerteans and seapens (OMV, 2001).

Surveys of benthic invertebrates in Bass Strait (Poore *et al*., 1985; Wilson and Poore, 1987) have shown:

- Crustaceans and polychaetes dominate the infaunal communities, many of which are unknown species.
- The high diversity of a wide range of invertebrate groups has been a recurrent observation of all surveys in Bass Strait and diversity is high compared with equivalent areas of the northern hemisphere.
- Many species are widely distributed across Bass Strait.
- Some invertebrate groups are allied with fauna from Antarctic seas. In winter, when the east coast of Tasmania is supplied with water from the sub-Antarctic, the overlap with the EAC contributes to high diversity due to the transportation of nutrient-rich waters.

Parry et al (1989) also found high diversity and patchiness of benthos sampled off Lakes Entrance, where a total of 353 species of infauna was recorded. Crustaceans (53%), polychaetes (32%) and molluscs (9%) dominated sample results by species richness.

Barton et al (2012) report that in the Ninety Mile Beach Marine National Park (28 km west-southwest of the Project area at their nearest points), reefs are dominated by invertebrates (70% coverage), including sponges, ascidians (sea squirts) and smaller bryozoans (resembling coral) and hydroids (colonies of tiny jellies attached to a feather-like base).

A search of the VBA for the EMBA reports 24 species of benthic and intertidal fauna species and includes sea snails, sea stars, sea urchins, sea slugs, rock lobsters and limpets (none of which are threatened species under Commonwealth or Victorian legislation). The most recorded species is the black-lip abalone (*Haliotis rubra*) with 118 sightings. The full list of benthic and intertidal species recorded in the EMBA is presented in **Appendix 2**.

For the EMBA, the ALA records thousands of species of benthic fauna, including bristle worms (168), crabs, lobsters, shrimps and amphipods (827), barnacles and copepods (155), seed shrimp (38), sea spiders (33), bryozoans (46), sea squirts (54), sea anemones, corals and sea pens (42), starfish (54), sea urchins (45), brittle stars (56), sea cucumbers (32), bivalves, including mussels, scallops, oysters and clams (270), sea snails and nudibranchs (844) and sponges (21). This confirms the diverse nature of the benthic environment in the Bass Strait and Southern Ocean regions.

Seabed assessments have been conducted throughout the Gippsland region for other petroleum infrastructure projects. The results of these seabed assessments include:

- Longtom pipeline route selection process (80 km east of the Project area) – the relative homogeneity of sandy seabed sediments across all areas surveyed suggests that the low density and low diversity of benthic invertebrates found in the Project area extends over a large area across Bass Strait (Fugro, 2005). There was no evidence of unusually high benthic invertebrate diversity in the sediment samples collected along the pipeline route. Sediment samples generally show a brown, coarse shelly sand, moderately well sorted with some shells.
- Patricia Baleen Project (95 km east of the Project area) – the inshore area has been characterised as containing scallops and other large bivalves, crabs, ascidians and small aggregations of sponges and bryozoans (CEE, 2001).
- Tasmanian Gas Pipeline (22 km southwest of the Project area) – benthic fauna studies (i.e., dredge samples) undertaken offshore of Seaspray in water depths ranging from 17-20 m found that there were mobile sands with irregular ripples that contained a variety of small mobile animals, such as crustaceans, bivalves, sponges, worm tubes and polychaete worms.

Project Area

In the Project area, the ALA records the occurrence of dozens of benthic species, including bristle worms (11), crabs (10), sea snails (14), shrimps and amphipods (20), brittle stars (7) and sea cucumbers (2). The VBA does not contain any records of benthic species in the Project area.

Independent of the proposed development, the CSIRO has conducted biological surveying and investigation at the sites presented in Figure 6.7. Investigations at these sites includes towed camera and ROV footage, fish baiting and sampling of epibenthic fauna.

At sites within the Project area, sled tows of various lengths as well as opportunistic sampling of epibenthic fauna were conducted. The general assemblage of epibenthic fauna at sites in the Project area is consistent with the literature describing the region, with gastropods, polychaetes, echinoderms, cnidarians, crustaceans, bivalves and an assortment of sponges being collected and identified (CSIRO, 2018). Where hard substrate is identified at investigation sites, such as at site 14 (1.8 km northeast of the Project area), species richness is higher than the soft substrate samples.

Table 6.10 presents the epibenthic fauna species recorded at sites 9, 10 and 11, which are within the Project area. Survey effort varied between sites in that there were different numbers and lengths of bottom tows conducted. As such, the results presented in Table 6.10 are not directly comparable between sites, but it provides an indication of the abundance and diversity of epibenthic fauna within the Project area. Additionally, it is likely that other benthic species present in the region, but not recorded in these surveys, are present in the Project area.

A total of 1,253 individuals were found recorded from the benthic tows within the Project area, represented by 6 phyla, 8 classes and 28 taxa. The number of taxa recorded at Site 9 (8 taxa) and Site 10 (6 taxa at Site 10(A/B) and 3 taxa at Site 10(2A/2B)) was generally lower compared to other sites from the survey area. The abundance of benthic fauna at Site 9 and 10 was lower than most sites, with 0.5 individuals/m^2 at Site 9, 0.3 individuals/m^2 at Site 10(A/B) and 0.7 individuals/m^2 at Site 10(2A/2B)) recorded. Both abundance and richness of benthic fauna taxa at Site 11(A/B) was the second highest of all surveyed sites, with 19 taxa and 24.8 individuals/m^2 recorded.

Table 6.10. Epibenthic fauna species abundance and richness at CSIRO investigation sites 9, 10 and 11 within the Project area

Site 9		Site 10		Site 11	
Species	Abundance	Species	Abundance	Species	Abundance
Amoria undulata	1	Alcyonacea	1	*Ascidian* sp.	1
Philine angasi	4	*Electroma georgiana*	8	*Sycozoa* sp.	2
Amphipod sp.	1	Nemertean	1	Alcyonacea	4
Amphiura elandiformis	1	*Ophiura kinbergi*	5	Amphipod sp.	2
Ophiuroidea sp.	1	*Philyra undecimspinosa*	1	Cominella	3
Electroma georgiana	10	Polychaete sp.	25	Cumacean	1
Euidotea bakeri	1			*Electroma georgiana*	1,031
Polychaete sp. 1	1			Gastropod sp.	1
				Isopod sp.	7

Site 9		Site 10		Site 11	
Species	Abundance	Species	Abundance	Species	Abundance
				Maoricolpus sp.	1
				Mitra sp.	1
				Ophiura kinbergi	107
				Paguristes sp.	1
				Philine angasi	2
				Philyra undecimspinosa	8
				Polychaete sp.	4
				Rissoina vincentiana	3
				Tawera gallinula	1
				Waimatea obscura	2
				Naxia aurita	1
				Paguristes sp.	4
				Pagurixus handrecki	3
				Philyra laevis	1

Evident from the data presented in Table 6.10 is that *Electroma georgiana* (little wing pearl shell) is the most abundant species at all three sites (and accounted for 75% of the abundance and 76% of total biomass across all the CSIRO sample sites). This species is known to grow rapidly and can consequently occur in large numbers such as those encountered during the CSIRO surveys. They're found in sheltered areas attached to seaweed and seagrass. This is a small bivalve species and the only member of the pearl oyster family (Ostreidae) living in southern Australian waters. They grow to a maximum size of 4 cm and are known to occur in large numbers (Museums Victoria, 2020), recorded at many sites within Bass Strait and southern Australian waters, and particularly Port Phillip Bay (ALA, 2020).

Ophiura kinburgi is also abundant at site 11. This is a brittle star that grows up to 2 cm in diameter and lives in soft sediments in water depths ranging from 2 to 500 m (Port Phillip Marine Life, 2020) and has been recorded at many sites within Bass Strait and southern Australian waters (ALA, 2020).

Site 9, close to the proposed HDD seabed exit point, has low species diversity and abundance.

Table 6.11. Summary of benthic habitat and species at CSIRO investigation sites within the Project area

CSIRO site (water depth)	Distance from Project area	Benthic habitat observed
9 (15.5 m)	Within Project area	The benthic habitat observed at the CSIRO sites within the Project area was observed to be dominated by sandy sediments. The paucity of marine flora and macroalgae indicates a lack of seabed habitat diversity (with the rocky reef to the west having higher diversity). As illustrated in Table 6.10, presence of benthic fauna varies between individual site with species richness (number of different species) at sites 9 and 10 observed as lower than the species richness at site 11.
10 (19 m)		
11 (20 m)		

Statistical analysis of the CSIRO benthic fauna data (using PRIMER©) was used to construct a non-metric multi-dimensional scaling by ERIAS Group (2020) to determine how benthic assemblages differed between sites and tows within the CSIRO survey area. This analysis found the following:

- A generally high degree of variability between sites, and in many cases replicate tows within sites, represented by the spread of the data points.
- Benthic assemblages from two tows (sites 12 and 18, outside the Project area) were distinct from the remaining sites and tows.
- Tows from Site 9 (inside the Project area) and Site 5 (outside the Project area) are loosely clustered together and somewhat separate from the other sites and tows. These two sites were located in similar water depths (15 m) and at similar distances from the shore and were the two shallowest depths sampled.
- All tows from Site 10 (inside the Project Area) are clustered together, indicating similarities in benthic fauna community composition, and are also similar to replicates from Site 4, 7 and 8 (noting however that one replicate from Site 10(2B), had no benthic fauna recorded).
- All tows from Site 11 (inside the Project Area) are clustered together, and therefore exhibit some degree of similarity regarding benthic fauna community composition. Tows from Site 11 are also similar to tows from Site 6, Site 8 and Site 19.

This analysis reveals that there is a high degree of variability between the type and abundance of benthic taxa recorded at the CSIRO sampling sites. This spatial variability if typical in relatively featureless soft sediment habitat (i.e., sand) such as those surveyed.

The notably higher benthic fauna abundance at Site 11 was primarily due to the localised aggregations of little wing pearl shells (*Electroma georgiana*). The little wing pearl shell accounted for 84% (1,049 individuals) of all benthic fauna recorded within the Project Area, with the majority of these (1,031 individuals) recorded at Site 11. In comparison, benthic fauna abundance and richness was much lower at Site 9 and 10.

To allow for more meaningful interpretation, the total abundance of benthic fauna recorded in the Project area from the benthic tows excluding all observations of the little wing pearl shell was undertaken. This analysis indicates that other abundant taxa included the brittle star *Ophiura kinbergi* (112 individuals) and polychaete? sp.1 (30 individuals). Malacostracans (a class of crustaceans) were also relatively abundant in the Project area (34 individuals). There were less than 10 individuals recorded of the remaining 25 taxa, with 16 of these taxa (57%) recorded only once in the Project area.

There were 10 taxa recorded within the Project area that were not recorded elsewhere in the survey area. These 10 taxa were only recorded on a single occasion in the Project area with the exception of Cominella ? sp.1 which was recorded from two tows, but with a total abundance of only three individuals. These taxa, while uncommon to the survey area, have a widespread distribution.

Overall, the benthic fauna recorded from the Project area and surrounds indicates that:

- Benthic fauna recorded by the CSIRO across their survey area generally exhibited a high degree of spatial variability with generally low abundance and richness recorded throughout, with the exception of localised aggregations of the little wing pearl shell and to a lesser degree the brittle star Ophiura kinbergi and polychaete worms. Ophiura kinbergi is known to occur abundantly in localised patches (Edgar, 2008) on soft sediments and has a widespread distribution while polychaete worms are typically one of the most abundant taxonomic groups in soft sediment habitats.
- Considering benthic fauna community composition, there is large spatial variability between benthic fauna communities in the CSIRO survey area.
- Sites within the Project area generally shared similar characteristics in benthic fauna community composition to other sites within the CSIRO survey area.
- With the exception of the little wing pearl shell (*Electroma georgiana*), abundance of benthic fauna was very low in the Project area.
    - Taxonomic richness was low at Site 9 and 10, with between 3 and 5 taxa recorded per tow.
    - Taxonomic richness was higher at Site 11 with between 7 and 14 taxa recorded per tow.
    - Abundance was low at Site 9 and 10 while notably higher at Site 11, which had the second highest abundance (and richness) of benthic fauna taxa in the survey area.
    - While the abundance and taxonomic richness of benthic fauna at Site 11 was higher compared to other sites in the survey area, given that habitat at this site is well represented outside of the Project area and that the taxa recorded are generally mobile in nature, this site is unlikely to represent habitat that is locally or regionally important for benthic faunal assemblages.
- Considering the taxa recorded in the Project area, with the exception of unknown cnidarians (suspected to be stony corals and sea whips), and bivalves (including the little wing pearl shell), all benthic fauna recorded are mobile taxa and their presence would therefore unlikely be limited to the soft sediment habitats available in the Project area, which are broadly represented outside of the Project area.
- The benthic fauna from the Project area consist of primarily predators, scavengers and grazers, with only a few taxa being filter feeders.

Towed camera footage captured the benthic habitat conditions at these sites, which is summarised in Table 6.11. Photo 6.14 to Photo 6.16 presents the seabed conditions at these sites as observed during the towed camera investigations.

Photo 6.14. Benthic habitat at CSIRO site 9 (at 15.5 m water depth)

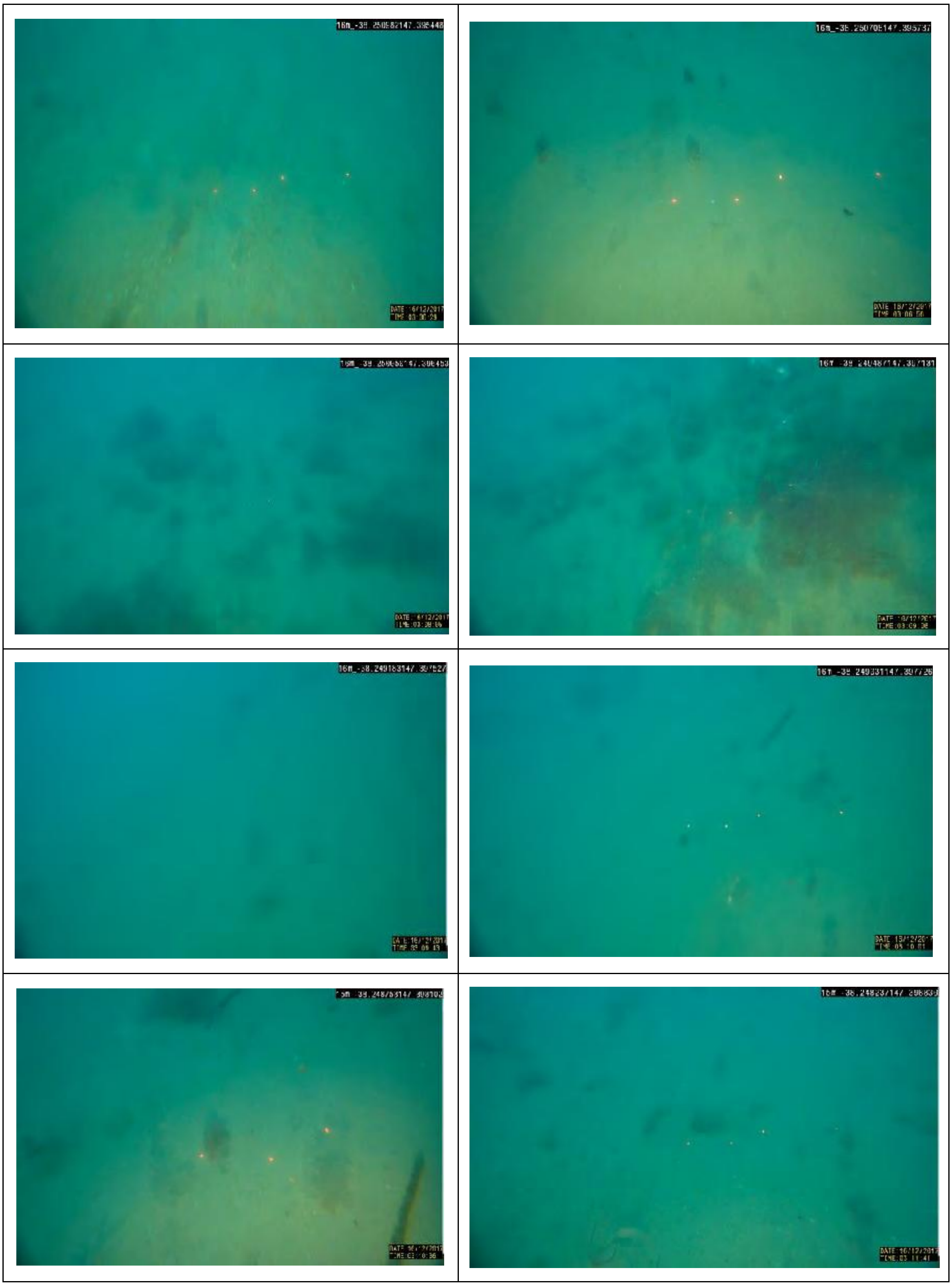


Photo 6.14. Benthic habitat at CSIRO site 9 (at 15.5 m water depth) (*cont'd*)

Photo 6.15. Observed benthic habitat at CSIRO site 10 (at 19 m water depth)

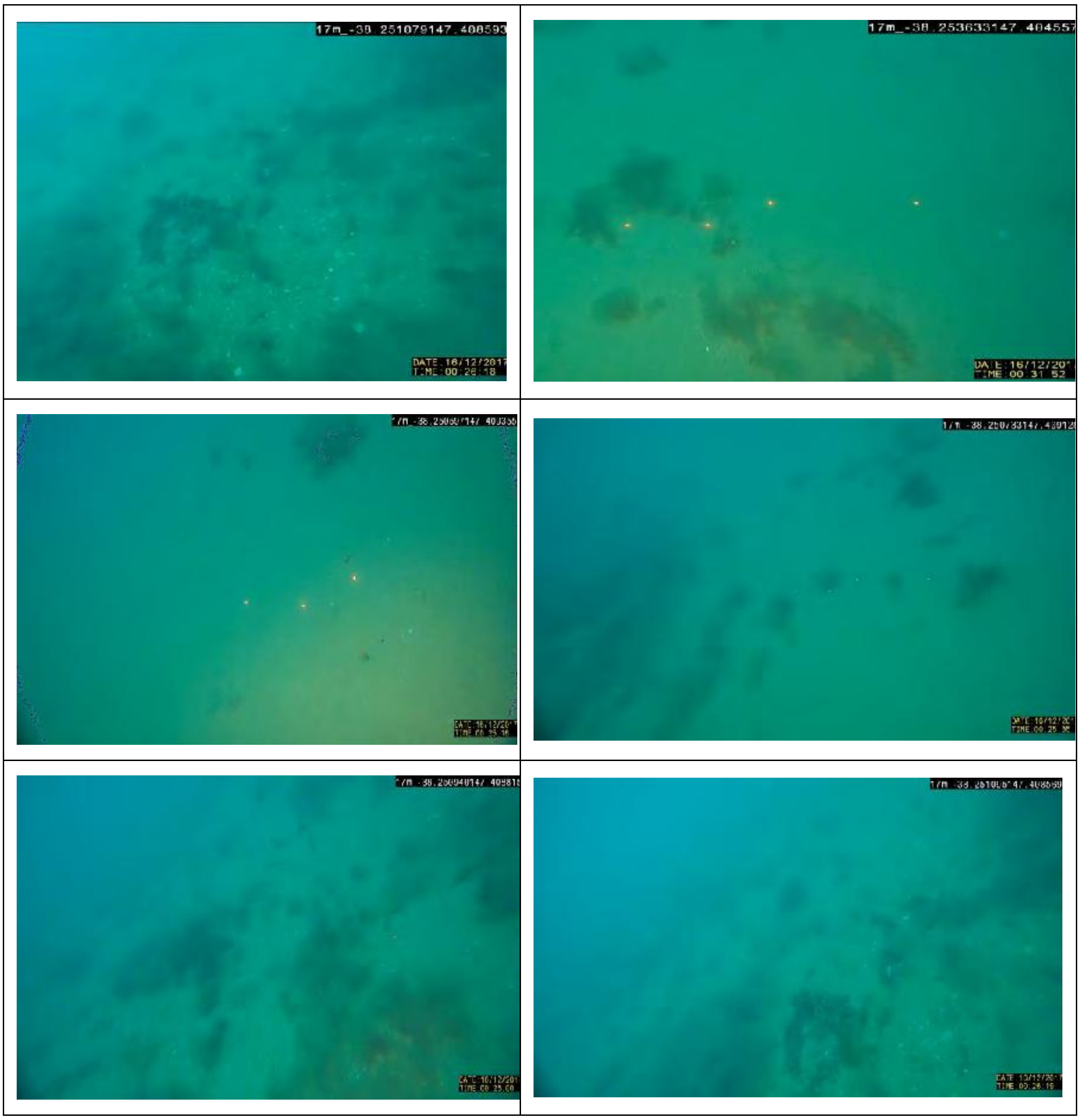


Photo 6.16. Benthic habitat at CSIRO site 11 (at 20 m water depth)

A marine habitat assessment was undertaken by CarbonNet for their Pelican 3D MSS and conducted in early April 2017 to characterise the seabed. This habitat assessment included 11 sites located less than 2.5 km away from the Project area. Figure 6.7 presents the location of the habitat assessment sites in relation to the Project area. Nine of the 11 sites consisted of sandy sediments and gravels/shells with contouring that is typical of mobile seabed affected by swell waves and strong tidal currents. Rocky reef was present at two sites located 800 m to 1 km to the southwest of the Project area. No beds of giant kelp, seagrass or sponges were observed at any of the 11 sites within 2.5 km of the Project area. The results of this sampling relevant to the Project area indicate that, in general, the seabed is dominated by fine sand with very little epibiota. Low profile discontinuous rocky reef was observed at sites 64, 65 and 67 (outside of the Project area) during the assessment.

Scallops

Fishing for commercial scallops (*Pecten fumatus*) does take place in the Project area. Scallops are present throughout Bass Strait, with a distribution along the southeast Australian coast from central NSW, Victoria, SA and Tasmania. They are found partially buried in soft sediment ranging from mud to coarse sand. Scallops aggregate into beds, with healthy scallops recessing their convex right valve beneath the sediment such that the flat left valve is level or slightly below the sediment surface (AFMA, 2017a; Przeslawski *et al*., 2016a). Commercial scallops are mainly found at depths of 10-20 m, but may also occur at depths of up to 120 m. While mainly sedentary, scallops can swim by rapidly opening and closing their shells, usually when disturbed by predators (AFMA, 2017a). Scallops feed on prey and detritus, while they are prey for starfish, whelks and octopus (AFMA, 2017a).

Scallops reach reproductive maturity after one year but do not spawn until the second year. Commercial scallops usually have a life span of less than 7 years, but wild populations have been known to die off rapidly after 3-5 years (AFMA, 2017a). Adult scallops normally spawn over an extended period between June and November (a sudden increase in water temperature is thought to trigger spawning), with individuals producing up to one million eggs (AFMA, 2017a). In Victoria, a spawning peak appears to take place in spring (September, October and November) (DPI, 2005). Information provided by Seafood Industry Victoria (SIV) indicates spawning occurs from September to December. Larval scallops drift as plankton for up to six weeks before first settlement, with peak settlement occurring in mid-late September (AFMA, 2017a; Przeslawski *et al*., 2016a). They attach to a hard surface, such as seaweed or mussel and oyster shells, and remain attached until reaching around 6 mm in length. The small scallops then detach themselves, settle into sediments and bury in so that only the top flat shell is visible. The juvenile scallops grow quickly and reach marketable size within 18 months (VFA, 2017). Scallop settlement is highly variable, both temporally and spatially (VFA, 2017).

Natural mortality for commercial scallops is variable, with a study from Port Phillip Bay indicating an annual mortality rate of 40%, with other studies in the 1980s indicating a mortality rate of 11-51% (DPI, 2005).

VFA data indicates that very little commercial fishing for scallops has been undertaken in the Project area in the last five years (see Section 6.6.3).

While the dominance of sandy sediments throughout the Project area and surrounds provides abundant suitable scallop habitat, recent surveys indicate that the presence of commercial scallops is nil to low and commercially viable scallop beds are not present.

The VFA undertook a scallop stock assessment survey in December 2017 and January 2018 (extending from the shoreline out to 20 nm and between Wilsons Promontory in the east and Point Hicks in the west, with a total area of 4,859 km^2) (Koopman *et al*., 2018).

Of the 148 survey tows in this area, several were undertaken near the Project area but not within it (Figure 6.11). The closest assessment areas were LE3, LE2 and LE5, which were located 7, 10 and 11 km southeast from the Project area, respectively. No commercial scallops were found at LE3 and LE5 and only 3 kg was uncovered at LE2. The most promising site in the area was LE1, which was located 20 km east of the Project area and averaged 30 kg of scallop per shot. With the exception of LE1, none of the assessment areas presented in Figure 6.11 contained sufficient quantities of scallop to be of commercial interest (Koopman *et al*., 2018).

The CarbonNet-commissioned pre-MSS marine habitat assessment conducted monitoring for scallops at sites close to the Project area. The scallop assessment was conducted in January 2018 using a non-intrusive towed camera and included 60 video transects of sites approximately 10 km southeast of the Project area. During the monitoring, commercial scallops were detected at only six sites with no beds of commercial scallop observed. Further, surveys of benthic fauna conducted by CSIRO in 2017 at sites within and adjacent to the Project area did not identify the presence of commercial scallops.

Southern rock lobster

The southern rock lobster (*Jasus edwardsii*) is found on coastal reefs from the south-west coast of WA to the south coast of NSW, including Tasmania and the New Zealand coastline. Southern rock lobsters are found to depths of 150 m (DPI, 2009). In the Gippsland region, southern rock lobster habitat occurs as patchy, discontinuous low-profile reef running parallel to the coast. Such habitat is known to occur between 800 m and 1 km southwest of the Project area.

The life cycle of the rock lobster is complex. After mating in autumn, fertilised eggs are carried under the tail of the female for approximately three months before being released, typically between September and November. Once released, rock lobster larvae, or phyllosoma, live in the water column as plankton and undergo eleven developmental stages over a period of one to two years while being carried by ocean currents. During metamorphosis, phyllosoma undergo metamorphosis to puerulus, at which stage they can actively swim and can settle in shallow reef habitat (DPI, 2009).

Rock lobsters grow by moulting or shedding their exoskeleton. The frequency of the moulting cycle declines with age, from five moults a year for newly settled juveniles to once a year for mature adults. Males grow faster and larger than females, reaching 160 mm in carapace length after ten years. Females generally reach 120 mm in the same period.

Adult rock lobsters are carnivorous and feed mostly at night on a variety of bottom dwelling invertebrates such as molluscs, crustaceans and echinoderms. Major predators include octopuses and various large fish and sharks. In Victoria, the abundance of rock lobster decreases from west to east reflecting a decrease in the availability of suitable rocky reef habitat (DPI, 2009). Rocky reef is present as scattered patches to the southwest and northeast of the Project area in waters less than 20 m depth (see Section 6.1.2).

During the CarbonNet pre-seismic survey habitat assessment in January 2018, 10 sites of known reef habitat were selected for rock lobster trapping with 81 rock lobster recorded (CarbonNet, 2020). The locations of these sites remain confidential.

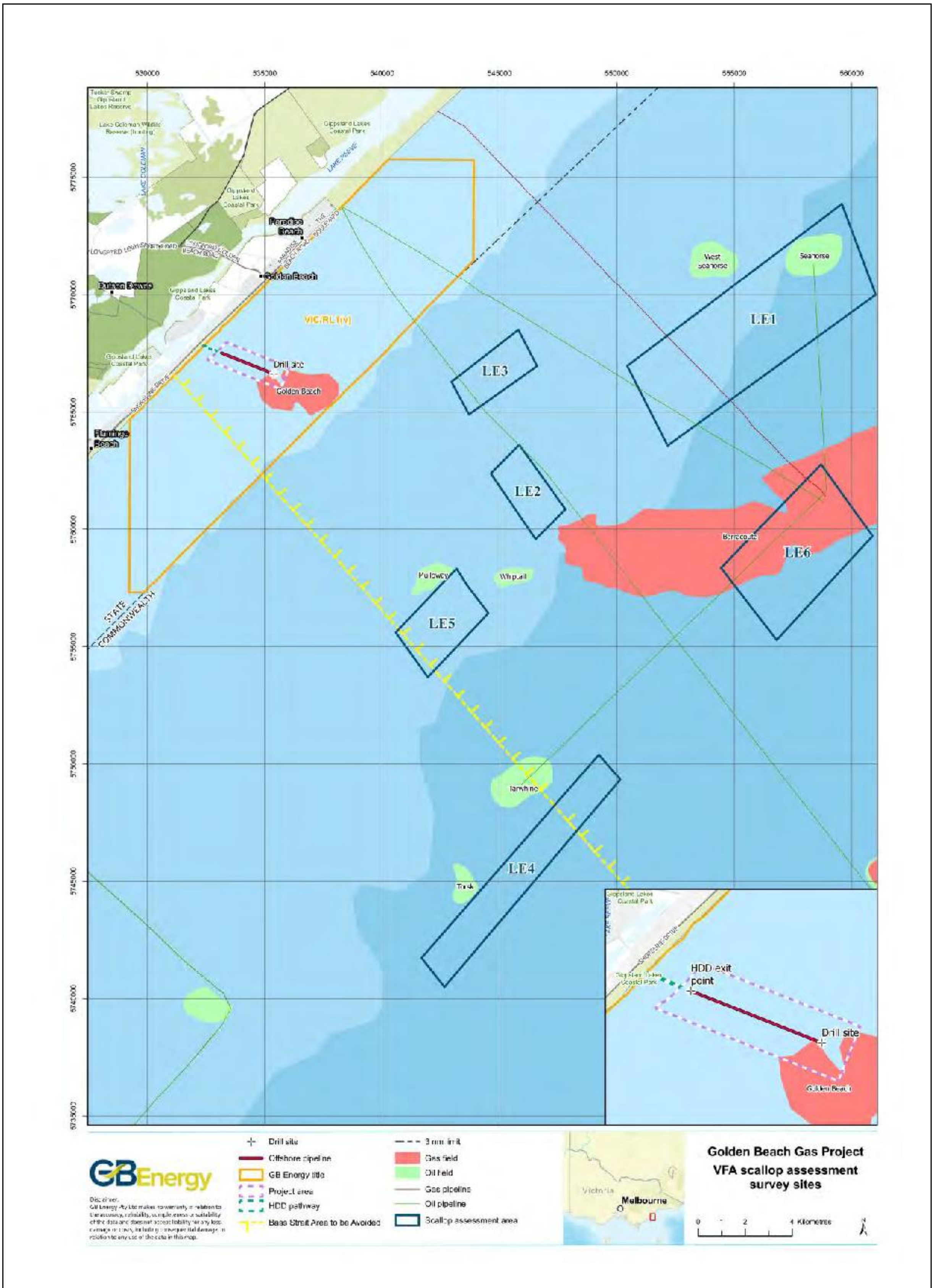


Figure 6.11. Location of VFA scallop investigation sites in proximity to the Project area

6.3.2. Flora

Literature searches, combined with OSRA mapping, indicate that marine flora, such as seagrasses and macroalgae, are generally not abundant in the extensive areas of subtidal sand flats in the nearshore waters of the EMBA, however there are sites in the EMBA where these do occur, such as at Mallacoota Inlet. This is likely due to the high-energy nature of the Gippsland coastline, the mobile nature of sands and the lack of available hard substrate, which prevents many species being able to anchor themselves.

A search of the VBA database for the EMBA reports 53 species of marine flora including red, green and brown algae species.

Barton et al (2012) report that in the Ninety Mile Beach MNP (23 km southwest of the Project area), reefs have sparse floral communities of small red algae. Given the park's proximity, this may be expected to be representative of flora present on rocky reefs near the Project area.

6.3.3. Plankton

Plankton is a key component in oceanic food chains and comprises two elements; phytoplankton and zooplankton, as described herein.

Phytoplankton (photosynthetic microalgae) 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 the currents, although some species have the ability to migrate short distances through the water column using ciliary hairs. Phytoplankton biomass is greatest at the extremities of Bass Strait (particularly in the northeast) where water is shallow and nutrient levels are high.

Zooplankton is the faunal component of plankton, comprising small crustaceans (such as krill) and fish larvae that feed on zooplankton. Zooplankton includes species that drift with the currents and also those that are motile. More than 170 species of zooplankton have been recorded in eastern and central Bass Strait, with copepods making up approximately half of the species encountered (Watson & Chaloupka, 1982). The high diversity may be due to considerable intermingling of distinctive water bodies and may be higher in eastern than in western Bass Strait. Although a high diversity of zooplankton has been recorded in central and western Bass Strait, Kimmerer and McKinnon (1984) found that seven dominant species make up 80% of individuals. The dominant species in order of abundance included:

- *Oithona similis*;
- *Calanus australis*;
- *Oikopleura* spp.*;*
- *Paracalanus indicus*;
- Thaliacea;
- *Penilia avirostis*; and
- *Evadne spinifera*.

An assessment of zooplankton was undertaken to determine pre- and post-MSS abundance of zooplankton at sites within CarbonNet's Pelican MSS area (8 km southeast of the Project area) and at reference sites during January and February 2018. Pre-MSS plankton samples collected were dominated by copepods, cladocerans and salps while post-MSS plankton samples were dominated by the dinoflagellate *Noctiluca scintillans*. Other groups present included siphonophores, fish larvae, fish eggs, polychaetes, ghost shrimps and cnidarians. There was variance between and within assessments, with samples exhibiting levels of diversity and abundance typical of healthy temperate coastal waters. Neither lobster nor scallop larvae were present in any of the samples assessed (CarbonNet, 2018).

Neira (2005) conducted opportunistic plankton surveys around nine offshore oil and gas platforms in Gippsland over summer and winter in 1998-1999. The platforms surveyed are located approximately 25-50 km south and east of the Project area. 108 day-night samples were collected alongside the platforms, which yielded 1,526 larval and early juvenile fish representing 55 taxa from 45 families. Epipelagic/mesopelagic taxa were dominant whereas hard/soft habitat-associated taxa were uncommon. Plankton from the fish families Carangidae (36.2%) and Myctophidae (31.5%) dominated in summer and winter, respectively. Fishes were the most abundant type of plankton, with *Trachurus declivis* (Carangidae, 35.1%) the most abundant taxon followed by *Bovichtus angustifrons* (Bovichtidae, 8.7%), *Scomberesox saurus* (Scomberesocidae, 3.7%) *Centroberyx affinis* (Berycidae, 3.0%) and *Arripis trutta* (Arripidae, 1.7%). Given the proximity of this survey to the Project area, it is expected that these (or similar) taxa may also be found within the Project area.

6.3.4. Fish

It is estimated that there are over 500 species of fish found in the waters of Bass Strait, including a number of species of importance to commercial and recreational fisheries (LCC, 1993). Fish species commercially fished in and around the Project area are listed in Section 6.6.3.

The pre- and post- seismic survey assessment of fish species undertaken by CarbonNet recorded 637 individuals from 39 species before and 523 individuals from 43 species after. The survey found that the most abundant (and common) species recorded during both assessments was the Barber perch (*Caesioperca razor*) (CarbonNet, 2020).

Many species of fish live in the Victorian nearshore waters either as permanent residents or as transients moving seasonally along the coastline. Major fish species that have commercial or recreational fishing importance are presented in Table 6.12.

There are 42 fish species listed under the EPBC Act with potential to occur in the spill EMBA (**Appendix 1**). This includes six species listed as threatened, five species listed as migratory and a further 33 listed marine species all of which are Sygnathiformes (seahorses, pipefishes and their relatives) (Table 6.13). Figure 6.12 illustrates the likely temporal presence and absence of these fish species in the Project area and EMBA. The threatened, migratory and marine species are described in this section. The remaining fish species are listed marine species and not considered threatened (or migratory); however, a permit is required to kill, injure, trade, take or move these species.

A search of the VBA records 75 fish species in the EMBA (DELWP, 2020b). These species are discussed in this section.

The ALA records 729 ray-finned fish in the EMBA, such as leatherjackets, bream, eels, flounder, cowfish, hatchetfish, dragonfish, pigfish, perch, goby, whiptails, dory, lanternfish, moray, whiting, weedfish, wrasse, flathead, flounder, tuna and goatfish. A further 111 cartilaginous fish (sharks, skates and rays) are recorded by the ALA in the EMBA, including catsharks, dogfish, blacktip shark, whitetip shark, lantern sharks, wobbegong, hammerhead, carpet shark, staingarees and rays. For the Project area, the ALA contains records for only two fish species, these being the ornate cowfish (*Aracana ornata*) and the southern pygmy leatherjacket (*Brachaluteres jacksonianus*).

A search of the NSW BioNet Atlas did not record any species of fish from within the Twofold Shelf Subregion. Although, two species of gulper shark (*Centrophorus harrissoni* and *Centrophorus zeehaani*), listed as conservation dependent under the EPBC Act, are predicted to occur in the subregion but no records have been made in the database.

Table 6.12. Principal fish species occurring in Bass Strait with commercial or recreational importance

Habitat	Species
Pelagic nearshore	Pilchards (*Sardinops neopilchardus*) Anchovies (*Engraulis australis*) Sandy sprat (*Hyperlophus vittatus*) Southern garfish (*Hyporhamphus melonochir*) Silver trevally (*Pseudocaranx dentex*) Blue warehou (*Seriolella brama*) Australian salmon (*Arripistrutta A. truttaceus*)
Demersal nearshore	Tiger flathead (*Platycephalus richardsoni*) Sand flathead (*Platycephalus bassensis*) School whiting (*Sillago bassensis*) King George whiting (*Sillaginodes punctatus*) Snapper (*Pagrus auratus*) Gummy shark (*Mustelus antarcticus*)
Demersal mid shelf	School shark (*Galeorhinus galeus*) Saw shark (*Pristiphorus* spp) Elephant shark (*Callorhynchus milii*)

Source: Basslink (2001).

Table 6.13. EPBC Act-listed fish that may occur in the Project area and EMBA

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		BIA within the EMBA?	FFG Act Status	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Freshwater											
Galaxiella pusilla	Dwarf galaxias	V	-	-	L	M	-	L	EN	-	AS
Prototroctes maraena	Australian grayling	V	-	-	L	H	-	L	VU	Yes	RP, AS
Oceanic											
Carcharodon carcharias	Great white shark	V	Yes	-	M	H	B/N	L	VU	-	RP, AS
Carcharias taurus	Grey nurse shark (eastern popltn)	CE	-	-	L	H	-	L	DD	-	RP
Epinephelus daemelii	Black rockcod	V	-	-	L	H	-	-	-	-	CA
Isurus oxyrinchus	Shortfin mako	-	Yes	-	L	H	-	-	-	-	-
Lamna nasus	Porbeagle	-	Yes	-	L	H	-	-	-	-	-
Manta birostris	Giant manta ray	-	Yes	-	L	L	-	-	-	-	-
Rhincodon typus	Whale shark	V	Yes	-	L	L	-	-	-	-	Expired

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		BIA within the EMBA?	FFG Act Status	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Pipefish, seahorses and seadragons											
Acentronura tentaculate	Shortouch pygmy pipehorse	-	-	Yes	L	L	-	-	-	-	-
Cosmo-campus howensis	Lord Howe pipefish	-	-	Yes	L	L	-	-	-	-	-
Heraldia nocturna	Upside-down pipefish	-	-	Yes	L	L	-	-	-	-	-
Hippo-campus abdominalis	Big-belly seahorse	-	-	Yes	L	H	-	-	-	-	-
Hippo-campus breviceps	Short-head seahorse	-	-	Yes	L	L	-	-	-	-	-
Hippo-campus minotaur	Bullneck seahorse	-	-	Yes	L	H	-	-	-	-	-
Hippo-campus whitei	White's seahorse	-	-	Yes	L	L	-	-	-	-	-
Histio-gamphelus briggsii	Crested pipefish	-	-	Yes	L	H	-	-	-	-	-

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		BIA within the EMBA?	FFG Act Status	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Histiogamphelus cristatus	Rhino pipefish	-	-	Yes	L	L	-	-	-	-	-
Hypselo-gnathus rostratus	Knifesnout pipefish	-	-	Yes	L	H	-	-	-	-	-
Kaupus costatus	Deepbody pipefish	-	-	Yes	L	H	-	-	-	-	-
Kimblaeus bassensis	Trawl pipefish	-	-	Yes	L	H	-	-	-	-	-
Leptoichthys fistularius	Brushtail pipefish	-	-	Yes	L	L	-	-	-	-	-
Lissocampus caudalis	Australian smooth pipefish	-	-	Yes	L	L	-	-	-	-	-
Lissocampus runa	Javelin pipefish	-	-	Yes	L	L	-	-	-	-	-
Maroubra perserrata	Sawtooth pipefish	-	-	Yes	L	L	-	-	-	-	-
Mitotichthys semistriatus	Half-banded pipefish	-	-	Yes	L	L	-	-	-	-	-
Mitotichthys tuckeri	Tucker's Pipefish	-	-	Yes	L	L	-	-	-	-	-
Notiocampus ruber	Red pipefish	-	-	Yes	L	L	-	-	-	-	-

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		BIA within the EMBA?	FFG Act Status	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Phycodurus eques	Leafy seadragon	-	-	Yes	L	L	-	-	-	-	-
Phyllopteryx taeniolatus	Common seadragon	-	-	Yes	L	L	-	-	-	-	-
Pugnaso curtirostris	Pugnose pipefish	-	-	Yes	L	L	-	-	-	-	-
Solegnathus robustus	Robust pipehorse	-	-	Yes	L	L	-	-	-	-	-
Solegnathus spino-sissimus	Spiny pipehorse	-	-	Yes	L	H	-	-	-	-	-
Soleno-stomus cyanopterus	Robust ghost pipefish	-	-	Yes	L	L	-	-	-	-	-
Stigmatopora argus	Spotted pipefish	-	-	Yes	L	H	-	-	-	-	-
Stigmatopora nigra	Widebody pipefish	-	-	Yes	L	H	-	-	-	-	-
Stipecampus cristatus	Ringback pipefish	-	-	Yes	L	L	-	-	-	-	-
Syngna-thoides biaculeatus	Double-end pipehorse	-	-	Yes	L	L	-	-	-	-	-
Urocampus carinirostris	Hairy pipefish	-	-	Yes	L	H	-	-	-	-	-

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		BIA within the EMBA?	FFG Act Status	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Vanacampus margaritifer	Mother-of-pearl pipefish	-	-	Yes	L	H	-	-	-	-	-
Vanacampus phillipi	Port Phillip pipefish	-	-	Yes	L	H	-	-	-	-	-
Vanacampus poecilo-laemus	Longsnout pipefish	-	-	Yes	L	L	-	-	-	-	-

Definitions

EPBC Act	Description
Listed threatened species	A native species listed in Section 178 of the *EPBC Act* as either extinct, extinct in the wild, critically endangered, endangered, and vulnerable or conservation dependent.
Listed migratory species	A native species that from time to time is included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the *EPBC Act*.
Listed marine species	As listed in Section 248 of the *EPBC Act*.

FFG Act	Description
Listed (L)	Listed as threatened
Nominated (N)	Nominated for listing as threatened but has not yet been listed. In some cases, the taxon may have received a preliminary or final recommendation indicating that it is eligible or ineligible for listing. In other cases, the nomination might not yet have been considered.
Invalid or ineligible (I)	Nominated but rejected for listing as threatened on the basis that the taxon was considered to be invalid (either undescribed or not widely accepted) or ineligible (taxon does not satisfy any of the primary listing criteria) by the SAC.
Delisted (D)	Previously listed as threatened but subsequently removed from the Threatened List following nomination for delisting.

DELWP Advisory List	Description
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual) and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Regionally Extinct (RX)	As for Extinct but within a defined region (in this case the state of Victoria) that does not encompass the entire geographic range of the taxon. A taxon is presumed Regionally Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout the region have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CE)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (IUCN Standards and Petitions Subcommittee 2010), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (IUCN Standards and Petitions Subcommittee 2010), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (IUCN Standards and Petitions Subcommittee 2010), and it is therefore considered to be facing a high risk of extinction in the wild
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future.
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

Key

EPBC status (@ April 2020)	V	Vulnerable
	E	Endangered
	CE	Critically endangered
BIA	A	Aggregation
	D	Distribution (i.e., presence only)
	F	Foraging
	M	Migration
Recovery plans	CA	Conservation Advice
(under the EPBC Act 1999)	CMP	Conservation Management Plan
	RP	Recovery Plan
(under the FFG Act 1988)	AS	Action Statement

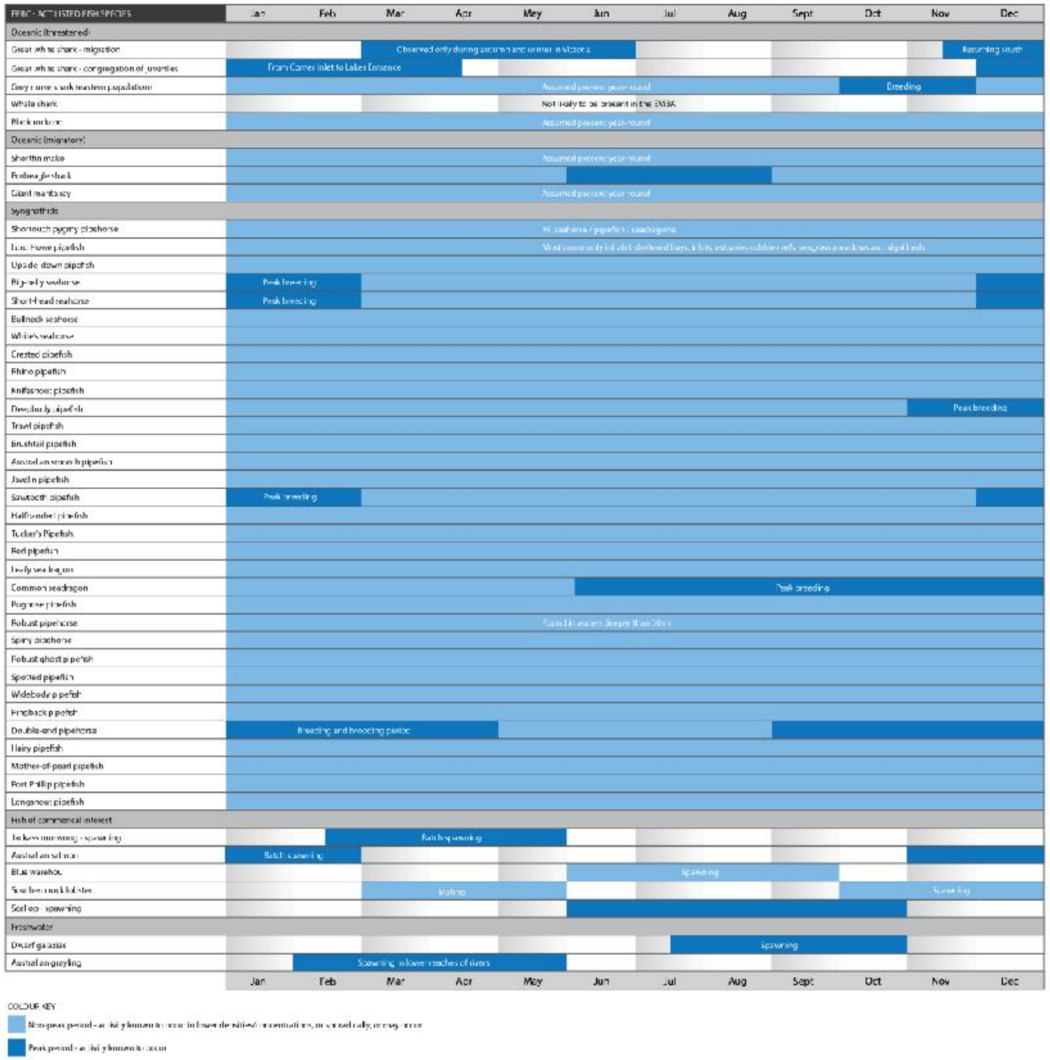


Figure 6.12. Likely temporal presence and absence of EPBC Act-listed fish species in the Project area and EMBA

Dwarf galaxias (*Galaxiella pusilla*) (EPBC Act: Vulnerable, FFG Act: Threatened)

Habitat suitable to the dwarf galaxias is slow flowing and still, shallow, permanent and temporary freshwater habitats such as swamps, drains and the backwaters of streams and creeks, often (but not always) containing dense aquatic macrophytes and emergent plants (Saddlier *et al*., 2010; DELWP, 2015a). Freshwater habitat does not occur within the Project area for this species.

There are 46 rivers and wetlands that are listed in the Dwarf Galaxias Action Statement (DELWP, 2015a) as being important to the species, none of which are intersected by the EMBA.

There are no records in the VBA or ALA of this species occurring within the EMBA. Neither database has records for this species in the Project area.

Australian grayling (*Prototroctes maraena*) (EPBC Act: Vulnerable, FFG Act: Threatened)

The Australian grayling is a dark brown to olive-green fish attaining 19 cm in length. The species typically inhabits the coastal streams of New South Wales, Victoria and Tasmania, migrating between streams and the ocean (Backhouse *et al*., 2008; DELWP, 2015b). The species spends most of its life in freshwater (DELWP, 2015b), and migrates to lower reaches of rivers to spawn in autumn (Museums Victoria, 2020), though timing is dependent on many variables including latitude and varying temperature regimes (Backhouse *et al*., 2008), with increased stream flows also thought to initiate migration (DELWP, 2015b).

Threatening processes to this species include barriers to movement, river regulation, poor water quality, siltation, introduced fish, climate change, diseases and fishing (Backhouse *et al*., 2008; DELWP, 2015b).

Several rivers intersected by the EMBA (at their mouths, when open) are listed as important locations for the species (DELWP, 2015b). The species may therefore be present in the EMBA in the relatively rare event that creek and river mouths are open and the species is spawning.

The ALA has records of this species occurring within the EMBA, though the VBA does not. Neither database has records for this species in the Project area.

Great white shark (EPBC Act: Vulnerable, FFG Act: Threatened)

The great 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 (DSEWPC, 2013).

Studies of great white sharks indicate that they are usually solitary animals, largely transient and only temporarily resident (e.g., days to weeks) in areas it inhabits (DSE, 2003; DSEWPC, 2013). However, individuals are known to return to feeding grounds on a seasonal basis (Klimley & Anderson, 1996). The species moves seasonally along the south and east Australian coasts, moving northerly along the coast during autumn and winter and returning to southern Australian waters by early summer.

Observations of adult sharks are more frequent around fur seal and sea lion colonies, including Wilsons Promontory (approximately 107 km southwest of the Project area) and the Skerries (approximately 196 km northeast of the Project area) (DSE, 2003).

Juveniles are known to congregate in certain key areas including the Ninety Mile Beach area (including Corner Inlet and Lakes Entrance), where a BIA for breeding is overlapped by the Project area (Figure 6.13).

Museums Victoria (2017) indicates that Corner Inlet may be an important nursery area for the eastern population of great white sharks, mostly from mid-summer through to autumn (DSEWPC, 2013). A BIA (distribution only) for the great white shark covers the entire southeast marine region, with the nearest feeding BIA being around Kangaroo Island in South Australia (875 km to the west-northwest).

Key threats to the species, as listed in the White Shark Recovery Plan (DSEWPC, 2013) and Great White Shark Action Statement (DSE, 2003) are mortality from targeted fishing, accidental fishing bycatch and illegal fishing, and mortality from shark control activities (such as beach meshing and drum lining), none of which will take place during the project. Similarly, the project will have no impact on the 10 objectives for protection listed in the plan. Given their transitory nature and the proximity of known congregation areas, great white sharks may occur within the Project area and EMBA, particularly during early summer.

The ALA has records of this species occurring within the EMBA, though the VBA does not. Neither database has records for this species in the Project area.

Black rockcod (EPBC Act: Vulnerable, FFG Act: Not listed)

The black rockcod (*Epinephelus daemelii*) is a large cod species distributed in warm temperate to temperate marine waters of south-eastern Australia, from southern Queensland to Mallacoota in Victoria, and rarely south of this point (DSEWPC, 2012b). The species inhabits caves, gutters and crevices generally to depths of 50 m, with juveniles found inshore. Individuals are highly territorial and have small home ranges (DSEWPC, 2012b). The black rockcod is a protogynous hermaphrodite, meaning it changes sex from female to male during its life cycle. The species has declined in number due to angling and spearfishing (DSEWPC, 2012b). Given their known distribution, the black rockcod may occur in suitable habitat within the far-eastern area of the EMBA north of Mallacoota.

The ALA has records of this species occurring within the EMBA, though the VBA does not. Neither database has records for this species in the Project area.

Grey nurse shark (east coast population) (EPBC Act: CE, FFG Act: Threatened)

The grey nurse shark (*Carcharius taurus*) (eastern population) is a large robust species that has become critically endangered due to commercial fishing, spearfishing and protective beach meshing (TSSC, 2001). It was historically widespread in sub-tropical and warm temperate seas and previously recorded from all Australian states except Tasmania, and have all but disappeared from Victorian waters (TSSC, 2001).

The species currently has a broad inshore distribution throughout sub-tropical to cool temperate waters on the continental shelf, with separate east coast and west coast populations (DoE, 2014b). The east coast population extends from central Queensland to southern NSW, occasionally as far south as the NSW/Victoria border (DoE, 2014b), which coincides with the BIA for their distribution and breeding (October to November).

Preferred habitat for grey nurse sharks is inshore rocky reefs or islands, generally aggregating near the seabed in water depths of 10-40 m in deep sandy or gravel filled gutters, or in rocky caves (DoE, 2014b). There are no known aggregation sites located off the Victorian coast (DoE, 2014b).

Given the current distribution of the grey nurse shark, it is unlikely to occur within the spill EMBA in significant numbers.

There are no records in the ALA or VBA of this species occurring within the EMBA. Neither database has records for this species in the Project area.

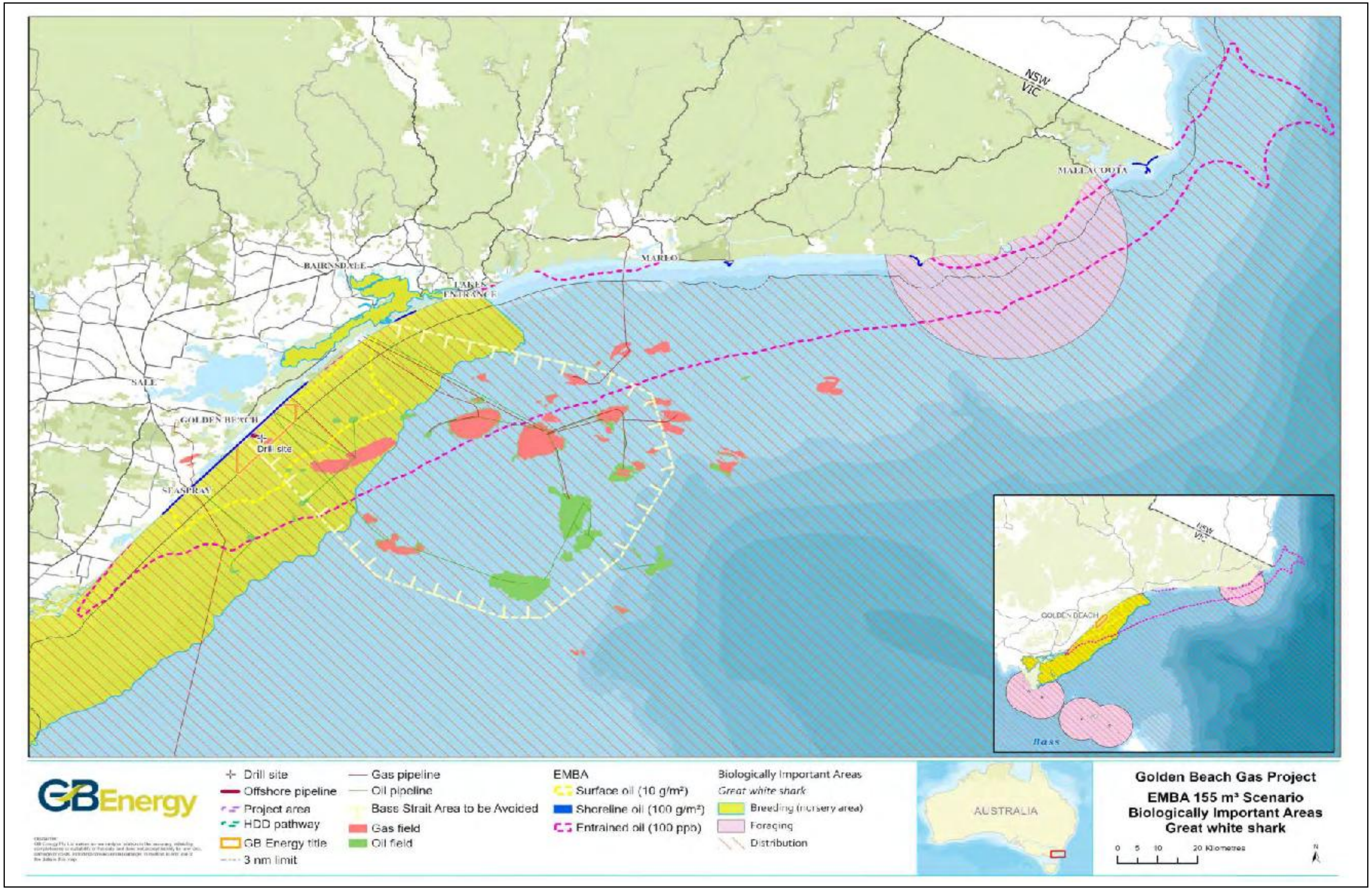


Figure 6.13a. Great white shark BIA intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

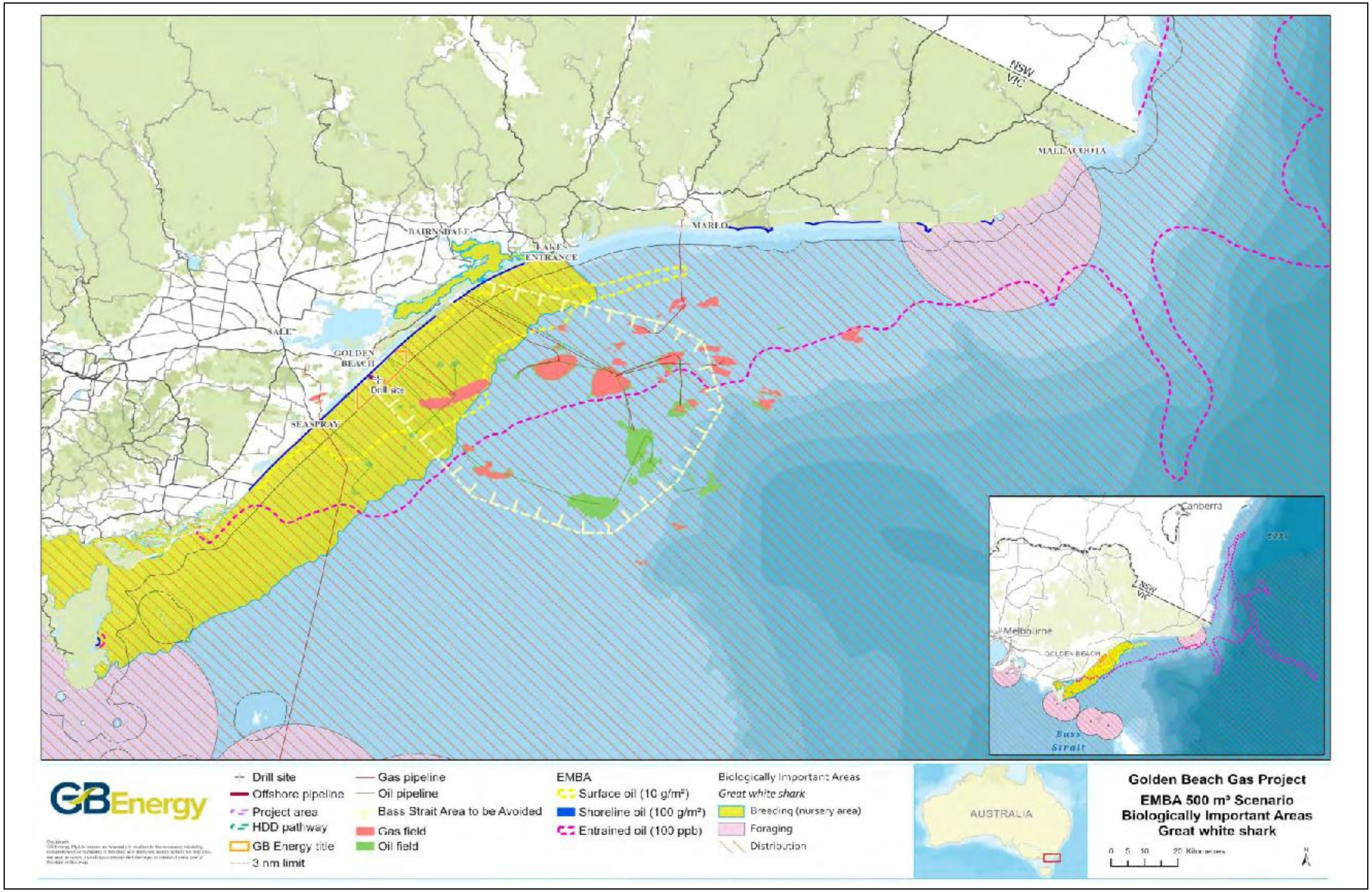


Figure 6.13b. Great white shark BIA intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

Shortfin mako shark (EPBC Act: Listed migratory, FFG Act: Not listed)

The shortfin mako shark (*Isurus oxyrinchus*) is a pelagic species with a circum-global, wide-ranging oceanic distribution in tropical and temperate seas (Mollet *et al*., 2000), though the timing of occurrence is not reported. It is widespread in Australian waters, commonly found in water with temperatures greater than 16°C (Museums Victoria, 2020). Populations of the shortfin mako are considered to have undergone a substantial decline globally. These sharks are common by-catch species of commercial fisheries (Mollet *et al*., 2000).

The ALA has records of this species occurring within the EMBA, though the VBA does not. Neither database has records for this species in the Project area.

Due to their widespread distribution in Australian waters, shortfin mako sharks may be encountered in the Project area and EMBA, albeit in low numbers.

Porbeagle shark (EPBC Act: Listed migratory, FFG Act: Not listed)

The porbeagle shark (*Lamna nasus*) is widespread in the southern waters of Australia (Museums Victoria, 2020), though the timing of occurrence is not reported. The species preys on bony fishes and cephalopods, and is an opportunistic hunter that regularly moves up and down in the water column, catching prey in mid-water as well as at the seafloor. It is most commonly found over food-rich banks on the outer continental shelf, but does make occasional foray close to shore or into the open ocean, down to depths of approximately 1,300 m. It also conducts long-distance seasonal migrations, generally shifting between shallower and deeper water (Pade *et al*., 2009).

The ALA has records of this species occurring within the EMBA, though the VBA does not. Neither database has records for this species in the Project area.

Due to their widespread distribution in Australian waters, porbeagle sharks may be encountered in the Project area and EMBA, albeit in low numbers.

Whale shark (EPBC Act: Vulnerable, listed migratory, FFG Act: Not listed)

The whale shark (*Rhincodon typus*) is the world’s largest fish and one of only three filter-feeding shark species (TSSC, 2015a). They have a broad distribution in warm and tropical waters of the world, and in Australia are known only to occur on the west coast of Western Australia, with a feeding aggregation occurring off the Ningaloo Reef between March and July each year (TSSC, 2015a). The species is not known to migrate through Bass Strait, and it is highly unlikely to occur within the Project area or the EMBA.

There are no records in the ALA or VBA of this species occurring within the EMBA. Neither database has records for this species in the Project area.

Giant Manta Ray (EPBC Act: Listed migratory, FFG Act: Not listed)

Giant manta rays (*Manta birostris*) are the largest species of ray in the world with a circumglobal distribution and are typically found in tropical and subtropical waters but can also be found in temperate waters. The giant manta ray is an ocean-going species and spends most of its life travelling with the currents and migrating to of upwellings where nutrient-rich water increases the availability of zooplankton (Museums Victoria, 2020).

There are no records in the ALA or VBA of this species occurring within the EMBA.

Giant manta rays may travel through the furthest eastern extent of the EMBA and are not likely to be present in the Project area. Neither database has records for this species in the Project area.

Sygnathids (EPBC Act: Listed marine species, FFG Act: Not listed)

Thirty-three (33) of the 42 marine ray-finned fish species identified in the EPBC Act PMST (79%) are sygnathiformes, which includes seahorses, seadragon, pipehorse and pipefish. The majority of these fish species are associated with seagrass meadows, macroalgal seabed habitats, rocky reefs and sponge gardens located in shallow, inshore waters (e.g., protected coastal bays, harbours and jetties) less than 50 m deep (Museums Victoria, 2020). They are sometimes recorded in deeper offshore waters, where they depend on the protection of sponges and rafts of floating seaweed such as *Sargassum*. It is likely that sygnathid species occur at the rocky reef to the southwest of the Project area and at rocky reef sites throughout the EMBA.

The PMST species profile and threats profiles indicate that the sygnathiforme species listed for the EMBA are widely distributed throughout southern, south-eastern and south-western Australian waters. The diverse range of ecological niches afforded by rocky reef sites throughout eastern Bass Strait would be expected to provide suitable habitat for these listed species. Whereas the absence of reef and seagrass habitat observed within the Project area (see Section 6.1.2) would suggest the diversity and abundance of these species would be far less in the Project area.

There are several syngnathid species recorded in the ALA for the EMBA, but no records in the VBA of sygnathids occurring within the EMBA. Neither database has records for this group in the Project area.

Fish Species Recorded in the ALA and VBA

In addition to the EPBC Act-listed fish species addressed in this section, the ALA records 729 ray-finned fish species and the VBA records 75 fish species within the EMBA. The Macquarie perch (*Macquaria australasica*) (one sighting) is listed as threatened under the FFG Act, however this is a freshwater species and not likely to be encountered in the EMBA.

Among the more commonly sighted fish species are wrasse and perch (DELWP, 2020b). These groups are described here. The full list of VBA records for fish species recorded in the EMBA is presented in **Appendix 2**, with those from the ALA in **Appendix 3**.

Unless otherwise referenced, this information is sourced from the Fishes of Australia online database (Museums Victoria, 2020).

<u>Wrasse</u>

Sightings of six species of wrasse (purple, blue throated, southern Maori, senator, luculent and rosy) are recorded in the VBA database within the spill EMBA. The purple wrasse is the most commonly recorded with 74 sightings. Wrasse are typically small fish (less than 20 cm long), widespread in southern Australian water, brightly coloured and most found at depths of 2 – 60 m (though the rosy wrasse occurs in depths up to 200 m). They are efficient carnivores, feeding on a wide range of hard-shelled benthic invertebrates such as gastropods, bivalve molluscs, crabs, chitons, limpets and sea urchins (Museums Victoria, 2020). Juveniles feed mostly on small crustaceans such as amphipods and isopods and have also been seen removing parasites from other fish. Generally, wrasses are found in shallow-water habitats such as coral reefs, rocky shores, sheltered sandy areas and in general association with reef habitat where they live close to the substrate. Given their habitat preferences, it is likely that wrasse are present within the shallow nearshore waters of the EMBA at all times of the year.

<u>Perch</u>

Six species of perch (butterfly, barber, reef ocean, Macquarie, estuary and flinders pygmy) are recorded in the VBA database for the EMBA. The butterfly perch is most commonly sighted. Butterfly, barber and reef ocean perch are widely distributed across southern Australia and vary in their feeding behaviours. The Macquarie and flinders pygmy perch are freshwater species and are unlikely to occur in the EMBA.

Butterfly and barber perch form large schools that feed on plankton above high-profile rocky reefs, outcrops and dropoffs of 4-100 m water depth. They shelter in caves and crevices at night, often sheltering in small groups, where they feed by sucking benthic invertebrates such as molluscs and polychaete worms from the bottom sediment and patches of turf algae (Museums Victoria, 2020). Reef ocean perch feed on squid, shrimp and other fish among coastal rocky reefs and sandy areas usually in deeper water (up to 425 m). Estuary perch are endemic to coastal rivers and estuaries of south-eastern Australia, including coastal rivers in Bass Strait. Adults inhabit brackish water, preferring the upper reaches of estuaries. Adults migrate to the mouths of estuaries to spawn during winter.

Butterfly, barber and reef ocean perch are likely to be present in the spill EMBA while estuary perch if present, would be restricted to the mouths of estuaries during winter.

CSIRO Investigations

The CSIRO investigations conducted in the Project area included fish baiting. Only raw video footage of these investigations was made available to GB Energy; no associated interpretive report or monitoring locations were made available. As such, it is not possible to determine species diversity and abundance. Though the exact location of the fish baiting cannot be identified, the footage captured can be used to assume that the fish present in the videos, such as sharks, are mobile through and around the Project area (Photo 6.17).

	
 Likely gummy shark (*Mustelus antarcticus*)	 Likely Port Jackson shark (*Heterodontus portusjacksoni*)

Photo 6.17. Fish species observed by CSIRO investigations

6.3.5. Cetaceans

The PMST indicates that 25 whale species and eight dolphin species may reside within or migrate through the Project area and EMBA. These species are presented in Table 6.14 and a description focused on threatened species follows. Figure 6.14 illustrates the likely temporal presence and absence of cetaceans in the Project area and EMBA.

All species recorded in the VBA database and NSW BioNet Atlas are also recorded in the PMST results. The ALA has no cetacean records for the Project area, but 21 species for the EMBA.

DELWP notes that all cetacean sightings from their annual aerial surveys are included in the VBA up to the end of 2018. For their 2019 surveys, there are no cetacean sightings from within the Project area and seven records (only of southern right whales) in the EMBA (east Gippsland and southern NSW).

Table 6.14. EPBC Act-listed cetaceans that may occur in the Project area and EMBA

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA ?	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Whales											
Balaenoptera acutorostrata	Minke whale	-	-	Yes	L	H	-	-	-	Yes	-
Balaenoptera bonaerensis	Antarctic minke whale	-	Yes	Yes	L	L	-	-	-	-	-
Balaenoptera borealis	Sei whale	V	Yes	Yes	L	L	-	-	DD	-	CA
Balaenoptera edeni	Bryde’s whale	-	Yes	Yes	L	L	-	-	DD	-	-
Balaenoptera musculus	Blue whale (pygmy)	E	Yes	Yes	M	H	L	F, D	CE	Yes	RP, AS
Balaenoptera physalus	Fin whale	V	Yes	Yes	L	H	-	-	DD	-	CA
Erardius arnuxii	Arnoux’s beaked whale	-	-	Yes	L	L	-	-	-	-	-
Caperea marginata	Pygmy right whale	-	Yes	Yes	L	H	-	F	-	-	-
Eubalaena australis	Southern right whale	E	Yes	Yes	M	H	L	M	CE	Yes	CMP, AS
Globicephala macrorhynchus	Short-finned pilot whale	-	-	Yes	L	L	-	-	-	-	-
Globicephala melas	Long-finned pilot whale	-	-	Yes	L	L	-	-	-	-	-

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA ?	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Hyperoodon planifrons	Southern bottlenose whale	-	-	Yes	L	H	-	-	-	-	-
Kogia breviceps	Pygmy sperm whale	-	-	Yes	L	H	-	-	-	Yes	-
Kogia simus	Dwarf sperm whale	-	-	Yes	L	H	-	-	-	-	-
Megaptera novaeangliae	Humpback whale	V	Yes	Yes	M	H	L	F	VU	Yes	CA, AS
Mesoplodon bowdoini	Andrew's beaked whale	-	-	Yes	L	L	-	-	-	-	-
Mesoplodon densirostris	Blainville's beaked whale	-	-	Yes	L	H	-	-	-	-	-
Mesoplodon ginkgodens	Ginko-toothed beaked whale	-	-	Yes	L	L	-	-	-	-	-
Mesoplodon grayi	Gray's beaked whale	-	-	Yes	L	H	-	-	-	Yes	-
Mesoplodon hectori	Hector's beaked whale	-	-	Yes	L	L	-	-	-	-	-
Mesoplodon layardii	Sharp-toothed beaked whale	-	-	Yes	L	H	-	-	-	-	-
Mesoplodon mirus	True's beaked whale	-	-	Yes	L	L	-	-	-	-	-
Physeter macrocephalus	Sperm whale	-	Yes	Yes	L	H	-	-	-	Yes	-

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA ?	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Tasmacetus shepherdi	Shepherd's beaked whale	-	-	Yes	L	L	-	-	-	-	-
Ziphius cavirostris	Cuvier's beaked whale	-	-	Yes	L	H	-	-	-	-	-
Dolphins											
Delphinus delphis	Common dolphin	-	-	Yes	M	H	-	-	-	-	-
Grampus griseus	Risso's dolphin	-	-	Yes	L	H	-	-	-	-	-
Lagenorhynchus obscurus	Dusky dolphin	-	Yes	Yes	L	L	-	-	-	-	-
Lissodelphis peronii	Southern right whale dolphin	-	-	Yes	L	L	-	-	-	-	-
Orcinus orca	Killer whale	-	Yes	Yes	L	H	-	-	-	Yes	-
Pseudorca crassidens	False killer whale	-	-	Yes	L	H	-	-	-	Yes	-
Tursiops aduncus	Indian Ocean bottlenose dolphin	-	-	Yes	L	H	-	-	-	-	-
Tursiops truncatus	Bottlenose dolphin	-	-	Yes	M	H	-	-	-	Yes	-

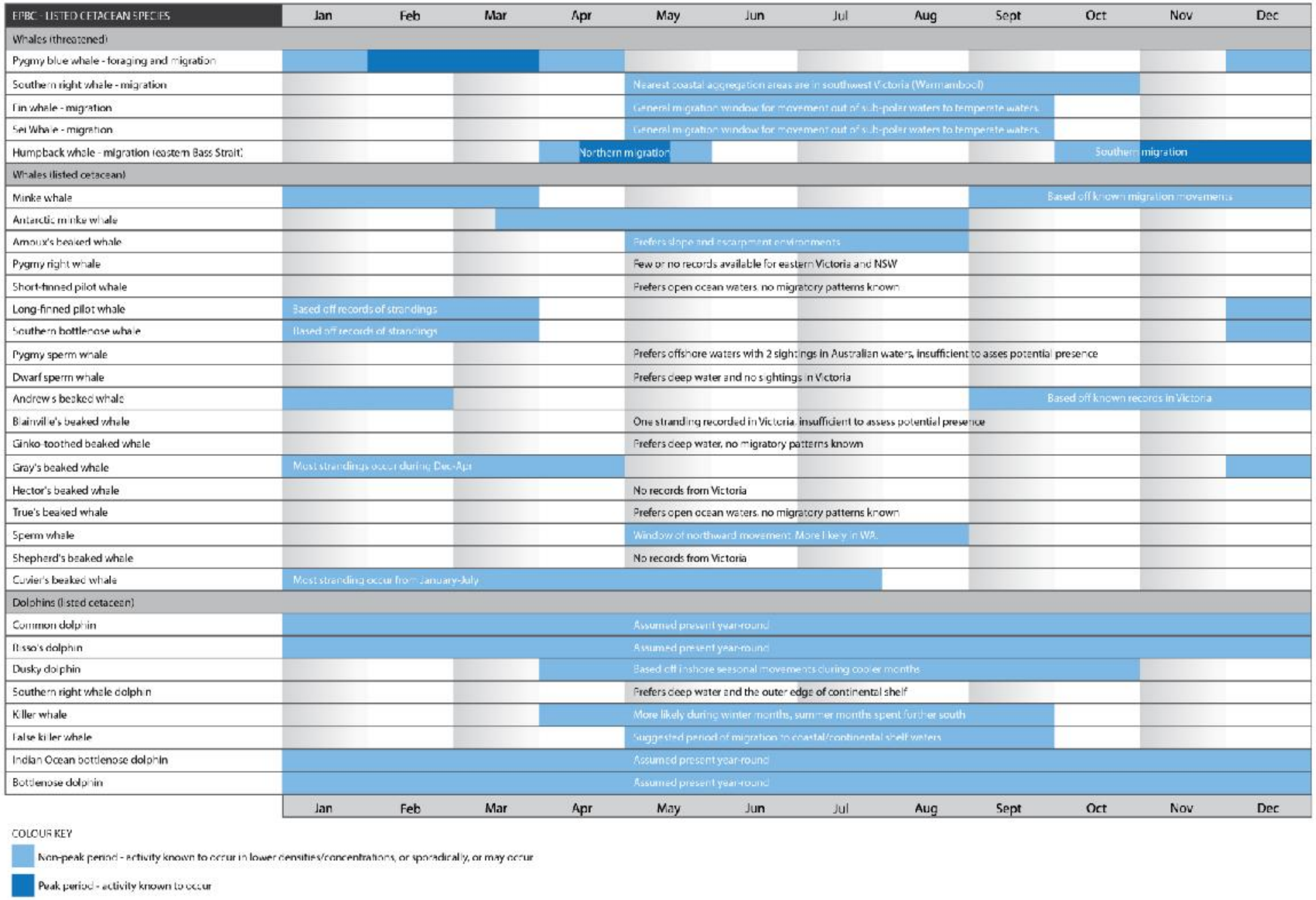


Figure 6.14. Likely temporal presence and absence of EPBC Act-listed cetacean species in the Project area and EMBA

Pygmy blue whale (EPBC Act: Endangered, listed migratory, FFG Act: Threatened)

Blue whales (*Balaenoptera musculus*) are the largest living animals on earth, growing to a length of over 30 m, weighing up to 180 tonnes and living up to 90 years (DoE, 2015b). The DoE (2015b) recognises three overlapping populations, being:

- Antarctic blue whale population – all those Antarctic blue whales occupying or passing through Australian waters;
- Indo-Australian pygmy blue whale – all those pygmy blue whales occupying or passing through waters from Indonesia to western and southern Australia; and
- Tasman-Pacific pygmy blue whale – all those putative pygmy blue whales occupying or passing through waters in southeast Australia and the Pacific Ocean.

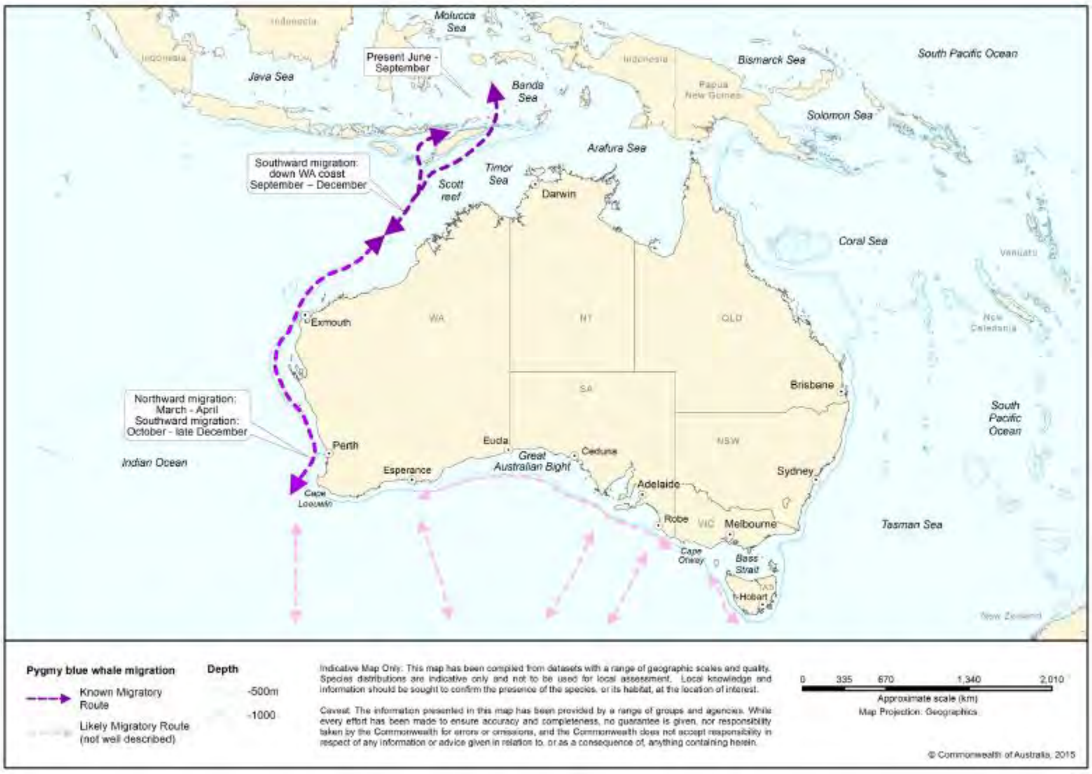
The Tasman-Pacific pygmy blue whale (*B. musculus. brevicauda*) is the sub-species that migrates through Bass Strait, found in waters north of 55°S (DoE, 2015b). Blue whales are a highly mobile species that feed on krill (euphausids, *Nyctiphane australis*).

The DoE (2015b) states that migratory routes for pygmy blue whales off the east coast of Australia are unknown (as seen by the absence of migratory routes in Figure 6.15). However, blue whale migration patterns are thought to be similar to 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 (DoE, 2015b).

A BIA for 'possible foraging area' for the pygmy blue whale covers most of eastern Bass Strait, including the Project area, with known foraging areas with high annual use (abundant food source) occurring off the southwest Victorian coast (Figure 6.16).

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 (DoE, 2015b; 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 upwelling favourable winds. 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, 2015b).

The Conservation Management Plan for the Blue Whale (DoE, 2015b) identifies vessel strike and anthropogenic noise as threats to the species, the latter important as it may mask vocalisations or cause injury or death. Given the intersection of the foraging BIA with the Project area, it is possible that pygmy blue whales migrate through the Project area, though this possibility is low, and sightings would be most likely to occur during autumn. The ALA and VBA both record this species in the EMBA.



Source: DoE (2015b)

Figure 6.15. Pygmy blue whale migration routes

Pygmy right whale (EPBC Act: Listed migratory, FFG Act: Not listed)

Pygmy right whales (*Caperea marginata*) 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 (DAWE, 2020b). 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, the absence of a BIA in Australian waters and the nearshore location of the survey area, it is considered unlikely that this species occurs within the Project area. The VBA contains no records for the species in the Project area or EMBA, while the ALA records the species in the EMBA but not the Project area.

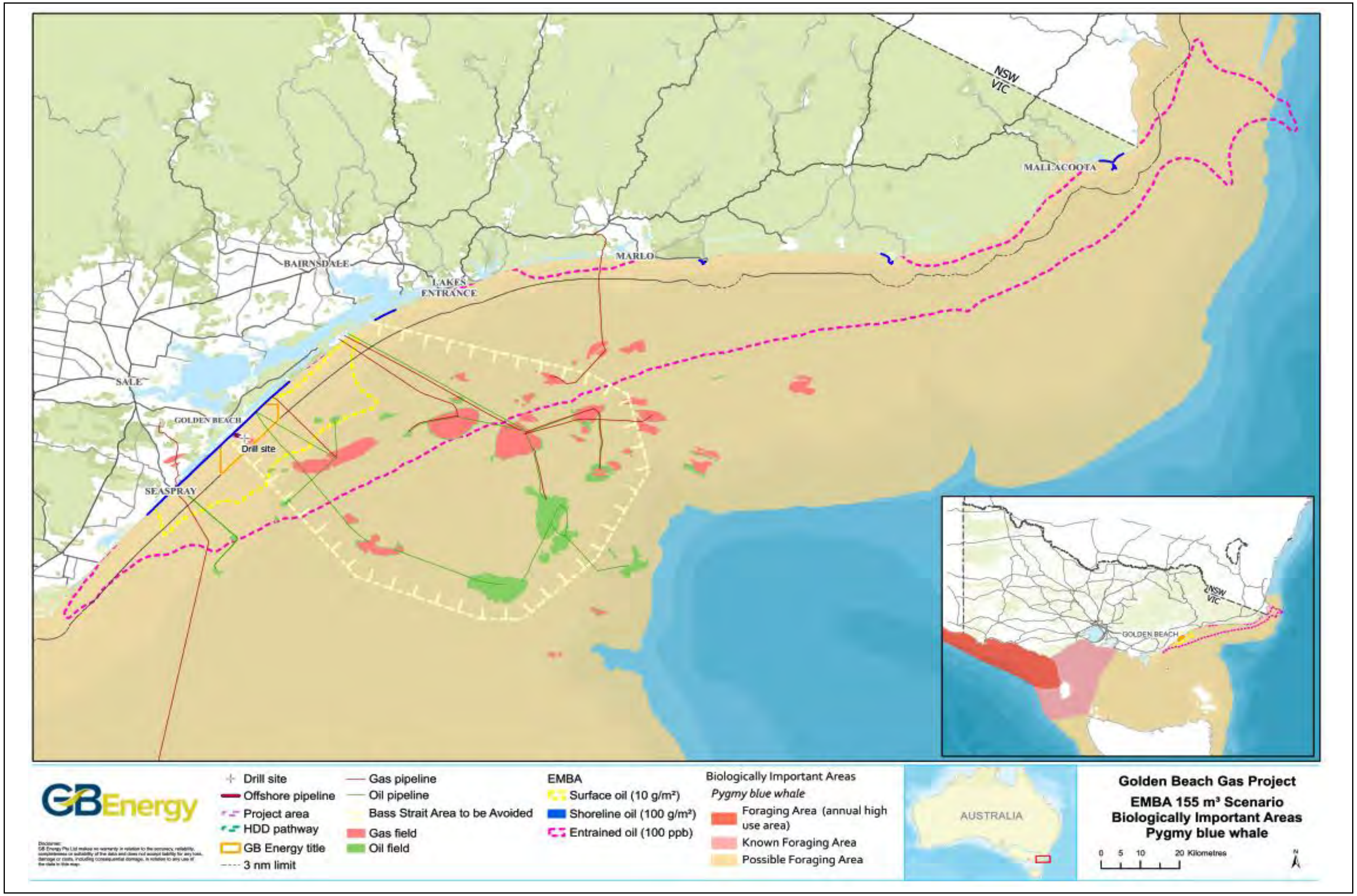


Figure 6.16a. Pygmy blue whale BIA intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

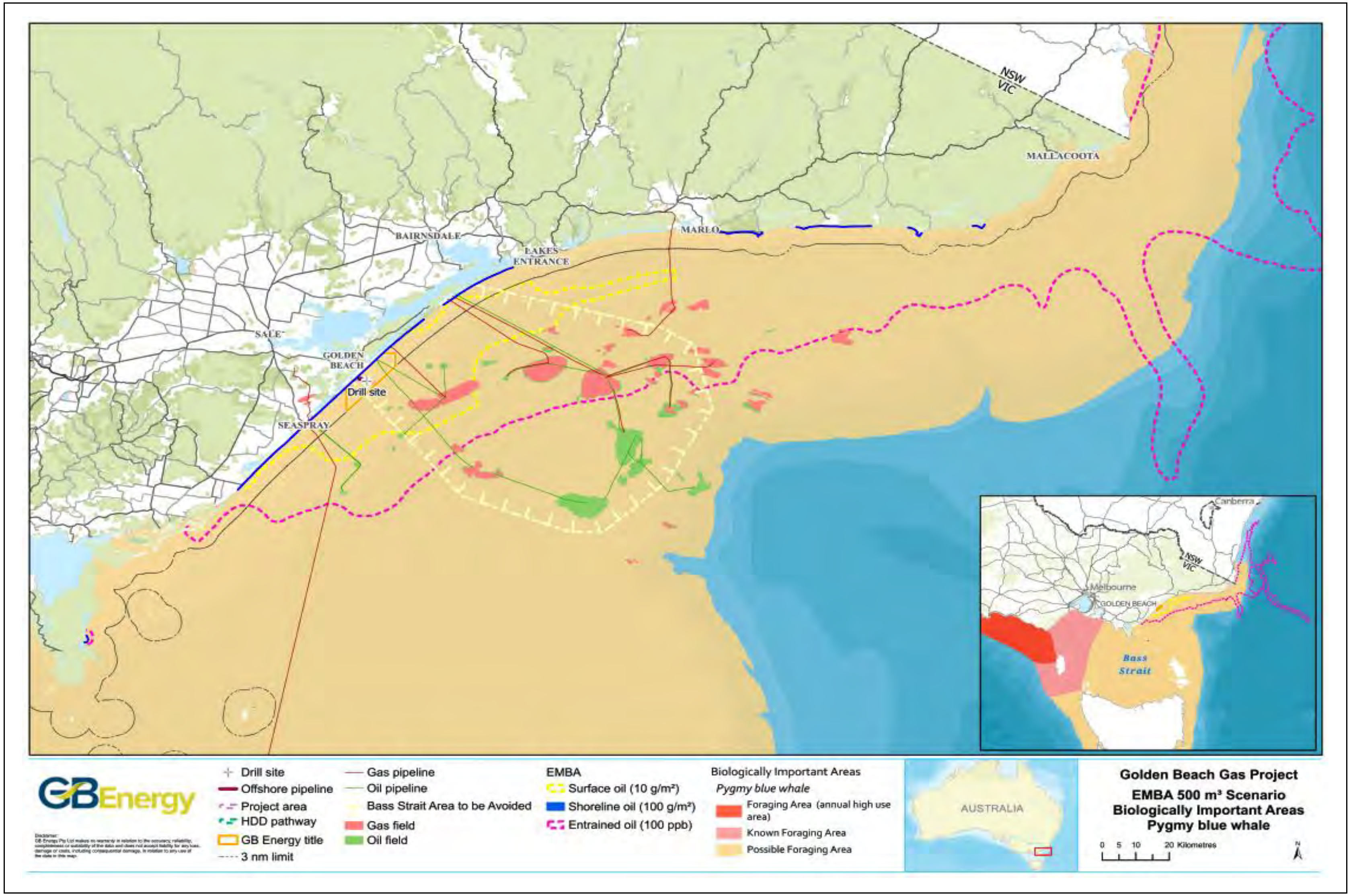


Figure 6.16b. Pygmy blue whale BIA intersected by the pipeline operations phase EMBA (500 m^3 spill scenario)

Southern right whale (EPBC Act: Endangered, listed migratory, FFG Act: Threatened)

Southern right whales (*Eubalaena australis*) are medium to large black (or less commonly grey-brown) baleen whales (DSEWPC, 2012c). They are recognisable by the lack of a dorsal fin, rotund body shape, and whitish callosities (patches of keratinised skin colonised by cyamids - small crustaceans) on the head. They reach a maximum length of approximately 17.5 m and a weight of around 80 tonnes, with mature females slightly larger than males (DSEWPC, 2012c).

Nineteenth century whaling drastically reduced southern right whale numbers. An estimated 55,000 to 70,000 whales were present in the southern hemisphere in the late 1700s (DSEWPC, 2012c). However, by the 1920s there may have been fewer than 300 individuals remaining throughout the southern hemisphere (DSEWPC, 2012c). Other reports suggest the number of individuals in Australia was reduced to 1,500 (Charlton *et al*., 2014). The Australian population is estimated at 3,500 individuals (Charlton *et al*., 2014).

The southern right whale is typically distributed between 16°S and 65°S in the southern hemisphere and is present off the Australian coast between May and October (sometimes as early as April and as late as November) (DSEWPC, 2012c) (Figure 6.17). This species generally migrates to the warmer waters of Southern Australia during winter and inhabits sub-Antarctic waters in the summer, where their main feeding grounds are generally between 40°S and 55°S (DoEE, 2005). During winter and spring southern right whales breed in shallow coastal waters, less than 5 m in depth (DoEE, 2005; Payne, 1986)

Southern right whales tend to be distinctly clumped in aggregation areas (DSEWPC, 2012c). Aggregation areas are well known, with the largest located at:

- Doubtful Island Bay area in WA;
- Israelite Bay area in WA; and
- Head of Bight in SA.

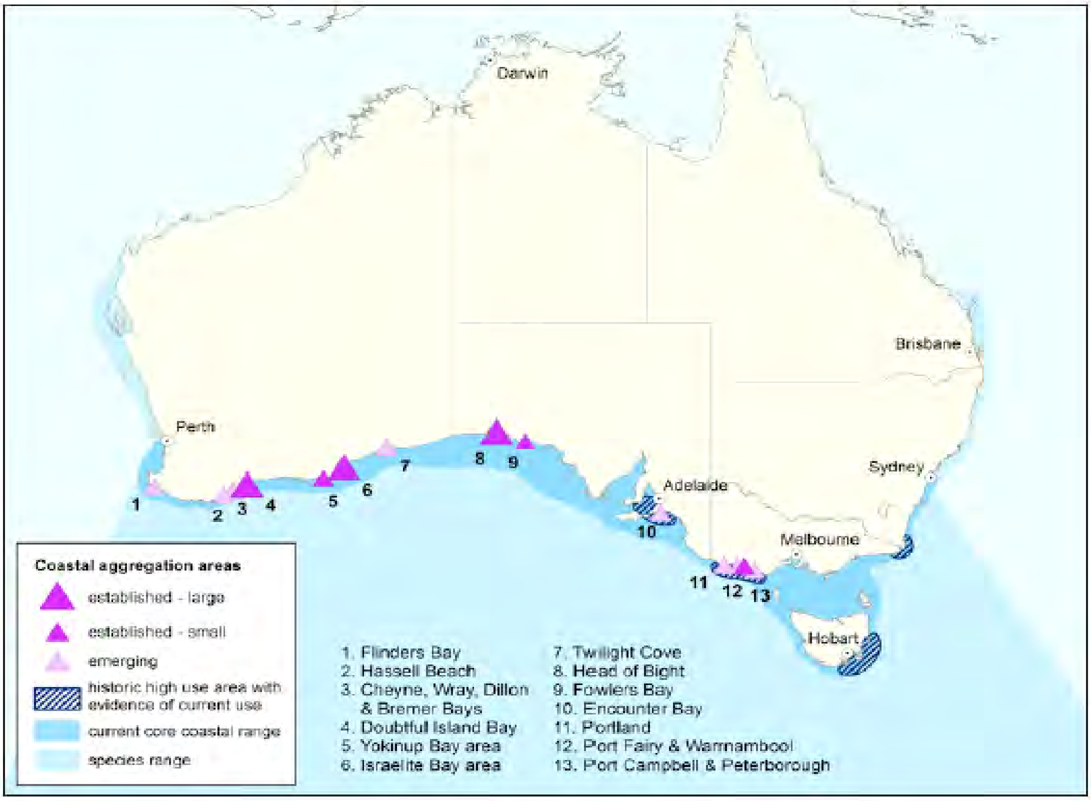
Several smaller established areas (regularly occupied) occur at:

- Yokinup Bay in WA; and
- The Warrnambool region in Victoria.

Emerging aggregation areas (sporadically used at present) occur at:

- Flinders Bay in WA;
- Hassell Beach in WA;
- Cheyne/Wray Bays in WA;
- Twilight Cove in WA;
- Fowlers Bay in WA; and
- Encounter Bay in SA (DSEWPC, 2012c).

A number of additional areas for southern right whales are emerging that might be of importance, particularly to the south-eastern population. In these areas, small but growing numbers of non-calving whales regularly aggregate for short periods of time. These areas include coastal waters off Peterborough, Port Campbell, Port Fairy and Portland in Victoria, located more than 400 km west of the Project area, with waters less than 10 m deep preferred (DSEWPC, 2012c).



Source: DSEWPC (2012)

Figure 6.17. Southern right whale aggregation areas

The closest known calving/nursery grounds to the Project area occurs at Logan's Beach off the coast of Warrnambool in southwest Victoria (approximately 426 km west of the Project area) and intermittently at Portland (507 km west of the Project area) (DSEWPC, 2012c).

The National Conservation Values Atlas recognises a BIA for migration/resting on migration for the southern right whale through all Victorian state waters, including those around the Project area (Figure 6.18), as they are known to generally occur within 2 km of shorelines (DSEWPC, 2012c).

However, a defined near-shore coastal migration corridor is considered unlikely given the absence of any predictable directional movement for the species (DSEWPC, 2012c).

Critical habitat for the southern right whale is not defined under the EPBC Act (DSEWPC, 2012c), though the BIA (aggregation area) illustrated in Figure 6.17 (around Warrnambool) may be considered critical habitat given that female southern right whales show calving site fidelity, which combined with their low and slow reproductive rate, make calving sites of critical importance to the species recovery (DSEWPC, 2012c).

The VBA records this species in the Project area (1 record) and EMBA (41 records). The ALA records the species in the EMBA but not the Project area. Southern right whales are likely to be present in the EMBA during their seasonal migration season of May to October. DELWP's 2019 aerial cetacean surveys did not record any southern right whales within the Project area, while there were seven records of this species in the eastern parts of the EMBA during July and August (off the coastlines of Marlo and Mallacoota in Victoria and Eden and Tathra in southern NSW).

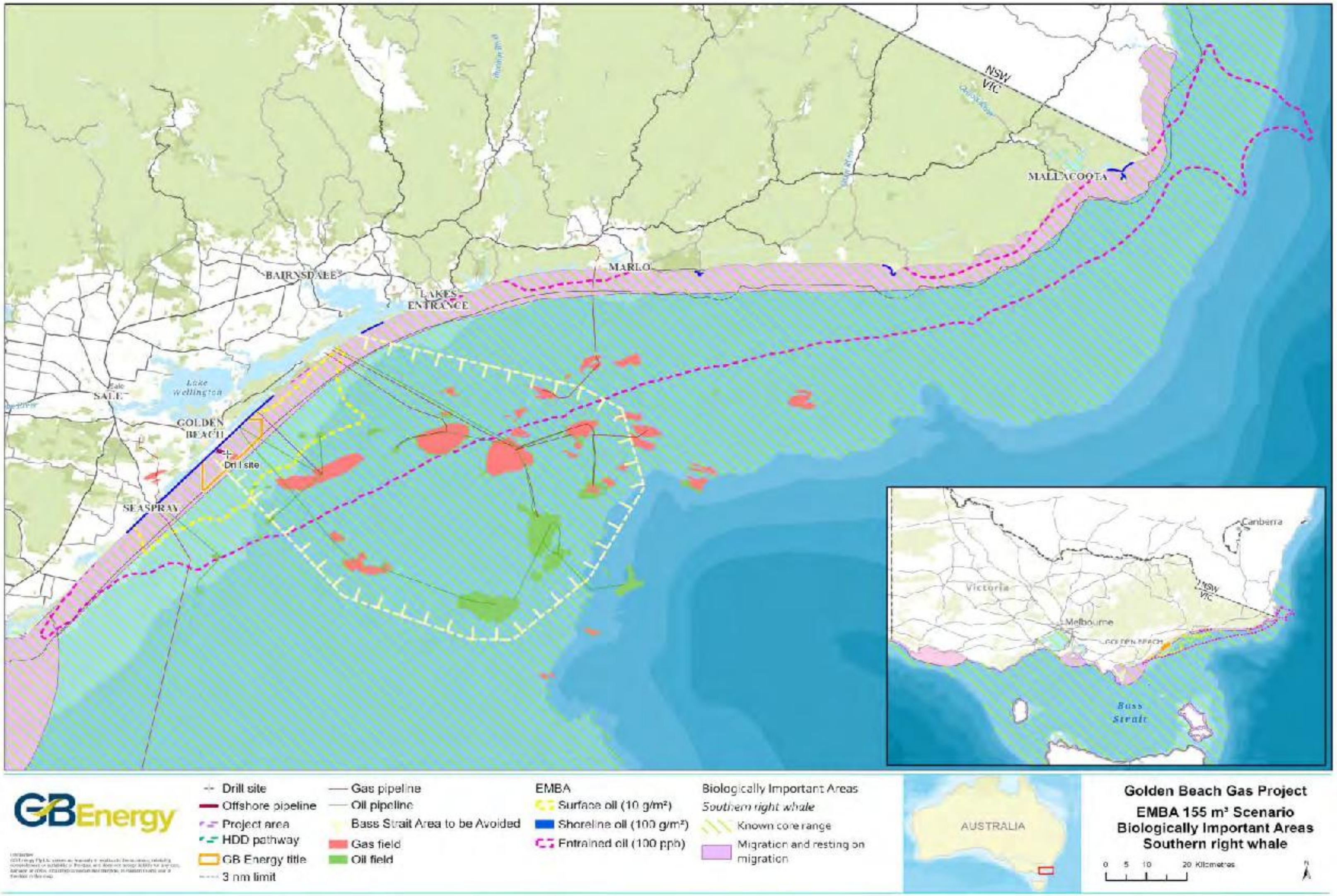


Figure 6.18a. Southern right whale BIA intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

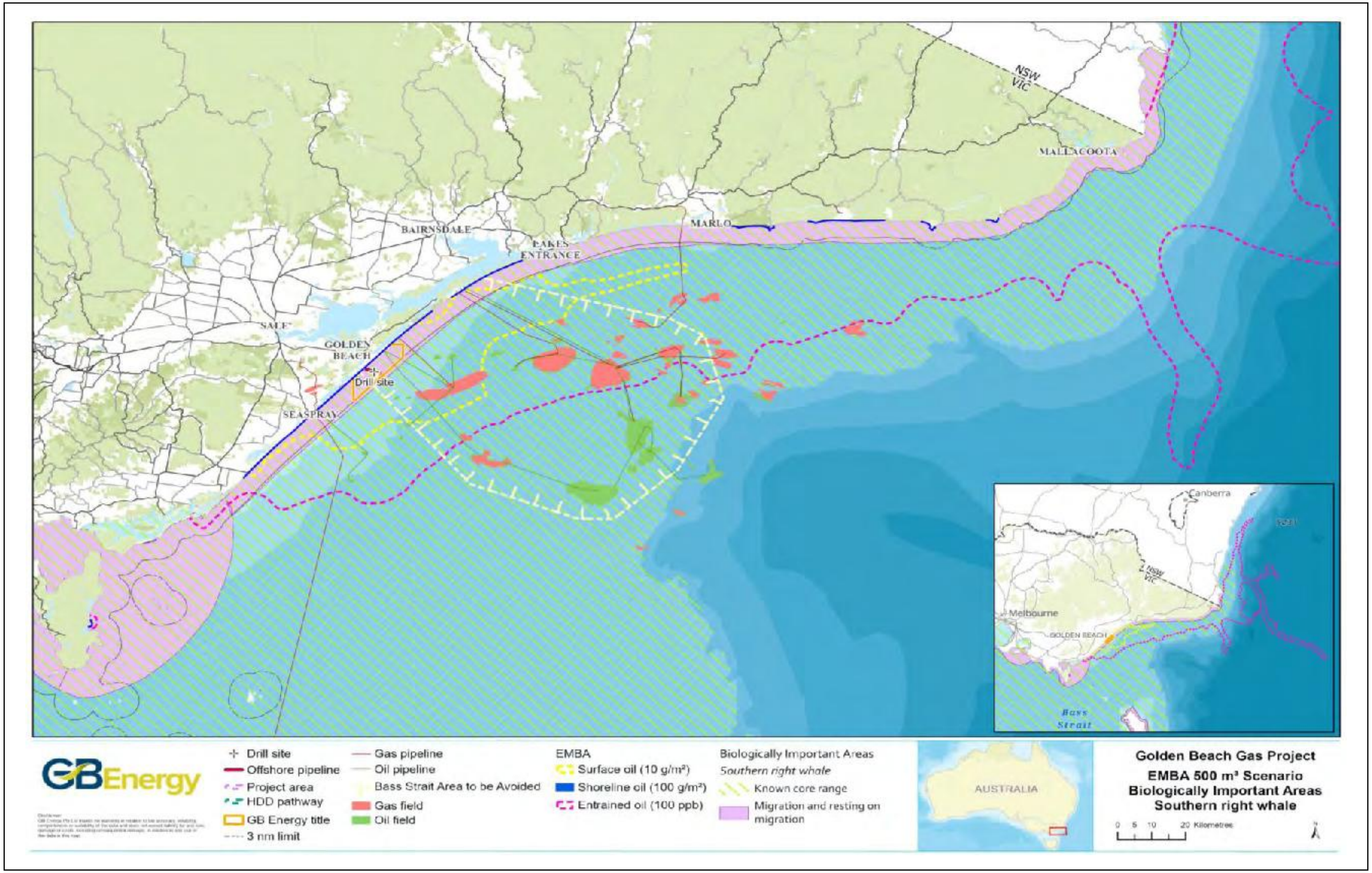


Figure 6.18b. Southern right whale BIA intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

Humpback whale (EPBC Act: Vulnerable, listed migratory, FFG Act: Threatened)

The humpback whale (*Megaptera novaeangliae*) is a moderately large (15-18 m long) baleen whale that has a worldwide distribution but geographic segregation. In the 19th and 20th centuries, humpback whales were hunted extensively throughout the world's oceans and as a result it is estimated that 95% of the population was eliminated. In Australia, commercial whaling of humpback whales ceased in 1963 and until this time, it is estimated that humpback whales were reduced to between 3.5 and 5% of pre-whaling abundance (TSSC, 2015b).

The TSSC (2015b) states that a 2012 and 2014 review of the conservation status of the species considered that it no longer meets any criteria for listing as threatened under the EPBC Act, though it remains listed as vulnerable.

Humpback whales are found in Australian offshore and Antarctic waters. They primarily feed on krill in Antarctic waters south of 55°S. The eastern Australian population of humpback whales is referred to as Group E1 by the International Whaling Commission, one of seven distinct breeding stocks in the southern hemisphere (TSSC, 2015b).

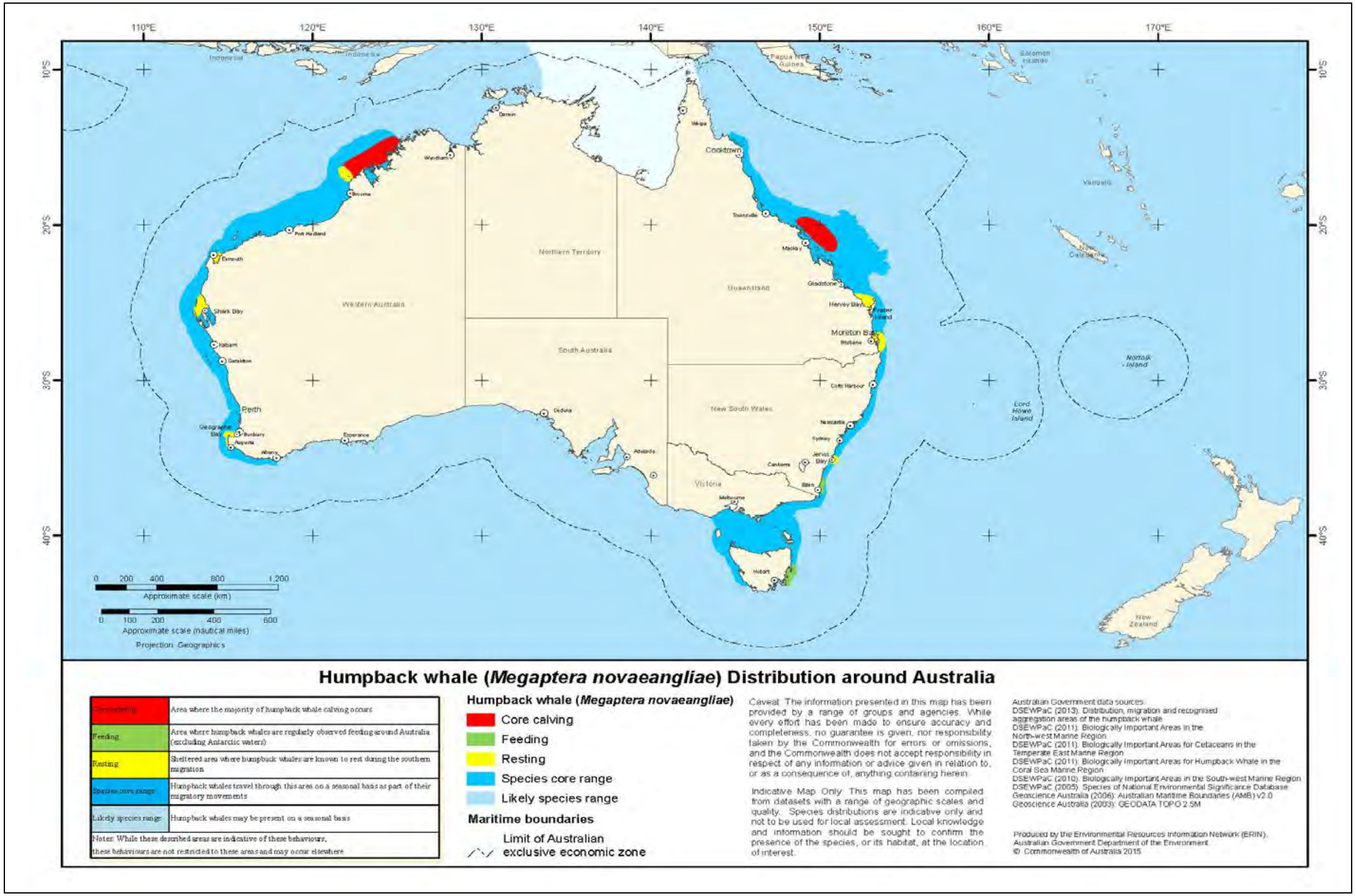
Bass Strait represents part of the core range of the E1 Group, but feeding, resting or calving is not known to occur in Bass Strait (TSSC, 2015b), though migration through Bass Strait may occur (Figure 6.19 and Figure 6.20). The nearest area that humpback whales are known to congregate (foraging BIA) is at the southern-most part of NSW (near the eastern border of Victoria), approximately 240 km northeast of the Project area and within the EMBA.

Humpback whales undertake annual migrations between their summer feeding grounds in Antarctic waters to their breeding and calving grounds in sub-tropical and tropical inshore waters, migrating up the Australian east coast (TSSC, 2015b). The northern migration off the southeast coast starts in April and May, with the southern migration occurring from November to December. This migration tends to occur close to the coast, along the continental shelf boundary in waters about 200 m deep (TSSC, 2015b) (Figure 6.20).

The Conservation Advice for the humpback whale (TSSC, 2015b) identifies vessel strike and anthropogenic noise as threats to the species, the latter important as it may mask vocalisations or cause injury or death.

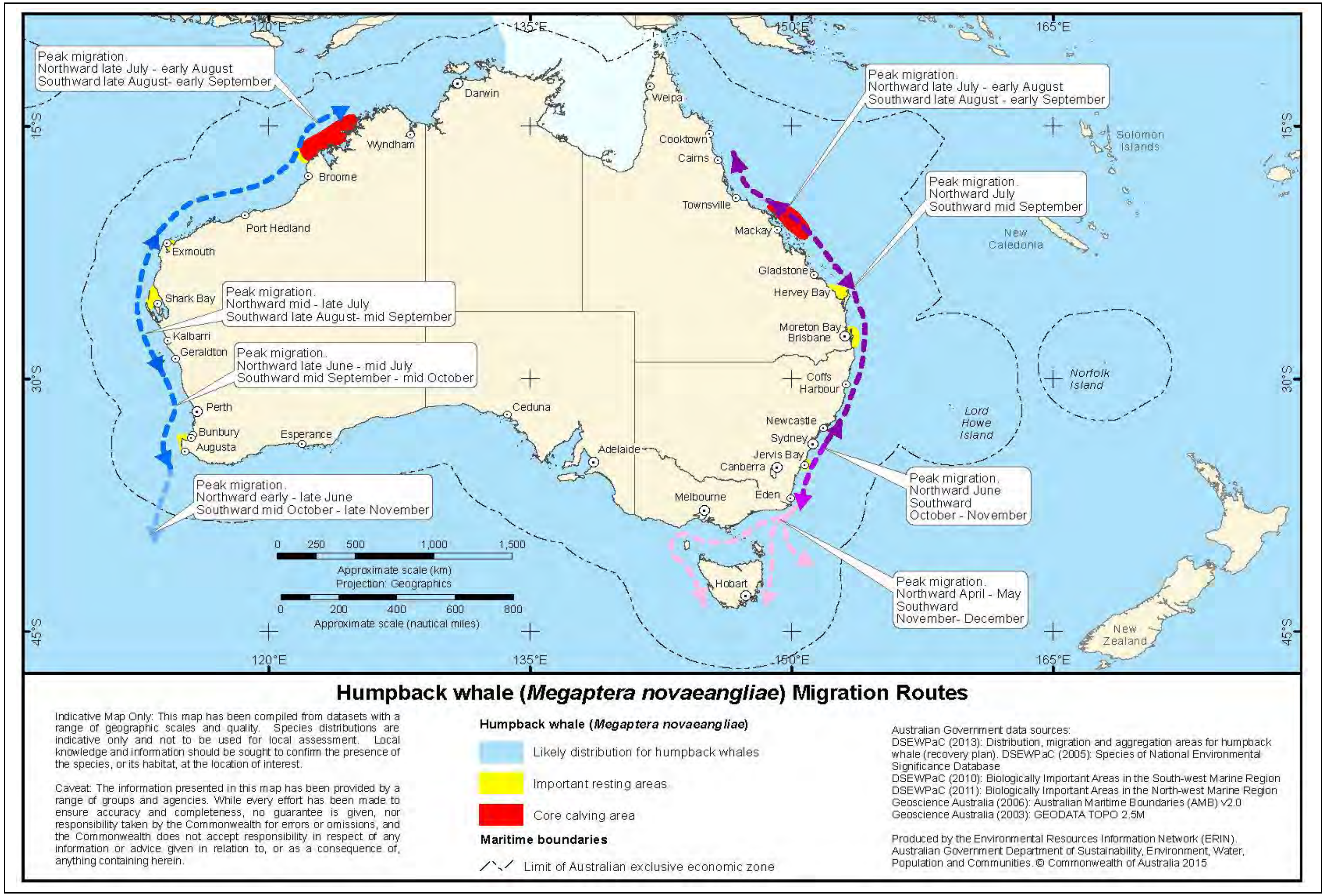
As the Project area and the EMBA represent a core range for humpback whales, they may be encountered, particularly during April, May, November and December, though the likelihood is considered low for the Project area due to their preference for migrating along the edge of the continental shelf in waters much deeper than those of the Project area.

The ALA and VBA both record this species in the EMBA but not the Project area.



Source: TSSC (2015b).

Figure 6.19. Distribution of the humpback whale around Australia



Source: TSSC (2015b).

Figure 6.20. Migration routes of humpback whales around Australia

Sei Whale (EPBC Act: Vulnerable, listed migratory, FFG Act: Not listed)

Sei whales (*Balaenoptera borealis*) 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, 2015c).

Sei whale global population is estimated to have declined by 80 % over the previous three generation period (TSSC, 2015b). 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, 2015c).

These whales are thought to complete long annual seasonal migrations from subpolar summer feeding grounds to lower latitude winter breeding grounds (TSSC, 2015c); details of this migration and whether it involves the entire population are unknown. There are no defined foraging and feeding areas nor are there known mating or calving areas in Australian waters.

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, 2015c).

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

Based upon the species preference for deep offshore waters, and the small number of sei whale sightings in southeast Australia, it is considered unlikely that this species occurs within the Project area. There are no records in the VBA for this species in the Project area or EMBA, while it is recorded in the ALA for the EMBA but not the Project area.

Fin Whale (EPBC Act: Vulnerable, listed migratory, FFG Act: Not listed)

The fin whale (*B. physalus*) is the second largest whale species after the blue whale, growing up to 27 m long and weighing up to 70 tonnes (TSSC, 2015d). Fin whales are considered a cosmopolitan species and occur from polar to tropical waters, and rarely in inshore waters. The full extent of their distribution in Australian waters is uncertain but they occur within Commonwealth waters and have been recorded in most state waters and from Australian Antarctic Territory waters (TSSC, 2015d).

Fin whales are generally thought to undertake long annual migrations from higher latitude summer feeding grounds to lower latitude winter breeding grounds (TSSC, 2015d). It is likely they migrate between Australian waters and Antarctic feeding areas (the Southern Ocean), sub-Antarctic feeding areas (the Southern Subtropical Front) and tropical breeding areas (Indonesia, the northern Indian Ocean and south-west South Pacific Ocean waters) (TSSC, 2015d).

Fin whales have been sighted inshore in the proximity of the Bonney Upwelling along the continental shelf in summer and autumn months (TSSC, 2015d). The sighting of a cow and calf in the Bonney Upwelling in April 2000 and the stranding of two fin whale calves in South Australia suggest that this area may be important to the species' reproduction, perhaps as a provisioning area for cows with calves (TSSD, 2015d). There are no defined foraging and feeding areas nor are there known mating or calving areas in Australian waters.

The conservation advice (TSSC, 2015d) identifies vessel strike and anthropogenic noise as threats to the species. Based on the fin whale preference for deep offshore waters, and the minimal sightings in Bass Strait, it is considered unlikely that this species occurs within the spill EMBA.

There are no records in the VBA for this species in the Project area or EMBA, while it is recorded in the ALA for the EMBA but not the Project area.

Dolphins (EPBC Act: Listed marine species)

None of the eight dolphin species listed in the PMST results are listed as threatened under the EPBC Act or FFG Act. Many dolphins are cosmopolitan species that are generally restricted to continental shelf environments. A brief description of these dolphin species is provided below.

- The common dolphin (*Delphinus delphis*) is an abundant species, widely distributed from tropical to cool temperate waters, and generally further offshore than the bottlenose, although small groups may venture close to the coast and enter bays and inlets. They have been recorded in waters off all Australian states and territories. Stranding statistics indicate that common dolphins are active in Bass Strait at all times of the year, though less so in winter (DAWE, 2020b). Common dolphins are likely to be present in the Project area and EMBA.
- 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. This species prefers 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). In Australia, the species has been recorded from all states except Tasmania and the Northern Territory. Fraser Island (off the southern Queensland coast) has the only suspected 'resident' population in Australia (Bannister *et al*., 1996). There are no known calving areas in Australian waters. The lack of resident populations in or near Bass Strait, and the lack of calving areas in Australia indicates there are no critical areas (and no BIA) for the species within the Project area or the EMBA.
- The dusky dolphin (*Lagenorhynchus obscures*) is primarily found from approximately 55°S to 26°S, though sometimes further north associated with cold currents. They are considered to be primarily an inshore species but can also be oceanic when cold currents are present (Gill *et al*., 2000; Ross, 2006). 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 occur across southern Australia from WA to Tasmania, confirmed sightings near Kangaroo Island and off Tasmania. No key localities or critical habitats in Australian waters have been identified (Bannister *et al*., 1996). Given the lack of sightings in Australian waters, it is unlikely that significant numbers of dusky dolphins would be present in the Project area or EMBA.
- The killer whale (*Orcinus orca*) (the largest member of the dolphin family) is thought to be the most cosmopolitan of all cetaceans and appear to be more common in cold, deep waters, though they have often been observed along the continental slope and shelf particularly near seal colonies (Bannister *et al*., 1996). The killer whale is widely distributed from polar to equatorial regions and has been recorded in all Australian waters with concentrations around Tasmania. The only recognised key locality in Australia is Macquarie Island and Heard Island in the Southern Ocean (Bannister *et al.,* 1996). The habitat of killer whales includes oceanic, pelagic and neritic (relatively shallow waters over the continental shelf) regions, in both warm and cold waters (DAWE, 2020b). In Victoria, sightings peak in June/July, where they have been observed feeding on sharks, sunfish, and Australian fur seals (Mustoe, 2008). The breeding season is variable, and the species moves seasonally to areas of food supply (Bannister *et al*., 1996; Morrice

et al., 2004). It is possible that killer whales may occur in the EMBA, however given the distance to the nearest seal colonies (see Section 6.3.6), the Project area is unlikely to represent an important habitat for this species.

- The Indian Ocean bottlenose dolphin (*Tursiops aduncus*) is distributed around the entire Australian mainland, but as the common name suggests, occur mainly in tropical and sub-tropical waters, usually coastal and shallow offshore areas. The species is thought to be common in discreet areas of eastern, northern and western Australia, though the total population size is not known (DAWE, 2020i). No critical habitats are known to occur within the Project area or EMBA. Indian Ocean bottlenose dolphins are unlikely to occur in the Project area but are likely to occur in the eastern extent of the EMBA.
- The bottlenose dolphin (*Tursiops truncatus*) has a worldwide distribution from tropical to temperate waters. While the species is primarily coastal, they are found in open oceans as well. There are two forms of bottlenose dolphin, a nearshore form and an offshore form. The nearshore form occurs in southern Australia (DAWE, 2020i). Most populations are relatively discrete and reside in particular areas, such as individual resident populations in Port Phillip Bay (240 km west of the Project area) and Westernport Bay (185 km west of the Project area). There may be some migration and exchange between the populations, but it is likely that most are local residents. Bottlenose dolphins are unlikely to occur in the Project area but are likely to occur in the EMBA.

Listed in the VBA database is the Burrunan dolphin (*Tursiops australis*), a species of bottlenose dolphin only recognised as a separate species in 2011, is present in the Gippsland Lakes. This species is listed as threatened under the FFG Act. Only two resident populations of Burrunan dolphin are known to occur, comprising about 50 individuals in the Gippsland Lakes and 100 individuals in Port Phillip Bay (Charlton-Robb *et al*., 2011). It is unclear whether migration occurs between these sites, though researchers from the Marine Mammal Foundation released information in mid-2017 indicating that there are genetic similarities between the dolphins in the Gippsland Lakes and around Tasmania's Freycinet Peninsula (ABC, 2017). The Marine Mammal Foundation believes a transient group of male dolphins swim between Gippsland and eastern Tasmania to breed with two different populations of female dolphins. The taxonomic validity of this new species has been questioned by the Committee for Taxonomy for the International Society for Marine Mammology (DRI, 2016). Burrunan dolphins, if present in the Project area or EMBA, are likely to just migrate through (rather than use these areas as permanent habitat).

6.3.6. Pinnipeds

There are two pinniped species recorded under the PMST as potentially occurring within the Project area and EMBA (Table 6.15) (DAWE, 2020a). These species are not listed as threatened under the FFG Act. Figure 6.21 illustrates the likely temporal presence and absence of pinnipeds in the Project area and EMBA.

There are no records of the Australian fur-seal and New Zealand fur-seal in the ALA and VBA for the Project area, but both databases record these species in the EMBA.

For the EMBA, the ALA and VBA also contain records of the southern elephant seal (*Mirounga leonina*), leopard seal (*Hydrurga leptonyx*), subantarctic fur-seal (*Arctocephalus tropicalis*) and crab-easter seal (*Lobodon carcinophaga*).

All pinnipeds recorded in the NSW BioNet Atlas are recorded in the PMST.

Table 6.15. EPBC Act-listed pinnipeds that may occur in the Project area and EMBA

Scientific name	Common name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA?	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Arctocephalus forsteri	New Zealand fur-seal	-	-	Yes	M	H	-	-	VU	Yes	-
Arctocephalus pusillus	Australian fur-seal	-	-	Yes	M	H	-	B	-	Yes	-

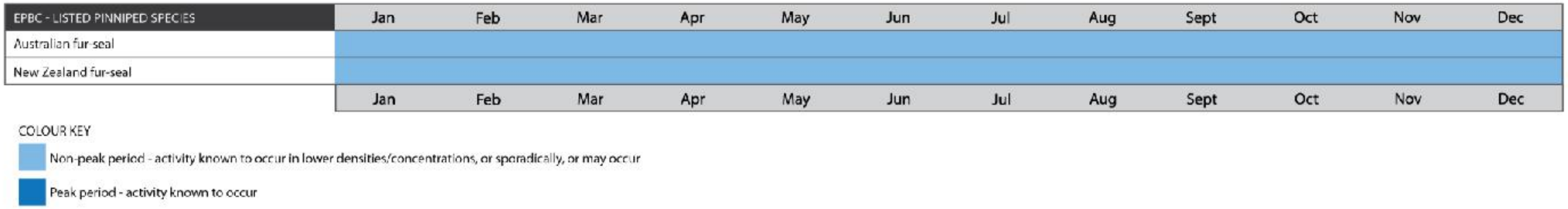


Figure 6.21. Likely temporal presence and absence of EPBC Act-listed pinniped species in the Project area and EMBA

New Zealand fur-seal (EPBC Act: Listed marine, FFG Act: Not listed)

New Zealand fur-seals (*Arctocephalus forsteri*) (also known as long-nosed fur-seals) are mostly found in central South Australian waters (Kangaroo Island to South Eyre Peninsula); 77% of their population is found here (Shaughnessy, 1999).

There are 51 known breeding sites for New Zealand fur-seals in Australia, with most of these outside of Victoria (47 in SA and WA) (DEHWA, 2007) (Figure 6.22). Lower density breeding areas occur in Victoria (Shaughnessy, 1999). Breeding locations in Victoria occur at Kanowna Island, off Wilson's Promontory (located 139 km southwest of the Project area) and the Skerries (located approximately 181 km northeast of the Project area) (Kirkwood *et al*., 2009).

During the non-breeding season (November to January) the breeding sites are occupied by pups/young juveniles, whilst adult females alternate between the breeding sites and foraging at sea (Shaughnessy, 1999).

Haul-out sites in Bass Strait, as reported by Barton et al (2012) and OSRA mapping, are listed below (all of which occur outside the EMBA):

- Beware Reef (129 km northeast of the Project area);
- Kanowna Island (138 km southwest of the Project area) - ~300 individuals;
- The Hogan Islands Group (110 km southwest of the Project area); and
- West Moncoeur Island (south of Wilson's Promontory, 133 km southwest of the Project area).

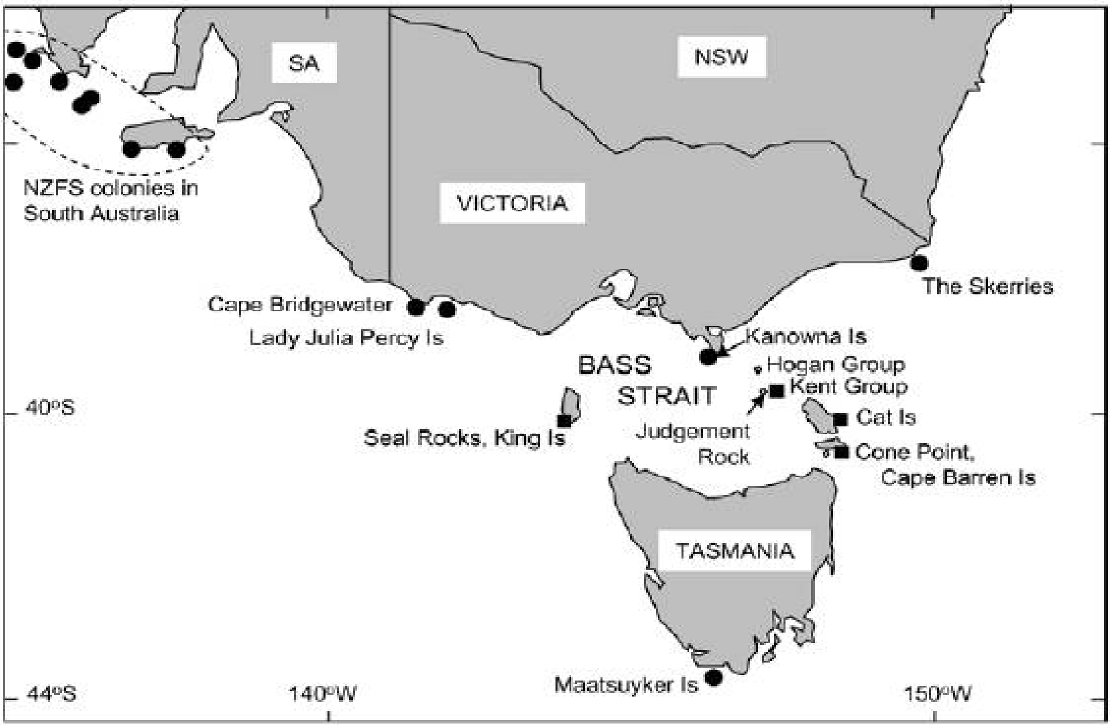
The species prefers the rocky parts of islands with jumbled terrain and boulders and prefers smoother igneous rocks to rough limestone. Breeding colonies in Bass Strait recorded by Shaughnessy (1999) and OSRA mapping are listed below (none of which occur in the EMBA):

- Rag Island (1,000 fur seal & 235 pups in 2006, 99 km southwest of the Project area);
- Kanowna Island (10,700 adults and 2,700 pups, 138 km southwest of the Project area);
- Anser Group of Islands (all more than 135 km southwest of the Project area);
- The Skerries (193 km northeast of the Project area) – 300 individuals and 78 pups (in 2002); and
- Judgment Rock in the Kent Island Group (~2,500 pups per year, 143 km south-southwest of the Project area) (Kirkwood *et al*., 2009)

New Zealand fur-seals feed on small pelagic fish, squid and seabirds, including little penguins (Shaughnessy, 1999). Juvenile seals feed primarily in oceanic waters beyond the continental shelf, lactating females feed in mid-outer shelf waters (50-100 km from the colony) and adult males forage in deeper waters (Shaughnessy, 1999).

There is no BIA for the New Zealand fur-seal in Bass Strait. Given the close proximity of the Project area to breeding colonies and haul-out sites, it is likely that the species feeds within the Project area. However, there are no islands or rock outcrops within the Project area, so a resident population does not occur.

The ALA and VBA records the New Zealand fur-seal in the EMBA but not the Project area.



Filled circles = current distribution. Filled squares = early 1800s distribution.
Source: Kirkwood et al (2009).

Figure 6.22 New Zealand fur-seal colonies in southeast Australia

Australian fur-seal (EPBC Act: Listed marine, FFG Act: Not listed)

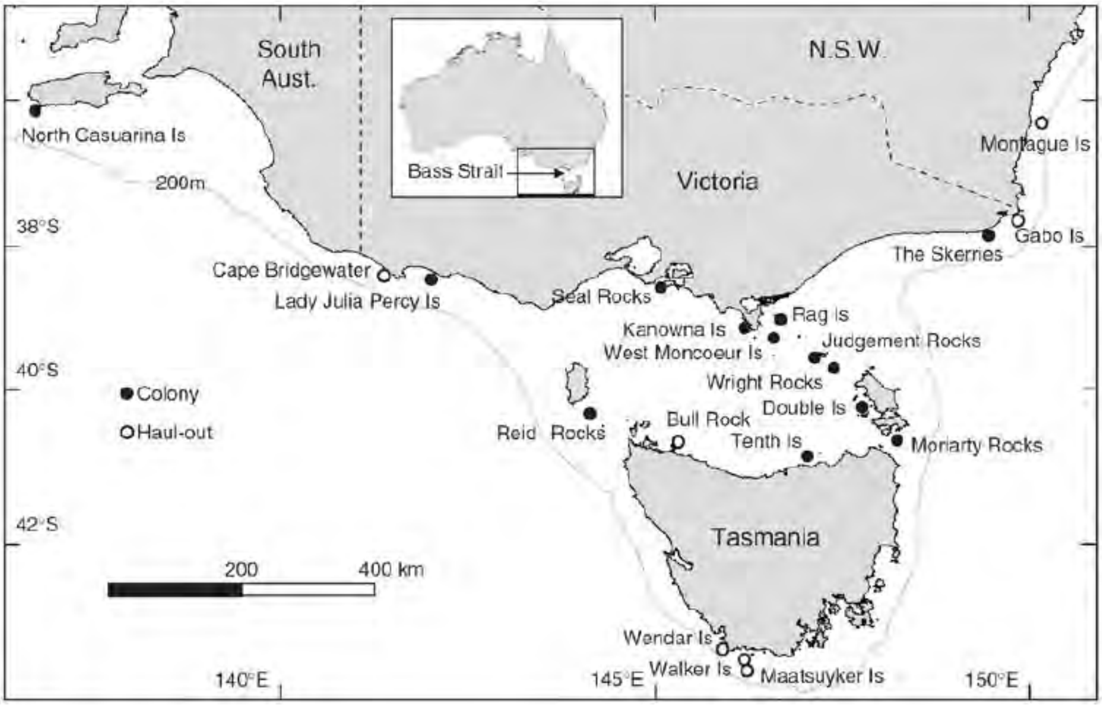
The Australian fur-seal (*Arctocephalus pusillus*) has a relatively restricted distribution around the islands of Bass Strait, parts of Tasmania and southern Victoria with no BIA in Bass Strait. The ALA and VBA records the Australian fur-seal in the EMBA but not the Project area.

There are 10 established breeding colonies of the Australian fur-seal that are restricted to islands in the Bass Strait; six occurring off the coast of Victoria and four off the coast of Tasmania (Shaughnessy, 1999) (Figure 6.23). The largest of the established colonies occur at Lady Julia Percy Island (26% of the breeding population and 470 km west of the Project area) and at Seal Rocks (25% of the breeding population and 192 km west of the Project area), in Victoria. These areas are not located within the EMBA.

Other breeding colonies in Bass Strait include:

- Rag Island (1,000 fur seal & 270 pups in 2007, 101 km southwest of the Project area);
- Kanowna Island (15,000 adults and 3,000 pups, 138 km southwest of the Project area);
- Anser Group of Islands (all more than 135 km southwest of the Project area);
- The Skerries (193 km northeast of the Project area) – 11,500 individuals and 3,000 pups (in 2002); and
- Judgment Rock in the Kent Island Group (~2,500 pups per year, 140 km south-southwest of the Project area) (Kirkwood *et al*., 2009, Shaughnessy, 1999).

All of the listed sites are located outside the EMBA. Historically, Australian fur-seal breeding colonies were more widespread, but several islands have not been occupied since their populations were removed by early commercial sealing (Shaughnessy, 1999).



Filled circles = breeding colonies. Empty circles = haul-out sites.
Source: Kirkwood et al (2009).

Figure 6.23. Australian fur-seal colonies and haul-out sites where pups were born in 2007 in southeast Australia

Their preferred habitat, especially for breeding, is a rocky island with boulder or pebble beaches and gradually sloping rocky ledges. Australian fur-seals are present in the region all year. Pups begin to forage in June/July and are generally weaned by September/October (Shaughnessy, 1999).

Australian fur-seals are also regularly seen resting and foraging on and around the petroleum production platforms off the Gippsland coast. Barton et al (2012), Carlyon et al (2011) and OSRA (2015) list the haul-out sites known in Bass Strait (none of which occur in the EMBA):

- Beware Reef (129 km northeast of the Project area) – a haul-out site where the seals are present most of year;
- Gabo Island (232 km northeast of the Project area) – 30-50 individuals; and
- The Hogan Island group (110 km southwest of the Project area) – ~300 animals.

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. The diet of Australian fur-seals is principally fish, including red-bait, leatherjackets and jack mackerel in winter and mostly cephalopods in summer (Shaughnessy, 1999).

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). The location of New Zealand and Australian fur-seal colonies in relation to the EMBAs are presented in Figure 6.24.

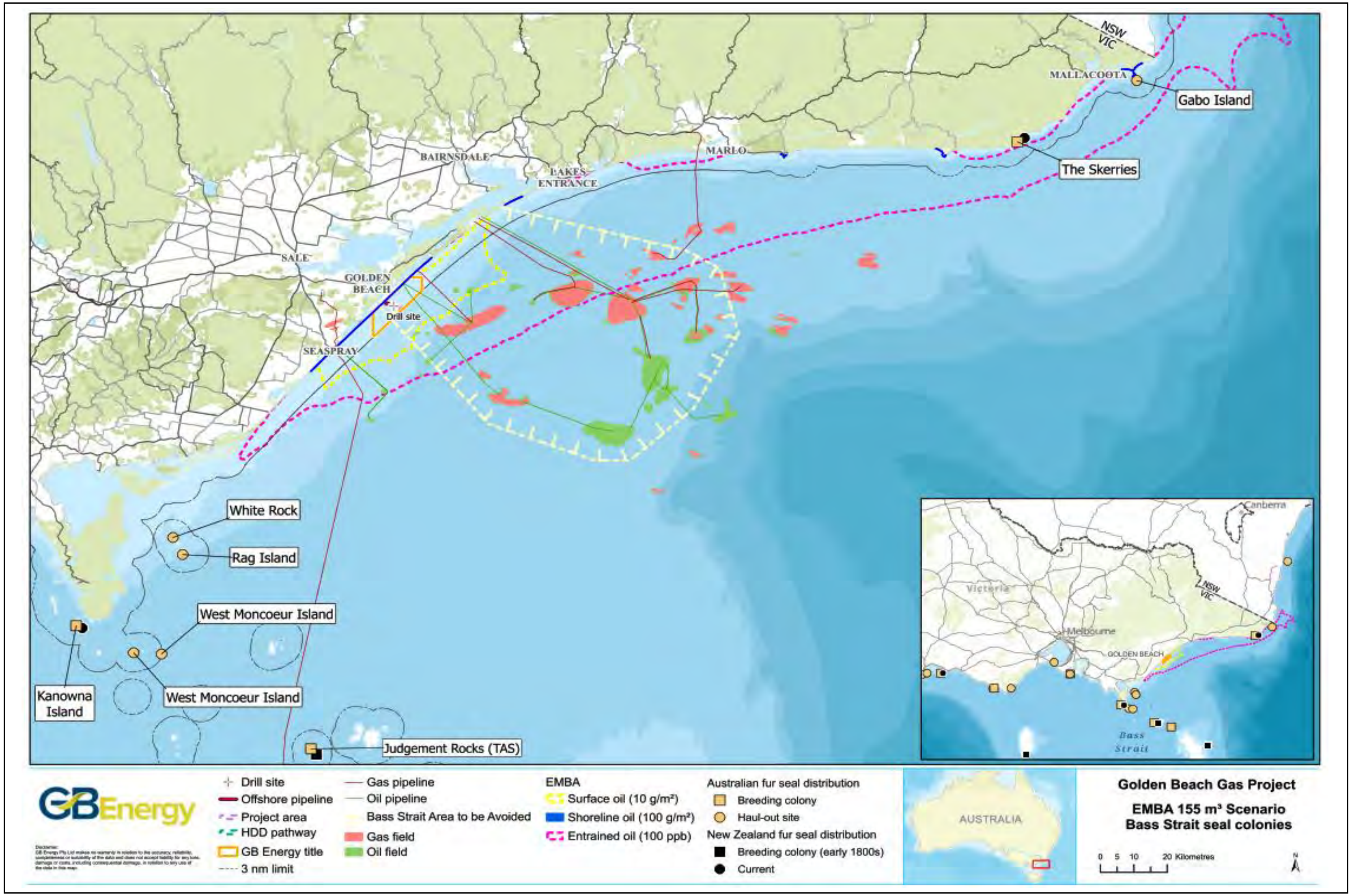


Figure 6.24a. Australian and New Zealand fur seal colonies intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

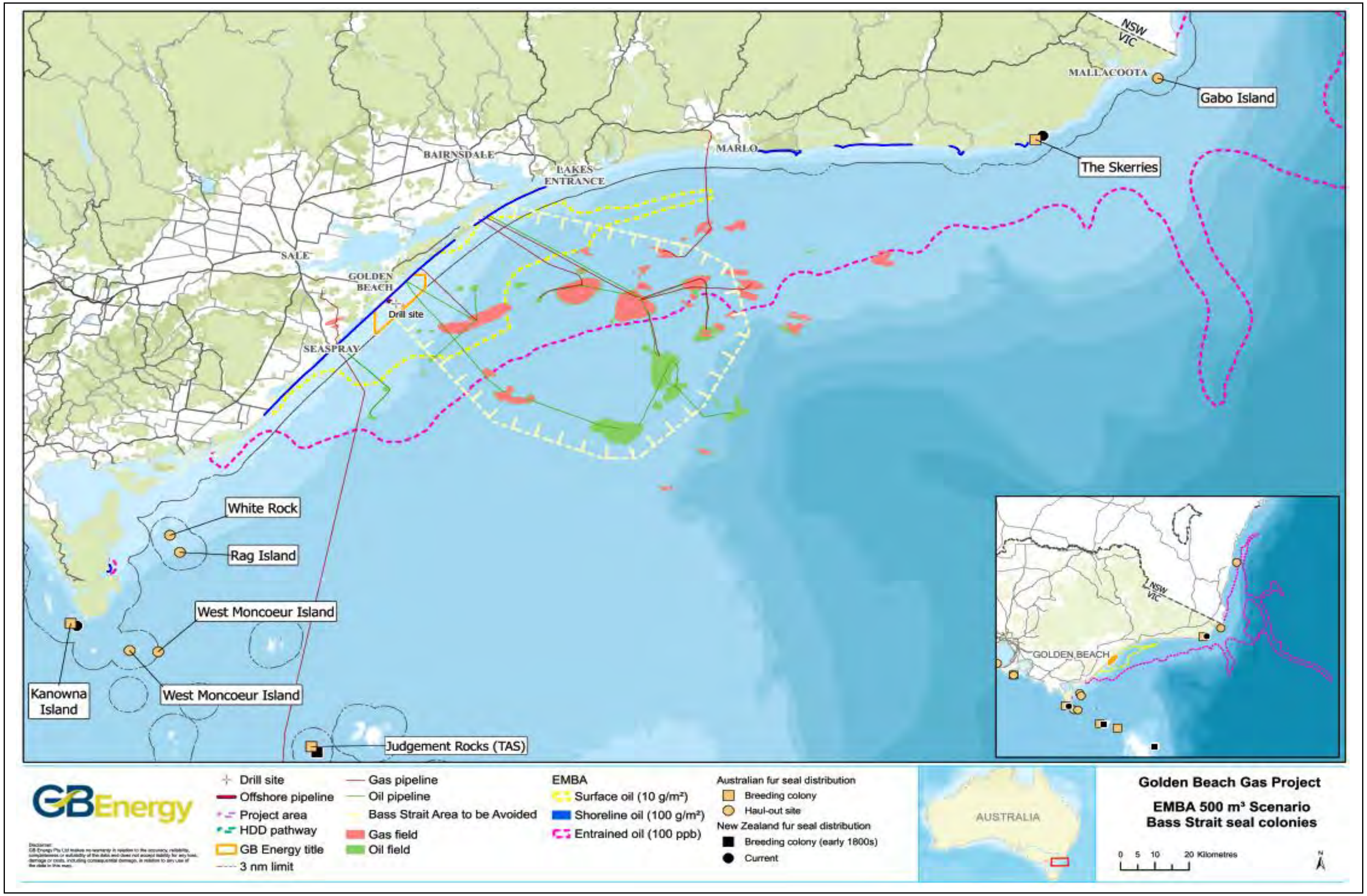


Figure 6.24b. Australian and New Zealand fur seal colonies intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

Southern elephant seal

There is a single record of the southern elephant seal (*Mirounga leonine*) in the VBA for the spill EMBA. In 2005, the world population was estimated at between 664,000 and 740,000 animals occurring in the South Atlantic, South Indian and Pacific Oceans. Tracking studies have indicated the routes travelled by elephant seals, demonstrating their main feeding area is at the edge of the Antarctic continent.

Elephant seals have a nearly circumpolar Southern Hemisphere distribution with most breeding colonies and haul-out areas occurring on subantarctic islands north of the seasonal pack ice zone (TSSC, 2016a). Within Australian jurisdiction, southern elephant seals breeds and hauls-out on Macquarie Island (1,900 km southeast) and Heard Island (5,500 km southwest). Historically, southern elephant seal populations occurred on islands of western Bass Strait before these were extirpated by European sealers (TSSC, 2016a). Currently, occasional pupping is seen on Maatsuyker Island (426 km south) in southern Tasmania where 12 individuals were recorded in 2015. Given the known distribution of southern elephant seals, it is not likely to occur in the Project area and unlikely to occur in significant numbers in the spill EMBA.

6.3.7. Reptiles

Five species of marine turtle are listed under the EPBC Act as potentially occurring in the EMBA, as listed in Table 6.16 (DAWE, 2020a). No BIAs for turtles occur within Bass Strait. EA (2003) reports that the turtles known to occur in Victorian waters are considered to be rare vagrants outside their usual range. No turtles are listed as threatened under the FFG Act 1988 (Vic), except for the leatherback turtle. Figure 6.25 illustrates the likely temporal presence and absence of turtles in the Project area and EMBA.

Additionally, Wilson and Swan (2005) report that 31 species of sea snake and two species of sea kraits occur in Australian waters, though none of these occurs in waters of the southern coast of Australia, with the exception of the yellow-bellied sea snake (*Pelamis platurus*) that extends into waters off the WA and Victorian coast. This species is the world's most widespread sea snake and feeds on fish at the sea surface (Wilson and Swan, 2005), and there are seven records for this species in the EMBA from the VBA.

All species captured in the NSW BioNet Atlas were noted in the PMST results and scientific literature.

Table 6.16 EPBC Act-listed marine reptiles that may occur in the Project area and EMBA

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA?	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Caretta caretta	Loggerhead turtle	E	Yes	Yes	L	H	-	-	-	-	Generic RP in place for all marine turtle species, + AS for leather-back turtle
Chelonia mydas	Green turtle	V	Yes	Yes	L	H	-	-	-	-	
Dermochelys coriacea	Leatherback turtle	E	Yes	Yes	L	H	T	-	CE	Yes	
Eretmochelys imbricate	Hawksbill turtle	V	Yes	Yes	L	H	-	-	-	-	
Natator depressus	Flatback turtle	V	Yes	Yes	L	L	-	-	-	-	

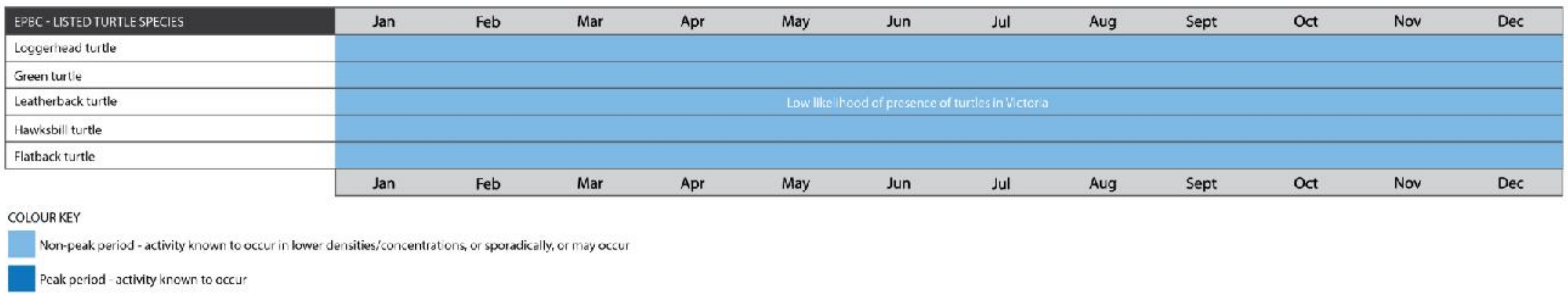


Figure 6.25. Likely temporal presence and absence of EPBC Act-listed turtle species in the Project area and EMBA

Loggerhead turtle (EPBC Act: Endangered, listed migratory, FFG Act: Not listed)

The loggerhead turtle (*Caretta caretta*) is globally distributed in sub-tropical waters (Limpus, 2008a), including those of eastern, northern and western Australia (DoEE, 2017), and is rarely sighted off the Victorian coast.

The main Australian breeding areas for loggerhead turtles are generally confined to southern Queensland and Western Australia (Cogger *et al.*, 1993). Loggerhead turtles will migrate over distances in excess of 1,000 km but show a strong fidelity to their feeding and breeding areas (Limpus, 2008a).

Loggerhead turtles are carnivorous, feeding primarily on benthic invertebrates such as molluscs and crabs in depths ranging from nearshore to 55 m (DoEE, 2017) in tidal and sub-tidal habitats, reefs, seagrass beds and bays (DoEE, 2017). No known loggerhead foraging areas have been identified in Victoria waters although foraging areas have been infrequently identified in waters off SA (DoEE, 2017).

The DAWE (2017) maps the loggerhead turtle as having a known or likely range within Bass Strait, but given this species preference for sub-tropical waters, it is unlikely to be encountered in the Project area. The ALA records this species in the EMBA but not in the Project area, while the VBA contains no records for this species.

Green turtle (EPBC Act: Vulnerable, listed migratory, FFG Act: Not listed)

The green turtle (*Chelonia mydas*) is distributed in sub-tropical and tropical waters around the world (Limpus, 2008b; DoEE, 2017). In Australia, they nest, forage and migrate across tropical northern Australia. Mature turtles settle in tidal and sub-tidal habitat such as reefs, bays and seagrass beds where they feed on seagrass and algae (Limpus, 2008b; DoEE, 2017).

There are no known nesting or foraging grounds for green turtles in Victoria, and they occur only as rare vagrants (DoEE, 2017). The DAWE (2020b) maps the green turtle as having a known or likely range within Bass Strait, with two sightings of the species recorded in the EMBA (CIE, 2020). The ALA records this species in the EMBA but not in the Project area, while the VBA contains no records for this species in the Project area or EMBA.

While there are suitable foraging sites, green turtles are unlikely to occur in the Project area.

Leatherback turtle (EPBC Act; Endangered, listed migratory, FFG Act: Threatened)

The leatherback turtle (*Dermochelys coriacea*) is widely distributed throughout tropical, sub-tropical and temperate waters of Australia (DoEE, 2017), including in oceanic waters and continental shelf waters along the coast of southern Australia (Limpus, 2009). Unlike other marine turtles, the leatherback turtle utilises cold water foraging areas, with the species most commonly reported foraging along the coastal waters of central Australia (southern Queensland to central NSW), southeast Australia (Tasmania, Victoria and eastern SA), and southern WA (Limpus, 2009).This species feeds on soft-bodied invertebrates, including jellyfish (Limpus, 2009).

No major nesting has been recorded in Australia, with isolated nesting recorded in the Northern Territory, Queensland and northern NSW (DoEE, 2017). This species nests only in the tropics. The DAWE (2020b) maps the leatherback turtles as having a known or likely range within Bass Strait, and a migration pathway in southern waters with 11 sightings of the species recorded in the EMBA (CIE, 2020). The ALA and VBA record this species in the EMBA but not in the Project area.

The waters of the Project area and EMBA do not represent critical habitat for the species, though it is possible it may occur in low numbers during migration.

Hawksbill turtle (EPBC Act: Vulnerable, listed migratory, FFG Act: Not listed)

The Hawksbill turtle (*Eretmochelys imbricate*) is widely distributed in the tropical and sub-tropical waters of Australia. Their eggs are laid on warm beaches with the most important nesting sites for the species located in northern Queensland, northeast Arnhem Land and Western Australia (DoEE, 2017). Adult hawksbill turtles are primarily found in tropical reefs where they are usually seen resting in caves and ledges or otherwise feeding on sea sponges. No major nesting sites have been recorded in Victoria or Tasmania, however the DoEE (2017) maps the hawksbill turtle as having a known or likely range in eastern Bass Strait. There has been one sighting of the species recorded in the EMBA (CIE, 2020). The ALA records this species in the EMBA but not in the Project area, while the VBA contains no records for this species in the Project area or EMBA.

The spill EMBA area does not intersect any known nesting beaches of the Hawksbill turtle; it possibly occurs in the spill EMBA as a vagrant.

Flatback turtle (EPBC Act: Vulnerable, listed migratory, FFG Act: Not listed)

In Australia, the flatback turtle (*Natador depressus*) is found only in the tropical waters of northern Australia, where it feeds on soft-bodied prey. Nesting occurs only in these tropical waters. The DAWE (2020b) maps the flatback turtle as having a known or likely range north of the Victorian/NSW border. The CIE database (2020) does not contain any records of this species. The ALA records this species in the EMBA but not in the Project area, while the VBA contains no records for this species in the Project area or EMBA.

This species could be encountered in the far eastern extent of the EMBA but is not likely to migrate through the Project area.

6.3.8. Avifauna

Given the focus on the marine impacts of the project in this technical report, the focus of this section is true seabirds (i.e., birds of the order *Procellariiformes*) and true shorebirds (i.e., birds of the order *Charadriiformes*). Seabirds are those whose normal habitat and food source is derived from the sea, whether that be coastal or offshore, while shorebirds spend more of their time (nesting, feeding and breeding) on the shoreline and don't swim.

The databases used to inform this section are noted below, with summaries of the findings of these database searches:

- PMST – records 84 bird species (seabirds and shorebirds) under the EPBC Act as potentially occurring in the Project area and EMBA (Table 6.17, **Appendix 1**). The majority of these are listed as migratory and marine species. The PMST results includes terrestrial species of birds that are protected under the EPBC Act. Figure 6.26 illustrates the likely temporal presence and absence of seabirds in the Project area and EMBA, and Figure 6.27 illustrates the likely temporal presence and absence of shorebirds adjacent to the Project area and EMBA.
- VBA – records 42 seabirds and 67 shorebirds from the EMBA, summarised in Table 6.17 (**Appendix 2**).
- ALA – records one seabird (short-tailed shearwater) in the Project area, and nine shorebirds (all of which are also recorded in the PMST and VBA for the Project area). For the EMBA, the ALA records 80 seabird species (predominantly shearwaters, albatross, penguins, petrels, gulls and prions), and 56 shorebird species (predominantly sandpipers, plovers, terns, curlews, oystercatchers and lapwings) (see **Appendix 3**).

- Shorebird 2020 – 41 species recorded for the area adjacent to the Project area, and 58 species are recorded for the shorelines of the EMBA (**Appendix 4**). Only one of these species (the red-kneed dotterel, *Erythrogonys cinctus*) is not recorded by the above-listed databases.
- eBird – the Golden Beach 'hotspot' location includes the silver gull (*Chroicocephalus novaehollandiae*), Pacific gull (*Larus pacificus*) and crested tern (*Thalasseus bergii*) and contains no records additional to those of the above-listed databases (**Appendix 5**).
- NSW BioNet Atlas – records 50 seabirds and 36 shorebirds in the Twofold Shelf Subregion. Fifty-nine (59) of the bird species recorded in the BioNet Atlas were also recorded in the PMST and VBA databases. A description of the broadly represented groups and threatened species is provided in this section.

Field surveys undertaken for the Golden Beach Gas Project (Practical Ecology, 2020) along the shoreline adjacent to the Project area identified the presence of the following shorebird and seabird species:

- Hooded plover (*Thinornis cucullatus*);
- Pacific golden plover (*Pluvialis fulva*);
- Pacific gull (*Larus pacificus*);
- Shy albatross (*Thalassarche cauta*);
- Pied cormorant (*Phalacrocorx varius*); and
- White-bellied sea eagle (*Haliaeetus leucogaster*).

Many of the birds listed in Table 6.17 are listed in the following international conventions that aim to protect the birds themselves and their habitat:

- Republic of Korea Migratory Birds Agreement 2006 (ROKAMBA);
- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA);
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.
- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 (JAMBA); and
- Convention on Wetlands of International Important especially as Waterfowl Habitat 1971 ('Ramsar Convention', see also Section 6.4.4).

Table 6.17. EPBC Act-listed bird species that may occur in the Project area and EMBA

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
True seabirds (34 species)											
Albatross											
Diomedea antipodensis	Antipodean albatross	V	Yes	Yes	L	L	-	F	-	-	Generic RP in place for all albatross in Australia, + AS for all albatross
Diomedea gibsoni	Gibson's albatross	V	Yes	Yes	L	L	-	F	-	-	
Diomedea epomophora	Southern royal albatross	V	Yes	Yes	L	H	L	-	VU	Yes	
Diomedea exulans	Wandering albatross	V	Yes	Yes	L	H	L	F	EN	Yes	
Diomedea sanfordi	Northern royal albatross	E	Yes	Yes	L	H	-	F	-	-	
Phoebetria fusca	Sooty albatross	V	Yes	Yes	L	H	L	-	-	Yes	
Thalassarche bulleri	Buller's albatross	V	Yes	Yes	L	H	L	F	-	Yes	
Thalassarche bulleri platei	Northern Buller's albatross	V	-	-	L	L	-	F	-	-	
Thalassarche cauta	Shy albatross	V	Yes	Yes	L	H	L	F	VU	Yes	

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Thalassarche cauta steadi	White-capped albatross	V	Yes	Yes	L	H	-	F	-	-	
Thalassarche chrysostoma	Grey-headed albatross	E	Yes	Yes	L	H	L	-	VU	-	
Thalassarche eremita	Chatham albatross	E	Yes	Yes	L	L	-	F	-	-	
Thalassarche impavida	Campbell albatross	V	Yes	Yes	L	H	-	F	-	-	
Thalassarche melanophris	Black-browed albatross	V	Yes	Yes	L	H	-	F	VU	Yes	
Thalassarche salvini	Salvin's albatross	V	Yes	Yes	L	H	-	F	-	-	
Thalassarche sp. nov.	Pacific albatross	V	Yes	Yes	L	L	-	F	-	-	
Petrels											
Fregetta grallaria	White-bellied storm-petrel	V	-	-	L	H	-	-	-	-	-
Halobaena caerulea	Blue petrel	V	-	Yes	L	L	-	-	-	-	CA
Macronectes giganteus	Southern giant petrel	E	Yes	Yes	L	H	L	-	VU	Yes	Generic RP and AS for

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Macronectes halli	Northern giant petrel	V	Yes	Yes	L	H	L	-	NT	Yes	giant petrels
Pterodroma leucoptera	Gould's petrel	E	-	-	L	H	-	-	-	-	RP
Pterodroma neglecta	Kermadec petrel (western)	V	-	-	L	H	-	-	-	-	-
Pelecanoides urinatrix	Common diving petrel	-	-	Yes	L	H	-	-	NT	Yes	-
Other seabirds											
Anous stolidus	Common noddy	-	Yes	Yes	L	H	-	-	-	-	-
Apus pacificus	Fork-tailed swift	-	Yes	Yes	L	H	-	-	-	Yes	-
Ardenna carneipes	Flesh-footed shearwater	-	Yes	Yes	L	H	-	F	-	Yes	-
Ardenna grisea	Sooty Shearwater	-	Yes	Yes	L	H	-	-	-	Yes	-
Ardenna pacifica	Wedge-tailed shearwater	-	Yes	Yes	L	H	-	-	-	Yes	-
Ardenna tenuirostris	Short-tailed shearwater	-	Yes	Yes	H	H	-		-	Yes	-
Calonectris leucomelas	Streaked shearwater	-	Yes	Yes	L	H	-		-	-	-

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Catharacta skua	Great skua	-	-	Yes	L	H	-	-	-	Yes	-
Haliaeetus leucogaster	White-bellied sea-eagle	-	-	Yes	H	H	L	-	VU	Yes	-
Pachyptila turtur subantarctica	Fairy prion (southern)	V	-	-	L	H	-	-	VU	Yes	CA
Pandion haliaetus	Osprey	-	Yes	Yes	L	H	-	-	-	-	-
True shorebirds (50 species)											
Actitis hypoleucos	Common sandpiper	-	Yes	Yes	L	H	-	-	VU	Yes	-
Arenaria interpres	Ruddy turnstone	-	Yes	Yes	L	H	-	-	-	Yes	-
Ardea alba	Great egret	-	-	Yes	L	H	L	-	-	Yes	-
Ardea ibis	Cattle egret	-	-	Yes	L	H	-	-	-	-	AS
Botaurus poiciloptilus	Australasian bittern	E	-	-	L	H	L	-	EN	Yes	CA
Calidris alba	Sanderling	-	Yes	Yes	L	H	-	R	NT	Yes	-
Calidris acuminata	Sharp-tailed sandpiper	-	Yes	Yes	L	H	-	R	-	Yes	-
Calidris canutus	Red knot	E	Yes	Yes	L	H	-	-	EN	Yes	

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Calidris ferruginea	Curlew sandpiper	CE	Yes	Yes	L	H	L	-	EN	Yes	-
Calidris tenuirostris	Great knot	CE	Yes	Yes	L	H	L	R	EN	Yes	CA
Calidris melanotos	Pectoral sandpiper	-	Yes	Yes	L	L	L	-	NT	-	-
Calidris ruficolis	Red-necked stint	-	Yes	Yes	L	H	-	-	-	-	-
Charadrius bicinctus	Double-banded plover	-	-	Yes	M	H	-	R		Yes	-
Charadrius leschenaultii	Greater sand plover	V	Yes	Yes	L	H	-	-	CE	Yes	CA
Charadrius mongolus	Lesser sand plover	E	Yes	Yes	L	H	-	-	CE	Yes	CA
Charadrius veredus	Oriental plover	-	Yes	Yes	L	H	-	-	-	-	-
Charadrius ruficapillus	Red-capped plover	-	-	Yes	M	H	-	-	-	Yes	-
Eudyptula minor	Little penguin	-	-	Yes	L	H	-	F	-	Yes	-
Gallinago hardwickii	Latham's snipe	-	Yes	Yes	L	H	-	-	NT	Yes	-
Gallinago megala	Swinhoe's snipe	-	Yes	Yes	L	L	-	-	-	-	-

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Gallinago stenura	Pin-tailed snipe	-	Yes	Yes	L	L	-	-	-	-	-
Himantopus himantopus	Black-winged stilt	-	-	Yes	L	L	-	-	-	-	-
Hirundapus caudacutus	White-throated needletail	-	-	Yes	L	H	-	-	VU	Yes	-
Larus novaehollandiae	Silver gull	-	-	Yes	H	H	-	-	-	Yes	-
Larus pacificus	Pacific gull	-	-	Yes	H	H	-	-	NT	-	-
Lathamus discolour	Swift parrot	CE	-	Yes	L	H	L	-	EN	Yes	AS
Limosa lapponica bauera	Bar-tailed godwit	V	Yes	Yes	L	H	-	-	-	Yes	-
Limosa limosa	Black-tailed godwit	-	Yes	Yes	L	H	-	-	VU	-	-
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	CE	Yes	Yes	L	L	-	-	-	-	-
Neophema chrysogaster	Orange-bellied parrot	CE	-	Yes	L	H	L	-	CE	Yes	RP, AS
Numenius madagascariensis	Eastern curlew	CE	Yes	Yes	L	H	L	-	VU	Yes	CA

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Numenius minutus	Little curlew	-	Yes	Yes	L	H	-	-	-	Yes	-
Numenius phaeopus	Whimbrel	-	Yes	Yes	L	H	-	-	VU	Yes	-
Phalacrocorax fuscescens	Black-faced cormorant	-	-	Yes	L	H	-	-	NT	Yes	-
Philomachus pugnax	Ruff	-	Yes	Yes	L	L	-	-	-	-	-
Pluvialis fulva	Pacific golden plover	-	Yes	Yes	L	H	-	-	VU	Yes	-
Pluvialis squatarola	Grey plover	-	Yes	Yes	L	H	-	-	EN	Yes	-
Recurvirostra novaehollandiae	Red-necked avocet	-	-	Yes	L	H	-	-	-	Yes	-
Rostratula australis	Australian painted snipe	E	-	Yes	L	H	L	-	CE	-	CA
Sterna albifrons	Little tern	-	Yes	Yes	L	H	L	-	VU	Yes	AS
Sterna bergii	Crested tern	-	Yes	Yes	H	H	-	-	-	Yes	-
Sterna caspia	Caspian tern	-	Yes	Yes	H	H	L	-	NT	Yes	-
Sterna fuscata	Sooty tern	-	-	Yes	L	H	-	-	-	Yes	-

Scientific Name	Common Name	EPBC Act status			Likelihood of occurrence		FFG Act status	BIA within the EMBA	DELWP Advisory List Status	Recorded in VBA Search	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Project area	EMBA					
Sterna (Sternula) nereis nereis	Australian fairy tern	V	-	-	L	H	L	-	EN	Yes	CA
Thinornis rubricollis rubricollis	Hooded plover (eastern)	V	-	Yes	H	H	L	-	VU	Yes	AS
Tringa brevipes	Grey-tailed tattler	-	Yes	Yes	L	H	L	-	CE	Yes	-
Tringa glareola	Wood sandpiper	-	Yes	Yes	L	H	-	-	VU	-	-
Tringa nebularia	Common greenshank	-	Yes	Yes	L	H	-	-	VU	Yes	-
Tringa stagnatilis	Marsh sandpiper	-	Yes	Yes	L	H	-	-	VU	Yes	-
Xenus cinereus	Terek sandpiper	-	Yes	Yes	L	H	L	-	EN	-	-

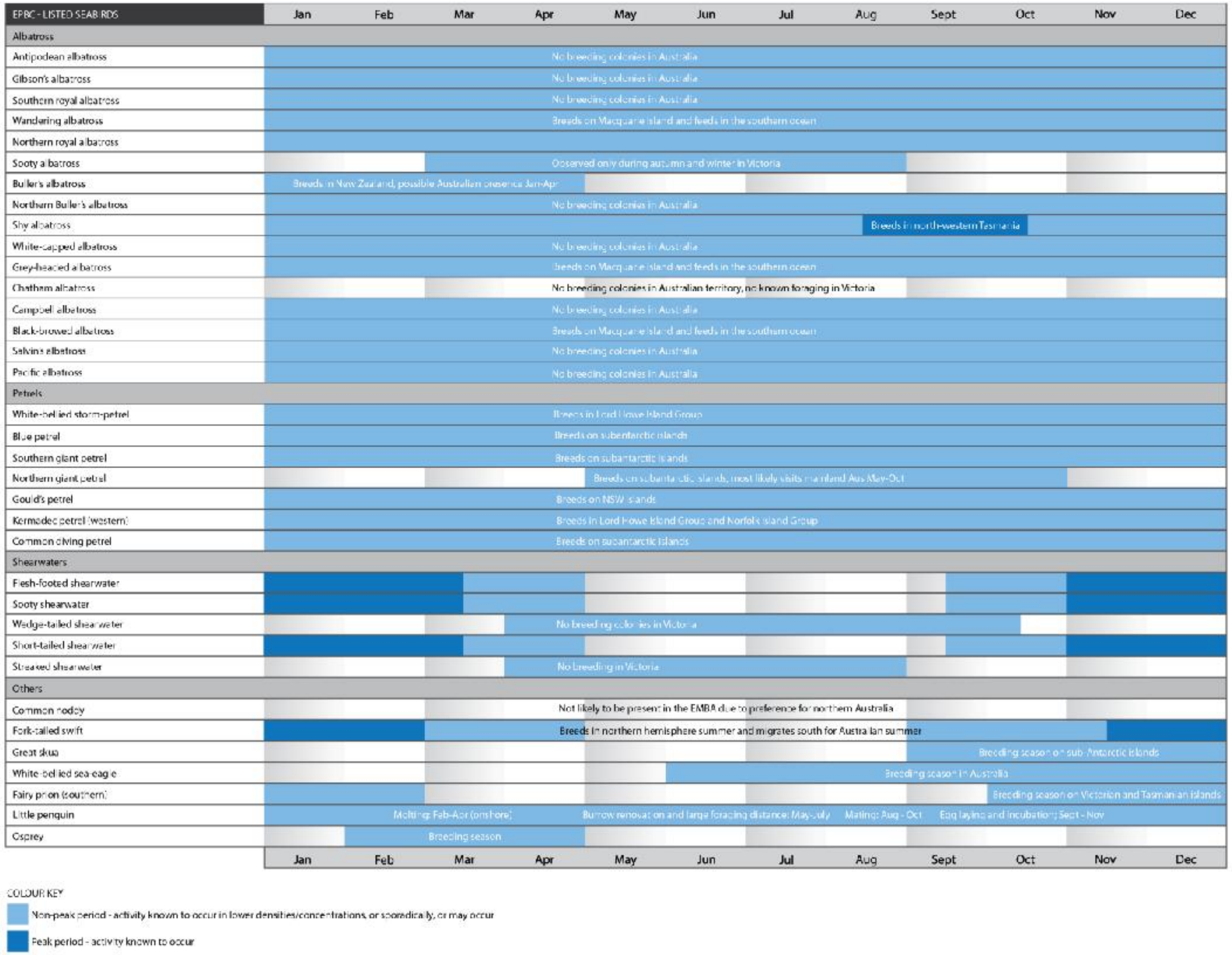


Figure 6.26. Likely temporal presence and absence of EPBC Act-listed seabird species in the Project area and EMBA

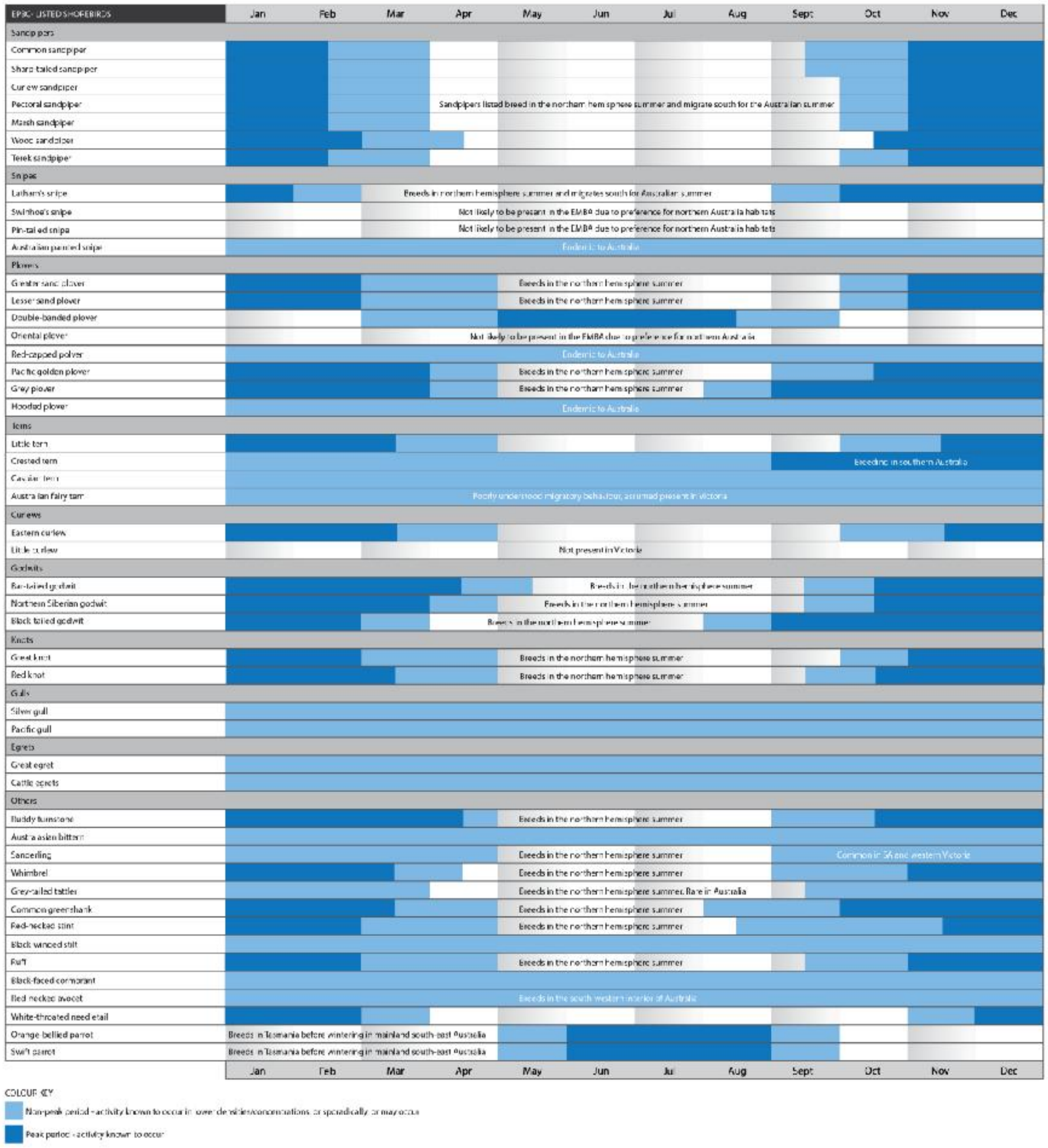


Figure 6.27. Likely temporal presence and absence of EPBC Act-listed shorebird species in the Project area and EMBA

Exclusively Seabirds

<u>Albatross (EPBC Act: Endangered & vulnerable, listed migratory, FFG Act: many listed as threatened)</u>

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 (EA, 2001). Only five species of albatross and the southern and northern giant petrel are known to breed within Australia. Breeding within Australian territory occurs on the isolated islands of Antarctica (Giganteus Island, Hawker Island and Frazier islands) and the Southern Ocean (Heard Island, McDonald Island, Macquarie Island, Bishop and Clerk Islands), as well as islands off the south coast of Tasmania and Albatross Island off the north-west coast of Tasmania in Bass Strait (DSEWPC, 2011a).

Albatross Island, supporting a breeding population of approximately 5,000 shy albatross (*Thallassarche cauta*), is the closest breeding colony of threatened seabird to the Project area, located approximately 335 km to the southwest.

All Australian waters can be considered foraging habitat for albatross and petrels, with the most important habitat considered to be south of 25°S (DSEWPC, 2011a), which includes the Project area. Given these species' ability to cover vast ocean distances while foraging, it is possible they may overfly and forage in the vicinity of the Project area. Key threats to albatross and petrels are incidental catch from fishing, competition with fisheries for prey, dependence on fishing discards, marine pollution and loss of nesting habitat (DSEWPC, 2011a).

The 16 albatross species listed in Table 6.17 have a widespread distribution throughout the southern hemisphere.

Albatrosses nest on isolated islands and forage across the ocean for food, usually in offshore areas during winter, and particularly along the continental shelf edge and open waters (DSEWPC, 2011a). All the albatross species listed in Table 6.17 are known to forage in Australian waters, with cephalopods, fish and crustaceans forming the basis of their diet, caught by diving (DSEWPC, 2011a). They undertake no annual migration, but disperse widely after breeding. No breeding colonies or nesting areas for the listed albatross species are located near the Project area or EMBA (DSEWPC, 2011a).

Four of the albatross species (wandering, black-browed, shy and grey-headed albatross) breed in or adjacent to the South-east marine Region on Macquarie Island (2,035 km southeast), Albatross Island (335 km southwest), Pedra Branca (630 km south) and Mewstone Island (625 km southwest of the Project area) (DoE, 2015a). These constitute critical habitat to the survival of albatross (DSEWPC, 2011a) and represent a small portion of the global population for each species (DoE, 2015a). These critical habitat areas are remote from the Project area and EMBA.

<u>Petrels (EPBC Act: Vulnerable and endangered, some listed migratory)</u>

The six petrel species listed in Table 6.17 as potentially occurring within the EMBA are widely distributed throughout the southern hemisphere. They nest on isolated islands and breed on sub-Antarctic and Antarctic islands. The northern giant-petrel and southern giant-petrel share the same breeding areas listed for the albatross (DSEWPC, 2011a). Outside the breeding season (October to February), petrels disperse widely and move north into sub-tropical waters (DAWE, 2020b). Most petrel species feed on krill, squid, fish, other small seabirds and marine mammals (DSEWPC, 2011a). No breeding colonies or nesting areas for the listed petrel species are located in or near the Project area or EMBA.

The DoE (2015a) states that the blue petrel occurs in Australian waters between July and September, the northern giant petrel occurs from May to October, and the southern giant petrel occurs during all months (except February).

<u>Other seabirds</u>

Other seabirds listed in the PMST that may occur within the Project area and EMBA are described here.

- The common noddy (*Anous stolidus*) is a medium-sized bird that breeds on offshore islands in large colonies, sometimes with up to 100,000 nests. The species feeds on small fish, squid, pelagic molluscs and insects that are most times skimmed from the surface of the ocean. The common noddy is widespread in tropical seas and may forage in the waters of the southern NSW coast.
- The fork-tailed swift (*Apus pacificus*) is a medium-sized bird has a large global distribution and population, and occurs throughout much of Australia. In Victoria,

it is widespread but sparsely scattered, and occurs over cliffs, beaches and sometimes well out to sea (Birdlife Australia, 2020). This species is almost exclusively aerial, feeding on insects in flight (Birdlife Australia, 2020). As a migratory species, it arrives in Australia from September to October, leaving southern Australia from mid-April (Birdlife Australia, 2020). As a common species, the fork-tailed swift may occur in the Project area and EMBA from September to April.

- The great skua (*Catharacta 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 Project area and EMBA (though scarce) during winter (Flegg, 2002).
- The southern fairy prion (*Pachyptila turtur subantarctica*) is mainly found offshore. The species diet is comprised mostly of crustaceans (especially krill), but occasionally includes some fish and squid. It feeds mainly by surface-seizing and dipping, but can also catch prey by surface-plunging or pattering Birdlife Australia, 2020). In Australia, it is known to breed only on Macquarie Island (2,030 km southeast of the Project area), and on the nearby Bishop and Clerk islands (Birdlife Australia, 2020).
- The white-bellied sea eagle (*Haliaeetus leucogaster*) is distributed along the coastline in coastal lowlands with breeding from Queensland to Victoria in coastal habitats and terrestrial wetlands in temperate regions. The breeding season is from June to January with nests built in tall trees, bushes, cliffs or rock outcrops. Breeding pairs are generally widely dispersed (Birdlife Australia, 2020). The species forages over open water (coastal and terrestrial) and feeds on fish, birds, reptiles, mammals and crustaceans and normally launches into a glide to snatch its prey, usually with one foot, from the ground or water surface. The species is widespread and makes long-distance movements (Birdlife Australia, 2020). This species may be present along the adjacent coastline during the project activities.
- The osprey (*Pandion haliaetus*) is a common, medium-sized raptor that is present around the entire Australian coastline, with the breeding range restricted to the north coast of Australia (including many offshore islands) and an isolated breeding population in South Australia (Birdlife Australia, 2020). Breeding occurs from April to February. Ospreys occur mostly in coastal areas but occasionally travel inland along waterways, where they feed on fish, molluscs, crustaceans, reptiles, birds and mammals. They are mostly resident or sedentary around breeding territories, and forage more widely and make intermittent visits to their breeding grounds in the non-breeding season (Birdlife Australia, 2020). Due to their broad habitat, osprey may be present in the Project area and EMBA.
- There are five shearwater species (sooty, flesh-footed, wedge-tailed, short-tailed and streaked**)** that were reported by the PMST and several more recorded in the ALA and VBA. Shearwaters are medium-size long-winged seabirds that are most common in temperate and cold waters. They spend the majority of their time foraging in the ocean and return to coastal cliffs and offshore islands only to breed. Shearwaters feed on fish, squid, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp) and other soft-bodied pelagic prey. Some shearwaters, such as the sooty and flesh-footed, are trans-equatorial migrants and are widely distributed across the Pacific Ocean. Due to their expansive ranges, it is possible that the listed shearwaters may overfly, forage or rest in the EMBA.

Shorebirds and Coastal Species

Plovers

There are seven EPBC Act-listed plovers (double-banded, greater sand, lesser sand, oriental, red-capped, pacific golden, and grey) that may occur within the EMBA and Project area. All seven species are recorded in the VBA database with 118 records of the hooded plover in the EMBA, and the ALA lists the same species (with the addition of the ringed plover, *Charadrius hiaticula*).

Plovers are medium sized wading birds that have wide-ranging coastal habitats comprising estuaries, bays, mangroves, damp grasslands, sandy beaches, sand dunes, mudflats and lagoons (Flegg, 2002), with roosting also taking place on sand bars and spits. Plovers feed on a range of molluscs, worms, crustaceans and insects. Plovers (with the exception of the hooded and red-capped lovers) breed in Asia and the Artic region and are more likely to be present in Australia during summer, depending on the species. The hooded plover breeds in Australia and builds its nests in sandy oceanic beaches. The location of these nests presents the greatest threat to this species' population, as nests, eggs and chicks are vulnerable to predation and trampling (Birdlife Australia, 2020). The sandy beaches of the Ninety Mile Beach are recognised nesting habitat for the hooded plovers.

Terns

The five EPBC Act-listed tern species that may occur within the EMBA are the fairy, little¸ sooty, crested, and Caspian terns. The ALA has records for two terns in the Project area (Caspian and crested) and several more in the EMBA, while the VBA has no records in the Project area but several in the EMBA. The gull-billed tern (*Gelochelidon nilotica*), which is a listed species of the FFG Act Threatened Species List was recorded in the Shorebirds 2020 database.

Terns are slender, lightly built birds with long, forked tails, narrow wings, long bills, and relatively short legs. Many of the tern species present along the southern Australian coastline are widespread and occupy beach, wetland and grassland habitats. Terns rarely swim; they hunt for prey in flight, dipping to the water surface or plunge-diving for prey (Flegg, 2002) usually within sight of land for fish, squid, jellyfish and sometimes crustaceans (DEHWA, 2007). Fairy terns feed by plunge diving on small baitfish in coastal waters, usually close to land (Birdlife Australia, 2020). The total number of Australian fairy terns is estimated to be 5000 mature individuals that utilise offshore, estuarine, lacustrine, wetland, beach and spit habitats (DSEWPC, 2011b). The species nests above the high water mark in clear view of the water and on sites where the substrate is sandy and the vegetation low and sparse (DSEWPC, 2011b). Fairy terns are threatened by predation from introduced mammals, disturbance by humans, dogs and vehicles (DSEWPC, 2011b).

Within the EMBA, habitat for these species occurs along Ninety Mile Beach and at the Gippsland Lakes and Corner Inlet Ramsar sites (Birdlife Australia, 2020). Depending on the time of the year, the little tern may occur within the EMBA.

Several records of terns including the common, white-fronted, white-winged and arctic have been recorded in the VBA as occurring within the EMBA.

Sandpipers

There are seven EPBC Act-listed sandpiper species that may occur within the Project area and EMBA including the curlew, common, sharp-tailed, pectoral, wood, marsh, and terek.

The ALA has no records of sandpipers in the Project area, but five sandpiper species within the EMBA (the same as those listed under the EPBC Act, with the addition of the broad-billed sandpiper, *Limicola falcinellus*). The VBA has no records of sandpipers in the Project area, but one record of the broad-billed sandpiper in the EMBA. Sandpipers are therefore not likely to occur in the Project area, but likely to be present within the EMBA, only during summer.

Sandpipers breed in Europe and Asia and migrate to Australia during the southern summer. Sandpipers are small wader species found in coastal and inland wetlands, particularly in muddy estuaries, feeding on small marine invertebrates. Up to 3,000 sharp-tailed sandpiper and up to 1,800 curlew sandpiper are known to congregate to feed at the Gippsland Lakes. Curlew sandpipers breed in Siberia and migrate to Australia, arriving around September each year (DoE, 2015c). The species forages mainly on invertebrates, including worms, molluscs, crustaceans and insects. Curlew sandpipers usually forage in water, near the shore or on bare wet mud at the edge of wetlands. The species is threatened by the sustained loss of intertidal mudflat habitat at key migration staging sites in the Yellow Sea (DoE, 2015c).

<u>Snipes</u>

There are four EPBC-Act listed snipe species that may occur within the Project area including Latham's, Australian painted, Swinhoe's and pin-tailed.

The ALA has no records of snipes in the Project area, but records of the Latham's snipe and Australian painted snipe. The VBA has no records of snipes in the Project area, but records of the Latham's snipe in the EMBA.

These snipe species (other than the Australian painted snipe, which is endemic to Australia) are present during the southern hemisphere summer (breeding in Asia and Russia in the northern hemisphere summer). They are medium-sized waders that roost among dense vegetation around the edge of wetlands during the day and feed at dusk, dawn and during the night on seeds, plants, worms, insects and molluscs (Birdlife Australia, 2020). There are few records of the pin-tailed and Swinhoe's snipe in Victoria, while the Australian painted snipe is known to occur at Mallacoota Inlet. The nest of the Australian painted snipe is usually a scrape in the ground lined with twigs and stalks of grass. The species is threatened by the loss and degradation of wetlands, through drainage and diversion of water for agriculture and reservoirs (Birdlife Australia, 2020).

Snipes are likely to be present within the EMBA during the summer, but not within the Project area.

<u>Godwits</u>

There are three EPBC Act-listed godwit species that may occur within the EMBA including the bar-tailed, Northern Siberian and black-tailed.

The ALA and VBA have no records of snipes in the Project area, but records of the bar-tailed and black-tailed godwits in the EMBA.

Godwits are large waders that are found around all coastal regions of Australia during the southern hemisphere summer (breeding in Europe during the northern hemisphere summer), though the largest numbers remain in northern Australia. Godwits are commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit where they forage on intertidal mudflats or sandflats, in soft mud or shallow water and occasionally in shallow estuaries (Birdlife Australia, 2020). They have been recorded eating annelids, crustaceans, arachnids, fish eggs and spawn and tadpoles of frogs, and occasionally seeds. The Nooramunga Marine and Coastal Park (71 km south-west of the Project area) has recorded the largest concentrations of bar tailed godwit in south-eastern Australia.

Godwits are likely to be present within the EMBA during the summer, but not within the Project area.

Egrets

The great and cattle egrets are EPBC Act-listed species that may occur in the EMBA.

The ALA and VBA have no records of egrets in the Project area, but in the EMBA, the ALA and VBA record the great, little and plumed egrets.

Egrets generally prefer freshwater and saltwater wetlands with different hunting strategies present between the species (Birdlife Australia, 2020). The little egret is a small dainty all-white bird with a long slender bill and dark legs with yellow soles. The species frequents tidal mudflats, saltwater and freshwater wetlands, and mangroves. While hunting in shallow waters, it feeds on a wide variety of invertebrates as well as fish and amphibians. The little egret is listed on the FFG Act threatened species list with 33 records in the VBA from within the EMBA.

Due to its habitat preferences, egrets may be present at the Gippsland Lakes and possibly in the coastal areas of the EMBA, but are not likely to occur within the Project area.

Knots

The red and great knots are EPBC Act-listed species that may occur within the Project area and EMBA during summer and are both recorded in the VBA.

The ALA and VBA have no records of knots in the Project area, but in the EMBA, the ALA and VBA both have records for the red and great knots.

Both the red and great knots have a coastal distribution around the entire Australian coastline when it is present during the southern hemisphere summer (breeding in eastern Siberia in the northern hemisphere summer). The red knot is a medium-sized wader that prefers sandy beach, tidal mudflats and estuary habitats, where they feed on bivalve molluscs, snails, worms and crustaceans (Birdlife Australia, 2020). Lake Reeve has supported the largest concentration (5,000) of red knot recorded in Victoria.

Curlews

Two curlews (eastern and little) are listed under the EPBC Act PMST. The ALA and VBA have no records of curlews in the Project area, with both registers listing the beach-stone curlew (not listed as threatened), in addition to the eastern and little curlew, as occurring in the EMBA.

Curlews are medium-sized migratory birds that breed in the far north of Siberia and winters in Australasia.

The eastern curlew is the world's largest shorebird and is widespread in coastal regions in the north-east and south of Australia, including Tasmania. It is commonly found on intertidal mudflats and sandflats where it uses its long beak to pick the surface and probes for crabs. Curlews are also found on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons (DoE, 2015d).

The status of the eastern curlew was amended from endangered to critically endangered in 2015 because research shows population decline potentially caused by wetland reclamation in some areas of Asia. In Victoria, the main strongholds are in Corner Inlet (115 km west) and Western Port Bay (160 km west), with smaller populations in Port Phillip Bay and scattered elsewhere along the coast. Eastern curlews are found on islands in Bass Strait and along the northwest, northeast, east and southeast coasts of Tasmania. Historically, sightings have been recorded in Bass Strait and depending on the time of year, curlews may be present in the spill EMBA. (DoE, 2015d).

The little curlew breeds in Siberia and is seen on passage through Mongolia, China, Japan, Indonesia and New Guinea. In Australia, the little curlew is a bird of coastal and inland plains of the north where it often occurs around wetlands and flooded ground. They often form large flocks, occasionally comprising thousands of birds and sometimes associate with other insectivorous migratory shorebirds.

Given the little curlew is present in Queensland and the Northern Territory but only rarely sighted in Victoria, it is unlikely to occur in the Project area (DAWE, 2020b).

Orange-bellied parrot (EPBC Act: Critically endangered, FFG Act: Threatened)

In addition to the PMST list, the orange-bellied parrot (*Neophema chrysogaster*) is also recorded in the ALA and VBA for the EMBA, with no records in the Project area.

The species breeds in Tasmania during summer, migrates north across Bass Strait in autumn and over-winters on the mainland. Birds depart the mainland for Tasmania from September to November (Green, 1969). The southward migration is rapid (Stephenson, 1991), so there are few migration records. The northward migration across western Bass Strait is more prolonged (Higgins, 1999).

The parrot's breeding habitat is restricted to southwest Tasmania, where breeding occurs from November to mid-January mainly within 30 km of the coast (Brown and Wilson, 1984). The species forage on the ground or in low vegetation (Brown and Wilson, 1980; 1984, Loyn *et al*., 1986).

During winter, on mainland Australia, orange-bellied parrots are found mostly within 3 km of the coast (DELWP, 2016). In Victoria, they mostly occur in sheltered coastal habitats, such as bays, lagoons and estuaries, or, rarely, saltworks. They are also found in low samphire herbland dominated by beaded glasswort (*Sarcocornia quinqueflora*), sea heath (*Frankenia pauciflora*) or sea-blite (*Suaeda australis*), and in taller shrubland dominated by shrubby glasswort (*Sclerostegia arbuscula*) (DELWP, 2016).

This species may occur around the Gippsland Lakes area, outside of the Project area and EMBA, during winter.

Swift parrot (EPBC Act: Critically endangered, FFG Act: Threatened)

The swift parrot (*Lathamus discolour*) is a small parrot that has rapid, agile flight. During summer, it breeds in colonies in blue gum forest of south-east Tasmania. Infrequent breeding also occurs in north-west Tasmania. The entire population migrates to the mainland for winter. On the mainland it disperses widely and forages on flowers and psyllid lerps in eucalypts. The birds mostly occur on inland slopes, but occasionally occur on the coast (TSSC, 2016b).

The ALA and VBA have no records of knots in the Project area, but records for this species exist for the EMBA in both databases.

Given its habitat preferences, this species does not occur within the Project area and is unlikely to occur within the EMBA other than overflying it.

Australasian bittern (EPBC Act: Endangered, FFG Act: Threatened)

The Australasian bittern (*Botaurus poiciloptilus*) is recorded in the PMST. The ALA and VBA have no records of knots in the Project area, and the ALA has no records for the species in the EMBA, though there are seven records for this species exist for the EMBA in the VBA.

The Australasian bittern is a large, stocky, heron-like bird that occurs from southeast Queensland to southern South Australia. In Victoria, the species is mainly found in coastal areas and the Murray River region of central Victoria (TSSC, 2019). The Australasian bittern occurs mainly in freshwater wetlands and, rarely, in estuaries or tidal wetlands (TSSC, 2019). The species is threatened by the clearing and modification of wetlands for urban and agricultural development, as well as the extraction of water from wetlands for irrigation (TSSC, 2019).

The Australasian bittern is unlikely to occur in the Project area.

Cormorants

One species of cormorant (black-faced) was recorded in the EMBA by the PMST. The VBA records two species in the Project area (great and pied) and these two and an additional two species (black-faced and little black) in the EMBA. The ALA records the pied cormorant from the Project area, and five cormorants from the EMBA (adding the little-pied)

Each of these birds, with the exclusion of the black-faced cormorant which is confined to inshore marine habitats, can be found at inland locations of permanent water bodies and in coastal environments such as inlets and estuaries (Birdlife Australia, 2020). Cormorants generally feed on prey from insects, fish, crustaceans and molluscs by diving. Each of these species are widely distributed around Australia (BirdLife Australia, 2020) and may be encountered in the EMBA though not likely to occur in the Project area.

Spoonbills (EBPC Act: not listed, FFG Act: not listed)

Two species of spoonbill have been recorded in the VBA search of the EMBA (but not the Project area) including the yellow-billed (*Platalea flavipes*) and royal (*Platalea regia*) spoonbill. The ALA has no records of spoonbills in the Project area or EMBA.

Both of these species feed on aquatic insects, crustaceans and small fish using their specialised bill to detect prey in murky and muddy environments. Due to its preference for freshwater environments and inland wetlands, the yellow-billed spoonbill is unlikely to be encountered in the EMBA. However, the royal spoonbill is known to inhabit intertidal flats where it hunts for shrimps (BirdLife Australia, 2020) and as such may be present in the EMBA though not likely to occur in the Project area.

Little penguin

The little penguin (*Eudyptula minor*) is a seabird that does not fly and is the smallest of the 17 penguin species in the world. They are permanent residents of the coastal and offshore islands of parts of the Victorian and Tasmanian coast and Bass Strait islands, with the South-east Marine Region representing about 60% of the species known breeding population (DoE, 2015a). Both the ALA and VBA have no records of the little penguin in the Project area but do contain records for the EMBA.

Individuals exhibit strong site fidelity, returning to the same breeding colony each year to breed in the winter and spring months. While on land, penguins remain in burrows to rest, nest and moult (PFPI, 2018). Nest building (in sand dunes or in rock crevices) occurs from June to December, breeding occurs from August to October, egg laying occurs from August to December, chick raising occurs from August to March and moulting occurs between February and April (during which time they must remain on land). During winter, penguins spend most of their time at sea, returning to the burrows to rest and attend to their burrows (PFPI, 2018).

Little penguins dive on average between 5 and 20 m in depth, with their preferred food sources being pilchards, anchovies, warehou, red cod, barracouta and squid (PFPI, 2018). They forage mostly from dawn to an hour before dusk, returning to their burrows at dusk (BirdLife Australia, 2020).

During the breeding season, little penguins forage within 5-25 km of the coast, and at other times, foraging can occur up to 75 km from the coast (SARDI, 2011). Based on

OSRA mapping, little penguin colonies in the Gippsland region are listed below (all of which are outside the Project area and EMBA):

- Wilsons Promontory (104 km west of the Project area at its closest point) – 400 breeding pairs on Shellback Island, 1,000 breeding pairs at Norman Island, 3,400 breeding pairs at the Glennie Group Islands, 500 breeding pairs at the Anser Group of Islands, 400 breeding pairs at Wattle Island, 1,000 breeding pairs on Seal Island, 1,000 breeding pairs on Notch Island, 400 breeding pairs at Rag Island, 8,000 breeding pairs on Rabbit Island and 200 breeding pairs at Rabbit Rock;
- Phillip Island (180 km west of the Project area) – 32,000 individuals;
- Tullaberga Island (226 km northeast of the Project area) – 900 breeding pairs; and
- Gabo Island (232 km northeast of the Project area) – 35,000 breeding pairs (50% of Victorian population).

Other Bass Strait islands with known populations of little penguins include:

- Babel Island – 20,000 pairs;
- Betsy Island – 15,000 pairs;
- Curtis Island group – 2,000 individuals;
- Hogan Island group – 10,000 individuals
- Furneaux Island group – over 40,000 pairs; and
- Forsyth, Passage and Gull islands – 80,000 pairs.

The nearest BIA for little penguins is presented in Figure 6.28.

Important Bird Areas

BirdLife Australia and Birdlife International, in association with Rio Tinto, identified 314 Important Bird Areas (IBAs) in Australia between 2005 and 2009. The IBA program was developed to identify the most important areas on Earth for birds, to promote their significance for conservation and assist in their prioritisation of conservation efforts and resources (Dutson *et al*., 2009). IBAs are sites (distinct areas or places from surrounding areas) and are not protected by legislation. The nearest IBA to the EMBA is the Gippsland Lakes.

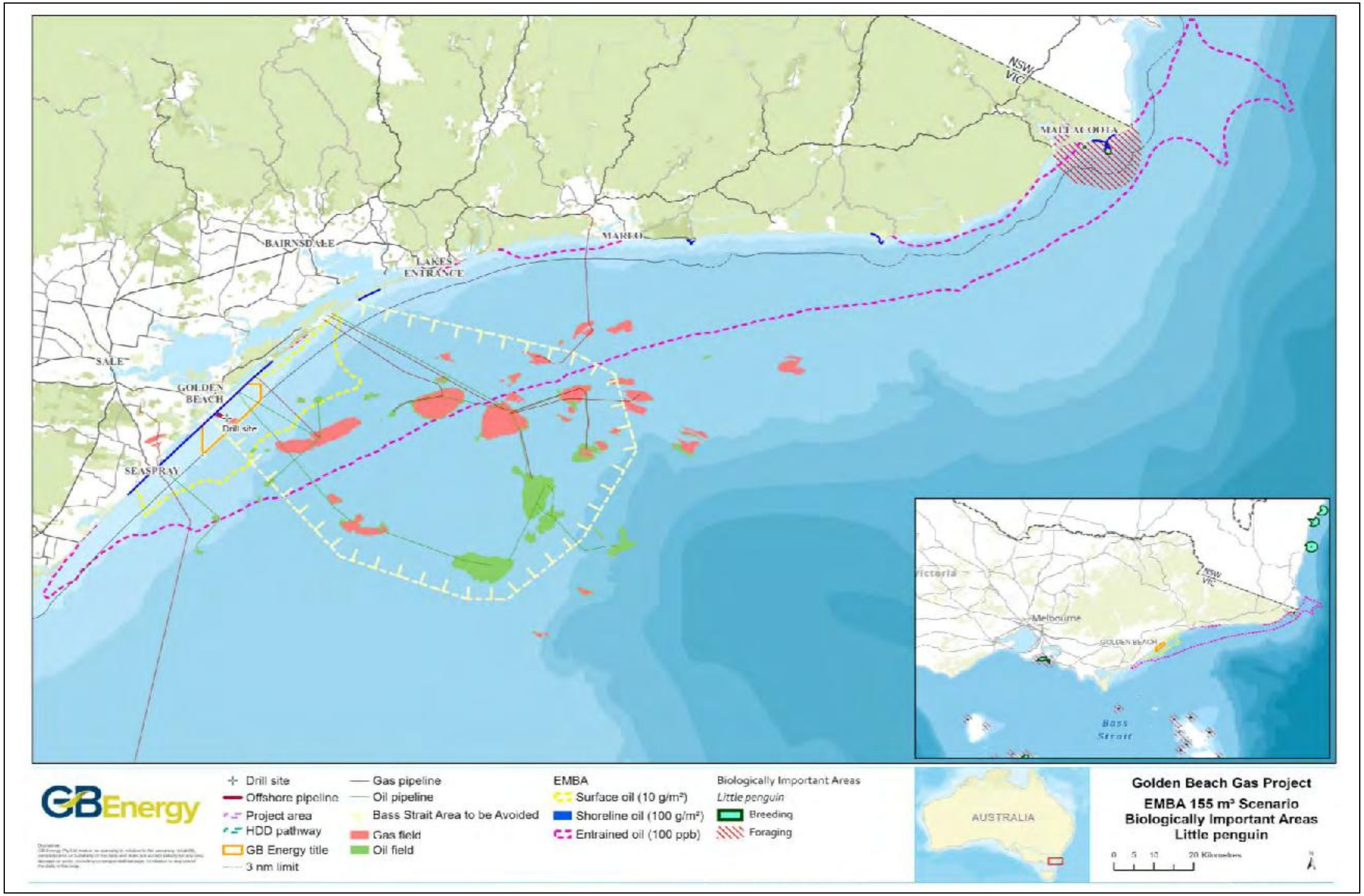


Figure 6.28a. Little penguin BIA intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

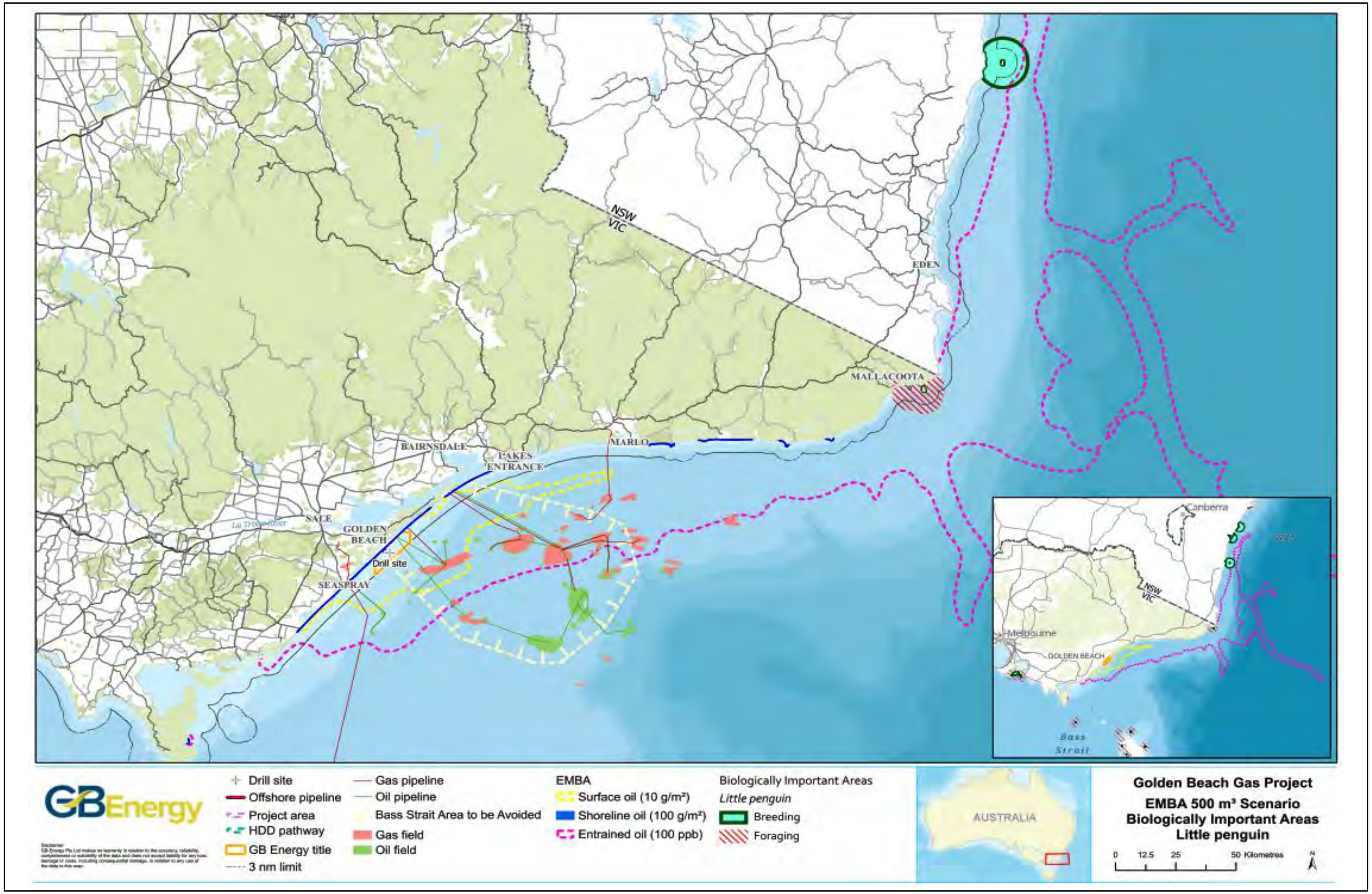


Figure 6.28b. Little penguin BIA intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.3.9. Marine Pests

It is widely recognised that marine pests can become invasive 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).

In the South-east Marine Region, 115 marine pest species have been introduced and an additional 84 have been identified as possible introductions, or 'cryptogenic' species (NOO, 2002). Several introduced species have become pests either by displacing native species, dominating habitats or causing algal blooms.

Marine pests known to occur in South Gippsland, according to Parks Victoria (2015) and Butler et al (2012) include:

- Pacific oyster (*Crassostrea gigas*) – small number of this oyster species are reported to occur in Western Port Bay, Tidal River in the Wilsons Promontory National Park and in the Gippsland Lakes.
- Northern pacific seastar (*Asterias amurensis*) – native to the shores of northern China, North Korea, South Korea and Japan, this species prefers soft sediment habitat, but also use artificial structures and rocky reefs, living in water depths usually less than 25 m (but up to 200 m water depths). It was first recorded in Tasmania in 1986 and was recorded in Port Phillip Bay and has since become established there (Ross *et al*., 2002). The species was also sighted in the Gippsland Lakes in January 2019. In the VFA's 2017 scallop abundance survey (see Section 6.3.1), it is noted that no northern pacific seastars were observed.
- 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 present in eastern Bass Strait, forming extensive and dense beds on sandy seabeds (Patil *et al*., 2004). It is known to occur in the Point Hicks Marine National Park.
- 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 presumed to occur in the Gippsland lakes and on the intertidal reefs of all the marine national parks in Gippsland, except the Ninety Mile Beach MNP (which has no intertidal reef).

The Marine Pests Interactive Map (DAFF, 2020) indicates that the major ports likely to be used to support the project (e.g., Geelong and Melbourne) are known to harbour the following species:

- Northern pacific seastar – as above.
- European shore crab – as above.
- European fan worms (*Sabella spallanzannii*) – attaches to hard surfaces, artificial structures and soft sediments, preferring sheltered waters up to 30 m deep. It reached Port Phillip Bay in the mid 1980s and is a nuisance fouler (Parks Victoria, 2020).
- Japanese kelp (*Undaria pinnatifida*) – occupies cold temperate oceanic waters up to 20 m deep, growing on rock, reef, stones and artificial structures. It rapidly forms dense forests and overgrows native species. It first established in Port Phillip Bay in the 1980s (Parks Victoria, 2020).

- Asian date mussel (*Musculista senhousia*) – prefers soft sediments in waters up to 20 m deep, forming mats and altering food availability for marine fauna.

These species have the potential to be picked up in the ballast water and transferred to the Project area. Two of these species (Pacific oyster and European green crab) are also known to occur in the Gippsland Lakes (Hirst & Bott, 2016).

Smaller ports in the region that may be used, such as (moving from west to east) Hastings, Port Welshpool, Barry Beach Marine Terminal, Port Anthony, Lakes Entrance and Eden, do not feature on the Marine Pests Interactive Map. Once exact ports are identified for use for each phase of the Project, their IMS status will be assessed as part of activity-specific EPs.

6.4. Conservation Values and Sensitivities

There are no formally listed or managed conservation areas that occur within the Project area.

The conservation values and sensitivities within the EMBA are described in this section, with Table 6.18 providing an outline of the conservation categories described.

Table 6.18. Conservation values in the EMBA

Category	Conservation classification	Section
MNES under the EPBC Act	Australian Marine Parks	Section 6.4.1
	World Heritage-listed properties	Section 6.4.2
	National Heritage-listed places	Section 6.4.3
	Wetlands of international importance	Section 6.4.4
	Nationally threatened species and threatened ecological communities	Throughout Section 6.3 and Section 6.4.5
	Migratory species	Throughout Section 6.3
	Great Barrier Reef Marine Park	Not applicable.
	Nuclear actions	Not applicable.
	A water resource, in relation to coal seam gas development and large coal mining development	Not applicable.
Other areas of national importance	Commonwealth heritage-listed places	Section 6.4.6
	Key Ecological Features (KEF)	Section 6.4.7
	Nationally important wetlands (NIW)	Section 6.4.8
State protected areas	Victorian protected areas	Section 6.4.9
	New South Wales protected areas	Section 6.4.10

6.4.1. Australian Marine Parks

The South-east Commonwealth Marine Reserves Network was designed to include examples of each of the provincial bioregions and the different seafloor features in the region (DNP, 2013). Provincial bioregions are large areas of the ocean where the fish species and ocean conditions are broadly similar. There are 14 Australian Marine Parks (AMPs) in the South-east Commonwealth Marine Reserves Network, with the closest being the East Gippsland AMP, located 215 km east of the Project area and within the 500 m^3 MDO spill scenario EMBA.

The East Gippsland AMP contains an extensive network of canyons, continental slope and escarpment at water depths from 600 m to more than 4,000 m, with an average depth of around 3,200 m. The mix of both warm and temperate waters in the reserve create habitat for free-floating aquatic plants or phytoplankton. The EAC combined with complex seasonality in oceanographic patterns creates large eddies of warm water with cooler, nutrient rich waters around the outside of the eddies (DNP, 2013). The mixing of these patterns creates conditions for highly productive phytoplankton growth, which support a rich abundance of marine life. Oceanic birds including albatrosses, petrels and shearwaters are known to forage in these waters. Humpback whales pass by the reserve during their migrations north and south (DNP, 2013).

6.4.2. World Heritage-Listed Properties

World Heritage Listed-properties are examples of sites that represent the best examples of the world's cultural and heritage values, of which Australia has 19 properties (DAWE, 2020d). In Australia, these properties are protected under Chapter 5, Part 15 of the EPBC Act.

No properties on the World Heritage List occur within the EMBA. The nearest site is the Royal Exhibition Building and Carlton Gardens in Melbourne, an onshore property located 221 km to the northwest of the Project area.

6.4.3. National Heritage-Listed Properties

The National Heritage List is Australia's list of natural, historic and Indigenous places of outstanding significance to the nation (DAWE, 2020e). These places are protected under Chapter 5, Part 15 of the EPBC Act.

There are no National Heritage-listed places in Bass Strait, with the nearest places all located onshore (Australian Alps National Parks and Reserves and the Point Nepean Defence Sites and Quarantine Station Area).

6.4.4. Wetlands of International Importance

Australia has 66 wetlands of international importance ('Ramsar wetlands') that cover more than 8.3 million hectares (as of August 2020) (DAWE, 2020f). Ramsar wetlands are those that are representative, rare or unique wetlands, or are important for conserving biological diversity, and are included on the List of Wetlands of International Importance developed under the Ramsar Convention. These wetlands are protected under Chapter 5, Part 15 of the EPBC Act.

There are two Ramsar wetlands in the EMBA. The 'Gippsland Lakes' and 'Corner Inlet' Ramsar sites (Figure 6.29) are intersected by the EMBA and are described here.

Gippsland Lakes

The Gippsland Lakes Ramsar site is a system of lakes and wetlands extending eastward from Sale to Lake Tyers, in some areas extending to the high-water mark of the ocean, and cover an area of 58,824 ha (Parks Victoria, 2003). The site is about 70 km long and 10 km wide (at its widest point) and was designated in 1982. These lakes and wetlands occur landwards of the coastal dunes adjacent to the EMBA, and at its nearest point, the site's boundary that runs to the high-water mark is located 5.5 km north of the EMBA.

The criteria met by the Gippsland Lakes site when it was listed were:

- 1(a) – it is a particularly good representative of natural or near-natural wetland characteristic of the appropriate biogeographical region;
- 3(a) – it regularly supports 20,000 water birds;

- 3(b) – it regularly supports substantial numbers from particular groups of waterfowl, indicative of wetland values, productivity or diversity; and
- 3(c) – it regularly supports 1% of individuals in a population of one species or subspecies of waterfowl.

Most of the Ramsar site (64%) is reserved under the *Crown Land (Reserves) Act* 1978 (Vic) as Nature Conservation Reserve, Natural Features Reserve and Public Purpose Reserve. Approximately one-third of the Gippsland Lakes Ramsar site is located within the Lakes National Park (2,390 ha) and Gippsland Lakes Coastal Park (17,584 ha), which are proclaimed under the *National Parks Act* 1975 (Vic).

The Gippsland Lakes are separated from the sea by sand dunes and fringed on the seaward side by the Ninety Mile Beach. The Gippsland Lakes form the largest navigable inland waterway in Australia. These features create a distinctive regional landscape of wetlands and flat coastal plains that is of considerable environmental significance in terms of its landforms, vegetation and fauna. The lakes are linked to the sea by an artificial entrance at its eastern end, being Lakes Entrance.

The Gippsland Lakes Ramsar site contains three main habitat types; permanent saline/brackish pools, coastal brackish/saline lagoons and permanent freshwater marshes (Parks Victoria, 2003). A significant quantity of threatened, endangered, vulnerable or rare native fish communities, and mammal, amphibian and plant species exist within these habitats.

The permanence of the main lakes and the relatively regular flooding of the adjacent wetlands mean that this wetland system is an important drought refuge for many waterfowl. The lakes and their associated swamps and morasses regularly support an estimated 40,000 to 50,000 ducks, swans, coots and other waterfowl. Lake Reeve (at the western end of the lake system) is a site of international zoological significance that attracts up to 12,000 migratory waders and is one of the five most important areas for waders in Victoria. The total concentration of waders at the south-western end of Lake Reeve fluctuates in response to local conditions of salinity, water depth and probably human disturbance (Parks Victoria, 2003). The lake has supported the largest concentration (5,000) of red knot (*Calidris canutus*) recorded in Victoria, as well as up to 3,000 sharp-tailed sandpiper (*Calidris acuminata*) and up to 1,800 curlew sandpiper (*Calidris ferruginea*) (Parks Victoria, 1999). Parks Victoria (2003) reports that 24 bird species listed under JAMBA and 26 species listed under CAMBA have been recorded at the lakes.

Most of the wetlands of the Gippsland Lakes are bordered by emergent reed beds dominated by common reed (*Phragmites australis*) or saltmarsh communities, with characteristic saltmarsh species including beaded glasswort (*Sarcocornia quinqueflora*) and sea rush (*Juncus kraussii*) (Parks Victoria, 2003).

There is a high concentration of archaeological sites in the Gippsland Lakes area including artefact scatters, shell middens, scarred trees, occupation sites, burials and axe-grinding grooves (Parks Victoria, 2003).

Parts of the Lakes system are heavily used for commercial and recreational fisheries and for other water-based recreation, while the immediate hinterland has been developed for agricultural uses and limited residential and tourism purposes (Parks Victoria, 2003).

Corner Inlet

The Corner Inlet Ramsar Site is located approximately 250 km south-east of Melbourne and includes Corner Inlet and Nooramunga Marine and Coastal Parks, and the Corner Inlet Marine National Park (MNP). It covers 67,192 ha and represents the most southerly marine embayment and intertidal system of mainland Australia (Parks Victoria, 2005a).

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

The Corner Inlet Ramsar Site Management Plan (WGCMA, 2014) identifies the key values of the site as:

- A substantially unmodified wetland that supports a range of estuarine habitats (seagrass, mud and sand flats, mangroves, saltmarsh and permanent marine shallow water);
- Presence of nationally threatened species including orange-bellied parrot, Australian grayling, fairy tern and growling grass frog;
- Non-breeding habitats for migratory shorebird species and breeding habitat for variety of waterbirds including several threatened species;
- Important habitats, feeding areas, dispersal and migratory pathways and spawning sites for numerous fish species of direct or indirect fisheries significance;
- Over 390 species of indigenous flora (15 listed species) and 160 species of indigenous terrestrial fauna (22 threatened species) and over 390 species of marine invertebrates;
- A wide variety of cetaceans and pinnipeds including bottlenose dolphins and Australian fur-seals, as well as occasional records of common dolphins, New Zealand fur-seals, leopard seals and southern right whales;
- Significant areas of mangrove and saltmarsh that are listed nationally as vulnerable ecological communities and provide foraging, nesting and nursery habitat for many species;
- Sand and mudflats, when exposed at low tide, that provide important feeding grounds for migratory and resident birds and at high tide provide food for aquatic organisms including commercial fish species;
- Ports and harbours – the four main ports (Port Albert, Port Franklin, Port Welshpool and Barry's Beach) service the commercial fishing industry, minor coastal trade, offshore oil and gas production and boating visitors;
- Fishing – the area supports the third largest commercial bay and inlet fishery in Victoria, including 18 licensed commercial fishermen, within an economic value of between $5 and $8 million annually;
- Recreation and tourism – Corner Inlet provides important terrestrial and aquatic environments for tourism and recreational activities such as fishing, boating, sightseeing, horse riding, scuba diving, bird watching and bushwalking;
- Cultural significance to the Gunaikurnai people, with the Corner Inlet and Nooramunga area located on the traditional lands of the Brataualung people who form part of the Gunaikurnai Nation. The area has a large number of cultural heritage sites that provide significant information for the Gunaikurnai people of today about their history. The Bunurong and the Boon Wurrung peoples also have areas of cultural significance in this region;
- Thirty-one shipwrecks are present in the site; and

- Research and education – the wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation within the Corner Inlet Ramsar Site provide a range of opportunities for education and interpretation.

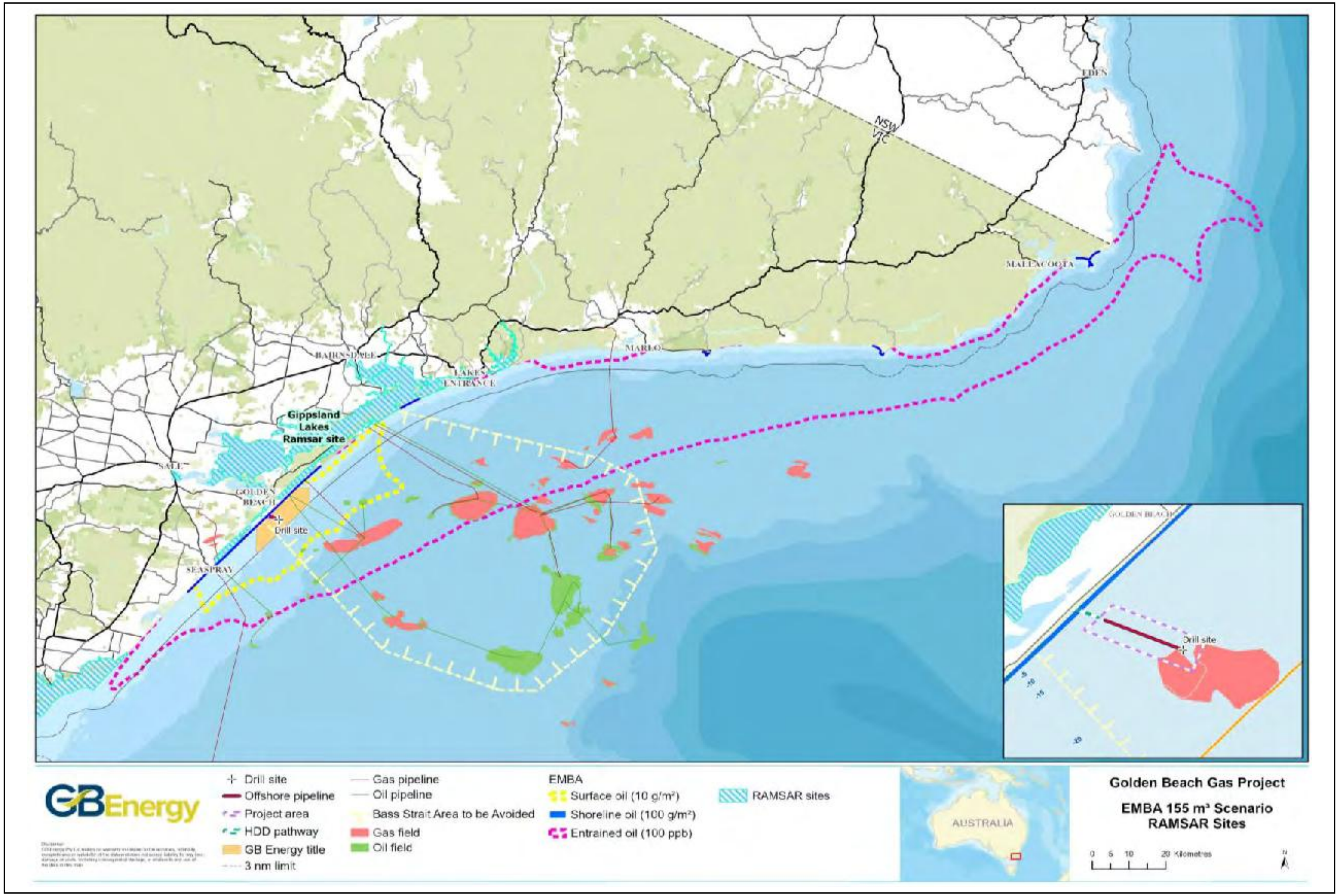


Figure 6.29a. Ramsar wetlands intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

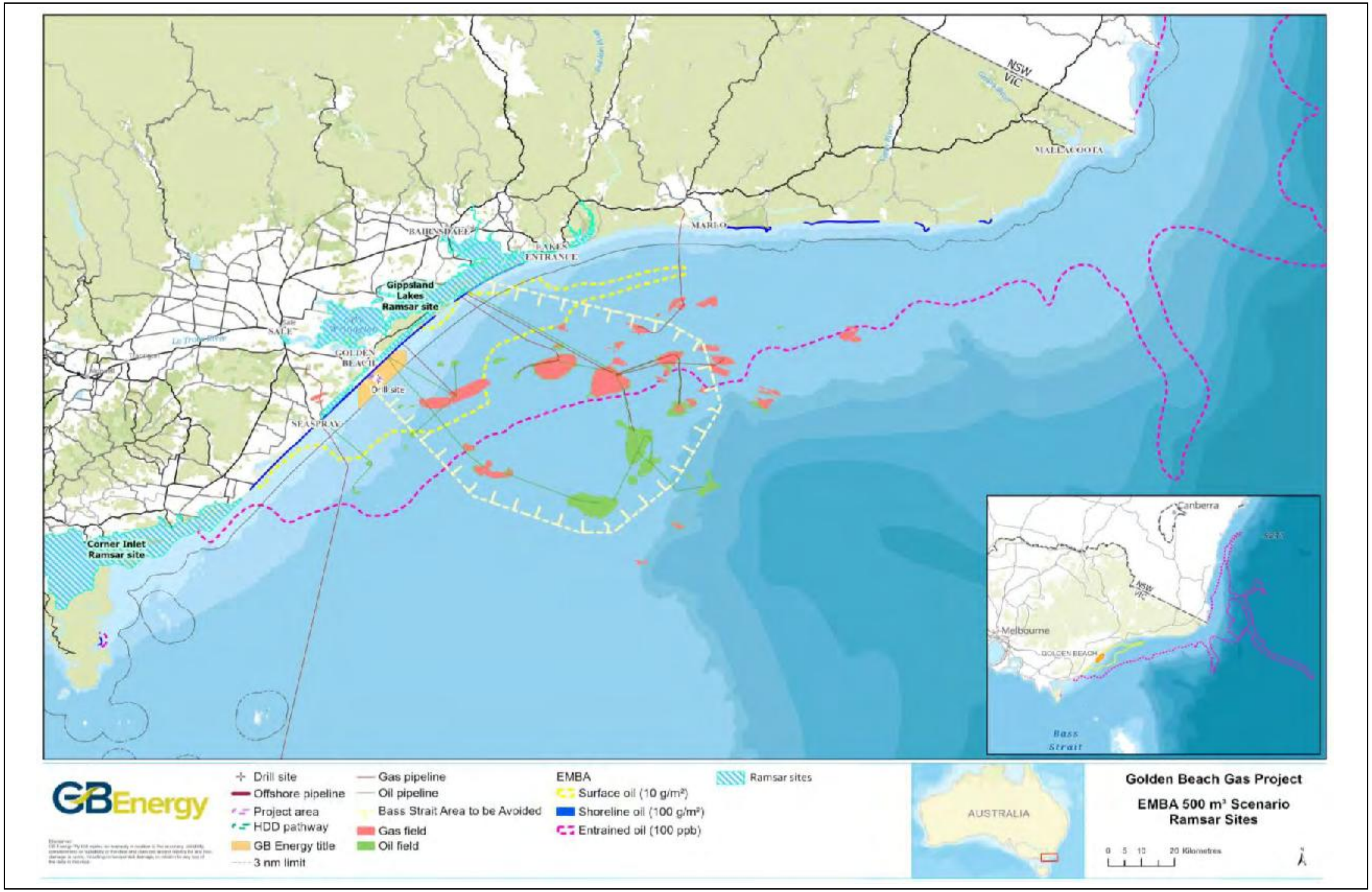


Figure 6.29b. Ramsar wetlands intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.4.5. Threatened Ecological Communities

The Australian Government is responsible for identifying and protecting MNES through the EPBC Act. Threatened Ecological Communities (TECs) are a MNES under the EPBC Act. TECs provide wildlife corridors and/or habitat refuges for many plant and animal species, and listing a TEC provides a form of landscape or systems-level conservation (including threatened species).

The PMST Report identifies the following TECs as occurring in the EMBA:

- Coastal swamp oak (*Casuarina glauca*) forest of New South Wales and south east Queensland ecological community;
- Giant kelp marine forests of south east Australia;
- Gippsland red gum (*Eucalyptus tereticornis* subsp. *mediana*) grassy woodland and associated native grassland;
- Illawarra and south coast lowland forest and woodland ecological community;
- Illawarra-Shoalhaven subtropical rainforest of the Sydney basin bioregion;
- Littoral rainforest and coastal wine thickets of eastern Australia;
- Lowland grassy woodland in the south east corner bioregion;
- Natural damp grassland of the Victorian coastal plains; and
- Subtropical and temperate coastal saltmarsh.

Only giant kelp marine forests of south east Australia and subtropical and temperate coastal saltmarsh TECs are described here as the remaining TECs are terrestrial and not present in the EMBA. Mapping presented in Figure 6.30 illustrates where TECs potentially occur due to the presence of suitable substrate and not necessarily where they are known to occur. TECs may occur outside the areas indicated. TECs are protected as MNES under Part 13, Section 181 of the EPBC Act.

Giant Kelp Marine Forests of South East Australia

The Giant Kelp Marine Forests of South East Australia TEC is mapped as potentially occurring within small coastal parts of the EMBA including a small area near Point Hicks (170 km northeast of the Project area) and areas east of Mallacoota (225 km northeast of the Project area). The majority of the TEC is mapped as potentially occurring along the Tasmanian coast and the west coast of the Furneaux Group, which is outside the EMBA.

According to the Approved Conservation Advice for Giant Kelp Marine Forests of South East Australia (DSEWPC, 2012a), giant kelp (*Macrocystis pyrifera*) is a large brown algae that grows on rocky reefs from the sea floor 8 m below sea level and deeper (DSEWPC, 2012a). Its fronds grow vertically toward the water surface, in cold temperate waters off southeast Australia. It is the foundation species of this TEC in shallow coastal marine ecological communities. The kelp species itself is not protected; to be considered a giant kelp marine forest, the plants must form a closed or semi-closed canopy at or below the water's surface and grow at depths generally greater than 8 m on a rocky substrate (DSEWPC, 2012a). Giant kelp is the largest and fastest growing marine plant. Its presence on a rocky reef adds vertical structure to the marine environment that creates significant habitat for marine fauna, increasing local marine biodiversity.

The large biomass and productivity of the giant kelp plants also provides a range of ecosystem services to the coastal environment. Giant kelp is a cold-water species and as sea surface temperatures have risen on the east coast of Australia over the last 40 years, it has been progressively lost from its historical range (DSEWPC, 2012a).

Giant kelp requires clear, shallow water no deeper than approximately 35 m below sea level (DSEWPC, 2012a). They are photoautotrophic organisms that depend on photosynthetic capacity to supply the necessary organic materials and energy for growth. O'Hara (in Andrew, 1999) reported that giant kelp communities in Tasmanian coastal waters occur at depths of 5 to 25 m. The largest extent of the ecological community is in Tasmanian coastal waters.

Subtropical and Temperate Coastal Saltmarsh

According to the Conservation Advice for Subtropical and Temperate Coastal Saltmarsh, this TEC occurs in a relatively narrow strip along the Australian coast, within the boundary along 23°37' latitude along the east coast and south from Shark Bay on the west coast of Western Australia (TSSC, 2013). The community is found in coastal areas which have an intermittent or regular tidal influence.

The coastal saltmarsh community consists mainly of salt-tolerant vegetation including grasses, herbs, sedges, rushes and shrubs. Succulent herbs, shrubs and grasses generally dominate and vegetation is generally less than 0.5 m in height (Adam, 1990). In Australia, the vascular saltmarsh flora may include many species, but is dominated by relatively few families, with a high level of endemism at the species level.

The saltmarsh community is inhabited by a wide range of infaunal and epifaunal invertebrates and low and high tide visitors such as fish, birds and prawns (Adam, 1990). It is often important nursery habitat for fish and prawn species. Insects are also abundant and an important food source for other fauna. The dominant marine residents are benthic invertebrates, including molluscs and crabs (Ross *et al*., 2009).

The coastal saltmarsh community provides extensive ecosystem services such as the filtering of surface water, coastal productivity and the provision of food and nutrients for a wide range of adjacent marine and estuarine communities and stabilising the coastline and providing a buffer from waves and storms. Most importantly, the saltmarshes are one of the most efficient ecosystems globally in sequestering carbon, due to the biogeochemical conditions in the tidal wetlands being conducive to long-term carbon retention. A concern with the loss of saltmarsh habitat is that it could release the huge pool of stored carbon to the atmosphere.

6.4.6. Commonwealth Heritage-listed Places

Commonwealth Heritage-listed places are natural, indigenous and historic heritage places owned or controlled by the Commonwealth (DAWE, 2020f). In Australia, these properties are protected under Chapter 5, Part 15 of the EPBC Act.

No properties on the Commonwealth Heritage List occur within the EMBA. Though the PMST Report lists the Gabo Lighthouse and Montague Island Lighthouse, each of these are located high above the high-water mark and as such, the lighthouses themselves are not considered part of the EMBA. The nearest place is Gabo Island Lighthouse, which is located 232 km northeast of the Project area.

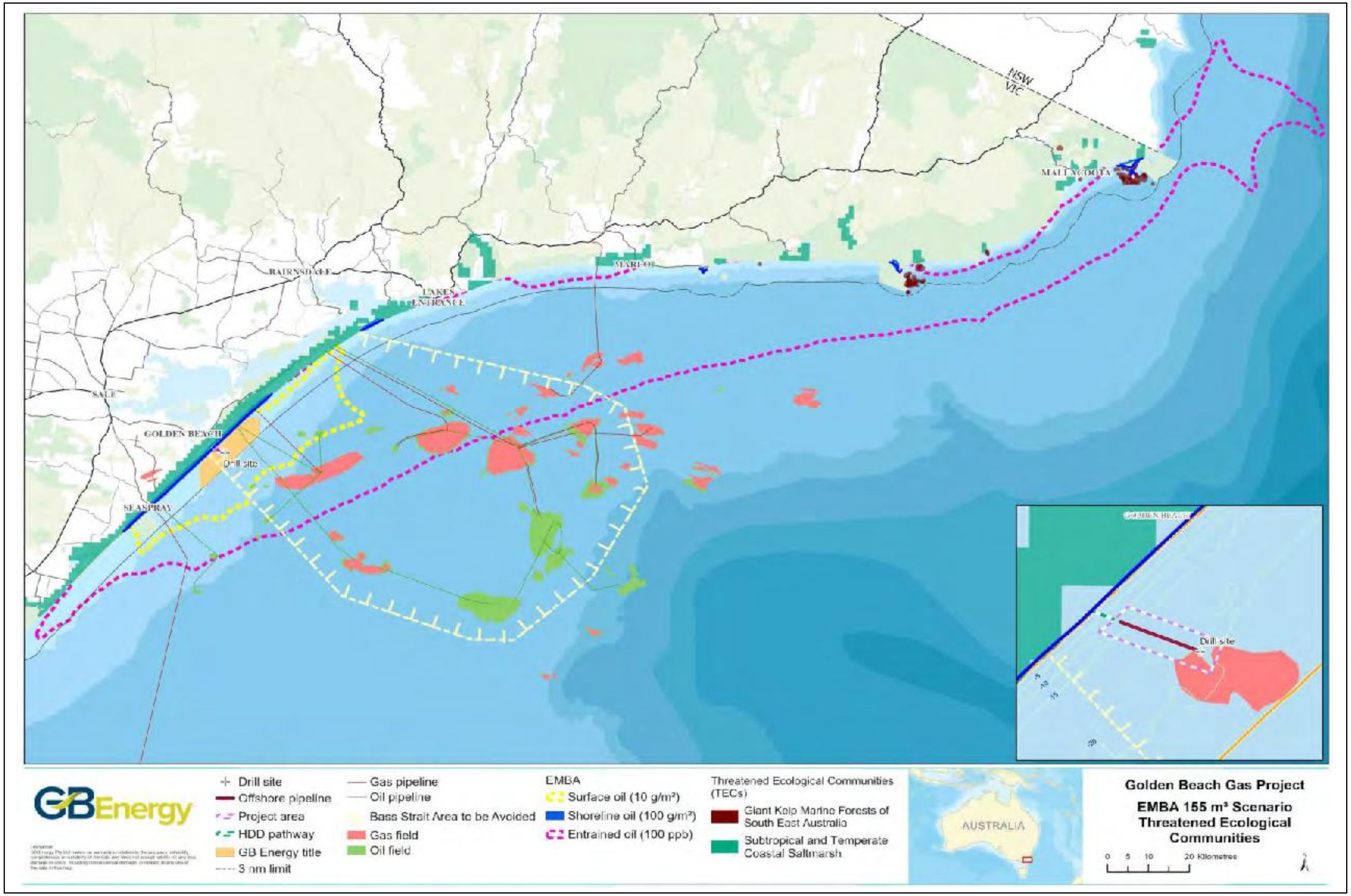


Figure 6.30a. TECs intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

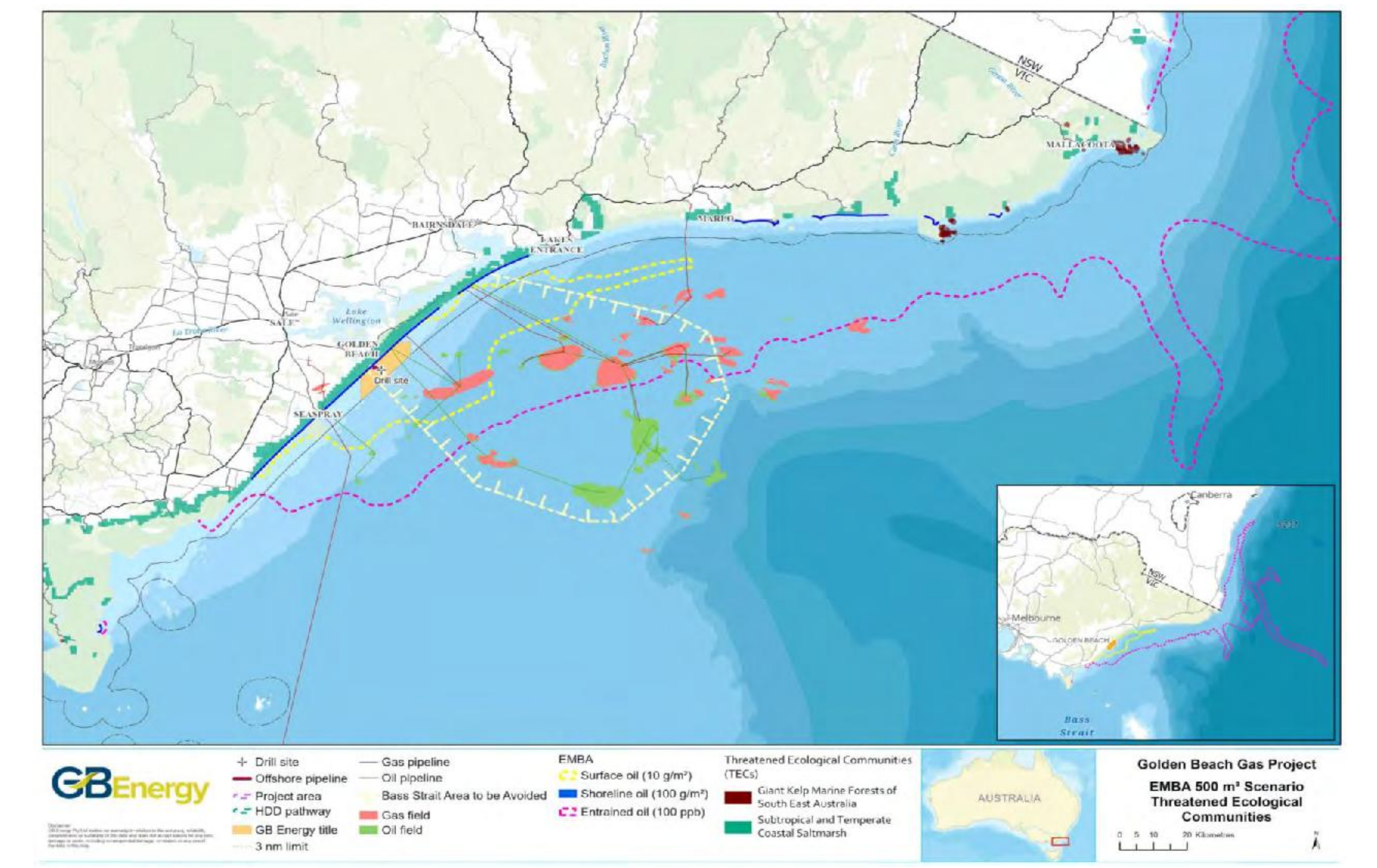


Figure 6.30b. TECs intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.4.7. Key Ecological Features

KEFs are elements of the Commonwealth marine environment that, based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity. KEFs have no legal status in decision-making under the EPBC Act, but may be considered as part of the Commonwealth marine area (DAWE, 2020b).

The spill EMBA intersects fours KEFs (Figure 6.31), these being the Big Horseshoe Canyon (163 km southeast of the Project), Upwelling East of Eden (53 km east of the Project area), Canyons of the Eastern Continental Slope (330 km northeast of the Project area) and Shelf Rocky Reefs (353 km northeast of the Project area). Each KEF is described here.

Big Horseshoe Canyon

The Big Horseshoe Canyon lies south of the coast of eastern Victoria and is the easternmost arm of the Bass Canyon system. The steep, rocky slopes provide hard substrate habitat for attached large megafauna. Canyons have a marked influence on diversity and abundance of species through their combined effects of topography, geology and localised currents, all of which act to funnel nutrients and sediments into the canyon. Sponges and other habitat forming species provide structural refuges for benthic fish, including the commercially important pink ling (*Genypterus blacodes*). It is the only known temperate location of the stalked crinoid (*Metacrinus cyaneu*), which occurs in water depths between 200 m and 300 m (DoE, 2015a).

Upwelling East of Eden

Dynamic eddies of the EAC cause episodic productivity events when they interact with the continental shelf and headlands. The episodic mixing and nutrient enrichment events drive phytoplankton blooms that are the basis of productive food chains including zooplankton, copepods, krill and small pelagic fish (DoE, 2015a). Therefore, the key value of the KEF is its high productivity and aggregations of marine life.

The upwelling maintains regionally high primary productivity that supports fisheries and biodiversity, including top order predators, marine mammals and seabirds. This area is one of two feeding areas for blue whales and humpback whales, known to arrive when significant krill aggregations form. The area is also important for seals, other cetaceans, sharks and seabirds (DoE, 2015a).

Canyons of the eastern continental slope

The canyons of the eastern continental slope are defined as a KEF as they provide a unique seafloor feature with enhanced ecological functioning, integrity and biodiversity, which apply to both its benthic and pelagic habitats. These canyons affect the water column by interrupting the flow of water across the seafloor and creating turbulent conditions in the water column. This turbulence transports bottom waters to the surface, creating localised upwellings of cold, nutrient-rich waters, which result in regions of enhanced biological productivity relative to the surrounding waters (DAWE, 2020b).

Shelf rocky reefs

Shelf rocky reefs of the Temperate East Marine Region are located on the eastern coast of Australia and support a range of complex benthic habitats that, in turn, support diverse benthic communities. Along the continental shelf, south of the Great Barrier Reef, benthic communities on rock outcrops and boulder substrates shift from algae-dominated communities to those dominated by attached invertebrates, including dense populations of large sponges, with a mixed assemblage of bryozoans and soft corals (DAWE, 2020b). This shift generally occurs at a depth of 45 metres. Below wave-influenced areas, massive and branched growth forms of sponges are more prevalent, and sponge species richness and density generally increases with depth along the New South Wales coast (DAWE, 2020b).

Collectively, these invertebrates create a complex habitat-forming community that supports microorganisms and other invertebrates, such as crustaceans, molluscs, annelids and echinoderms (DAWE, 2020b). These habitats also contribute to increased survival of juvenile fish by providing refuge from predation. Rocky reef habitats on Australia's east coast support a diverse assemblage of demersal fish, which show distinct patterns of association with shelf-reef habitats (DAWE, 2020b). For example, the jackass morwong, barracouta, orange-spotted catshark, eastern orange perch, butterfly perch and warehou are species that distinguish rocky-reef habitats at depths greater than 45 metres from those of soft sediments.

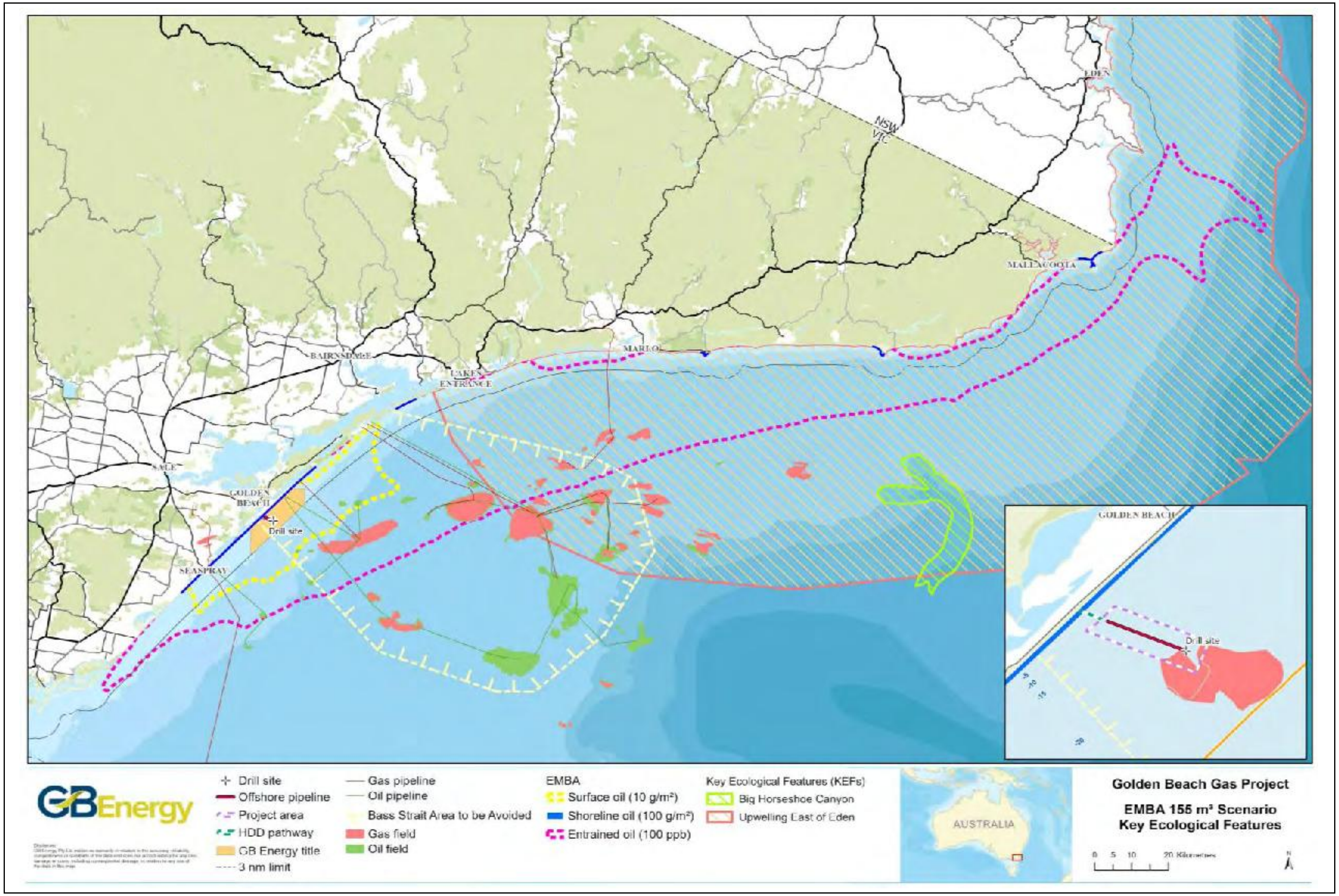


Figure 6.31a. KEFs intersected by the drilling and operations phase EMBA (155 m³ spill scenario)

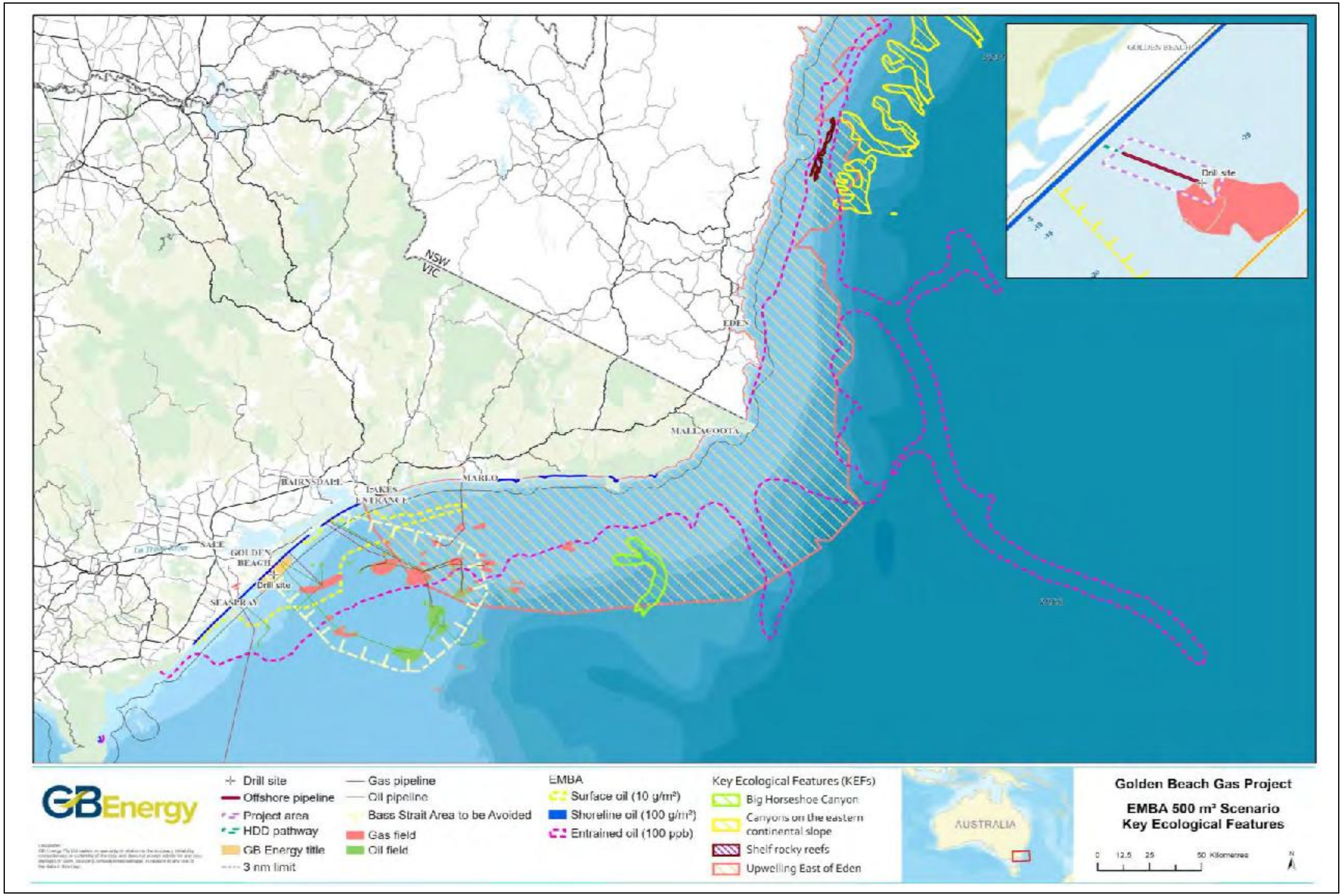


Figure 6.31b. KEFs intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.4.8. Nationally Important Wetlands

NIWs are considered significant for a variety of reasons, including their importance for maintaining ecological and hydrological roles in wetland systems, providing important habitat for animals at a vulnerable or particular stage in their life cycle, supporting 1% or more of the national population of any native plant or animal taxa or for its outstanding historical or cultural significance (DAWE, 2020g).

In Victoria, management of wetlands is regulated under various legislation, including the EPBC Act 1999 (Cth), FFG Act 1988, *Planning and Environment Act 1987*, *Catchment and Land Protection Act 1994* and *Water Act 1989*.

Thirteen (13) NIW were identified that are intersected by the EMBA (Figure 6.32). Ten (10) of these NIW would only be intersected by the spill EMBA if they are open to the sea at the time of a spill. These NIWs are described below based on DAWE (2020g) moving west to east along the EMBA.

- Corner Inlet (VIC066) – Corner Inlet is listed as a Ramsar site and supports 22 waterbirds species listed under the JAMBA and 17 waterbird species under the CAMBA agreements. The site is described in detail in Section 6.4.4.
- Jack Smith Lake State Game Reserve (VIC069) – Jack Smith Lake was once likely a bay that has now been isolated from the sea by the development of a sandy barrier. The wetland features thickets of swamp paperbark (*Melaleuca ericifolia*), which are subject to regular wetting and drying cycles. There is an artificial ocean outlet that controls water levels within the site. Over 100 bird species including 45 waterbird species have been recorded on the reserve including the threatened orange-bellied parrot (*Neophema chrysogaster*).
- Lake King Wetlands (VIC071) – The Lake King Wetlands form part of the Gippsland Lakes Ramsar Site and consists of two large coastal lagoons and associated channels with surrounding salt marshes and brackish to fresh marshes. The wetlands are high value for ecological, recreational, scientific, cultural and landscape features and supports 46 waterbird species including ten species listed under the JAMBA and CAMBA agreements.
- Lake Bunga (VIC085) – Lake Bunga is part of the Gippsland Lakes Ramsar Site. The lake is fed by the Bunga Creek and is rarely open to the sea. The wetland has supported 21 waterbird species including the little tern (*Sterna albifrons*), hooded plover (*Thinornis rubricollis*) and white-bellied sea-eagle (*Haliaeetus leucogaster*).
- Lake Tyers (VIC086) – Lake Tyers is a branched inlet formed by the marine submergence of incised valleys and is fed by several creeks including Stony and Boggy Creeks. The wetland has a well-developed tidal delta with marshy islets and is occasionally open to the sea. The wetland supports 54 waterbird species and is of ecological, scientific and cultural importance due to its forested shores, unspoilt character and Aboriginal archaeological sites.
- Ewing's Marsh (Morass) (VIC132) – This wetland was formerly an open lagoon supplied with seawater and freshwater floods though is now virtually enclosed within a barrier. Ewing's Marsh has thick shrub, sedge, rush and grass-dominated vegetation merging into heathland and forest on its inland side, and into dune shrubland on the seaward border. Approximately 440 plant taxa have been recorded at the site.
- Snowy River (VIC150) – The Snowy River wetland reach is 175 km long and an average corridor size of 400 m. Closer to the sea, the lower reach is characterised by low relief plains. The lower reach areas are high value for their

ecological, recreational, scientific, educational and scenic values. The wetlands are an excellent example of a floodplain system consisting of a diverse range of habitats and contain extensive areas of swamp paperbark (*Melaleuca ericifolia*), reed beds, salt marsh and mudflats which have been cleared or badly degraded elsewhere throughout the Snowy River floodplain.

- Sydenham Inlet Wetlands (VIC134) – The Sydenham Inlet Wetlands include a variety of wetland types affected by fresh to saline water and provides a large area of estuarine habitat and supports a high diversity of flora and fauna. Approximately 260 plant taxa have been recorded at the site as well as 10 bird species listed under the JAMBA and CAMBA agreements.
- Tamboon Inlet Wetlands (VIC135) – This wetland is located in east Gippsland and hosts a variety of wetland types that are affected by fresh and saline water, which supports a diversity of flora and fauna in estuarine habitat. 96 plant taxa (including 38 introduced) have been recorded in the Tamboon Inlet area. The inlet is fringed by multiple vegetation classes including riparian scrub complex and coastal saltmarsh. The south of the inlet is separated from Bass Strait behind a dune and barrier system that forms part of Ninety Mile Beach. The inlet may flow to Bass Strait during times of high flow, though generally remains closed.
- Thurra River (VIC155) – The reach corridor of Thurra River has an area of 2,920 ha and flows through State forest and Croajingolong National Park. There are 29 threatened flora species and 37 threatened fauna species within the wetland. Ninety Mile Beach and the associated dunes create a barrier to Bass Strait, which may be open during times of high flow, though generally remains closed.
- Benedore River (VIC154) – This wetland occurs in east Gippsland in the Croajingolong National Park. The Benedore River has no introduced fish species and a natural assemblage of native species, which indicates pristine conditions. There are 16 threatened flora species recorded in the wetland. There are 25 threatened fauna species including the little tern (*Sterna albifrons*). The Benedore River is contained behind Ninety Mile Beach dunes, which may be open during times of high flow.
- Mallacoota Inlet Wetlands (VIC133) – This wetland was formed by the submergence of two river valleys and partial closure of the marine embayment by a sandy barrier and accumulation of dunes. Eighty-nine (89) waterbird species have been recorded at Mallacoota Inlet. The wetland is fringed by lowland forest and coastal saltmarsh.
- Nadgee Lake and tributary wetlands (NSW187) – Nadgee Lake is an intermittently open/closed coastal lake that is fed by large swamps and ephemeral creeks flowing from the Nadgee Range. The wetland is an important drought refuge for waterbirds. Estuarine aquatic vegetation includes seagrass beds of *Ruppia sp.* That occurs in shallower water near the southern and western foreshores.

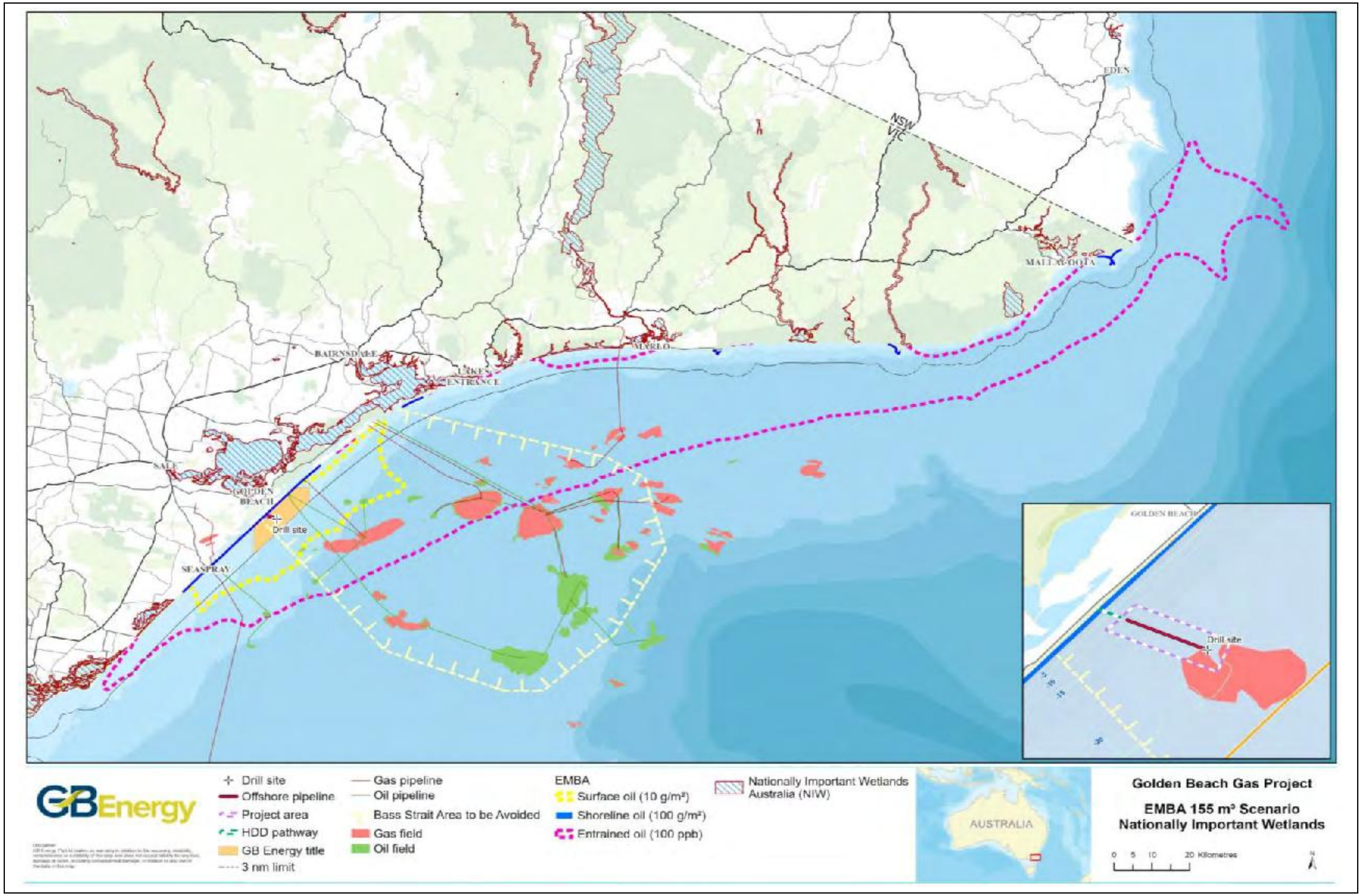


Figure 6.32a. NIWs intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

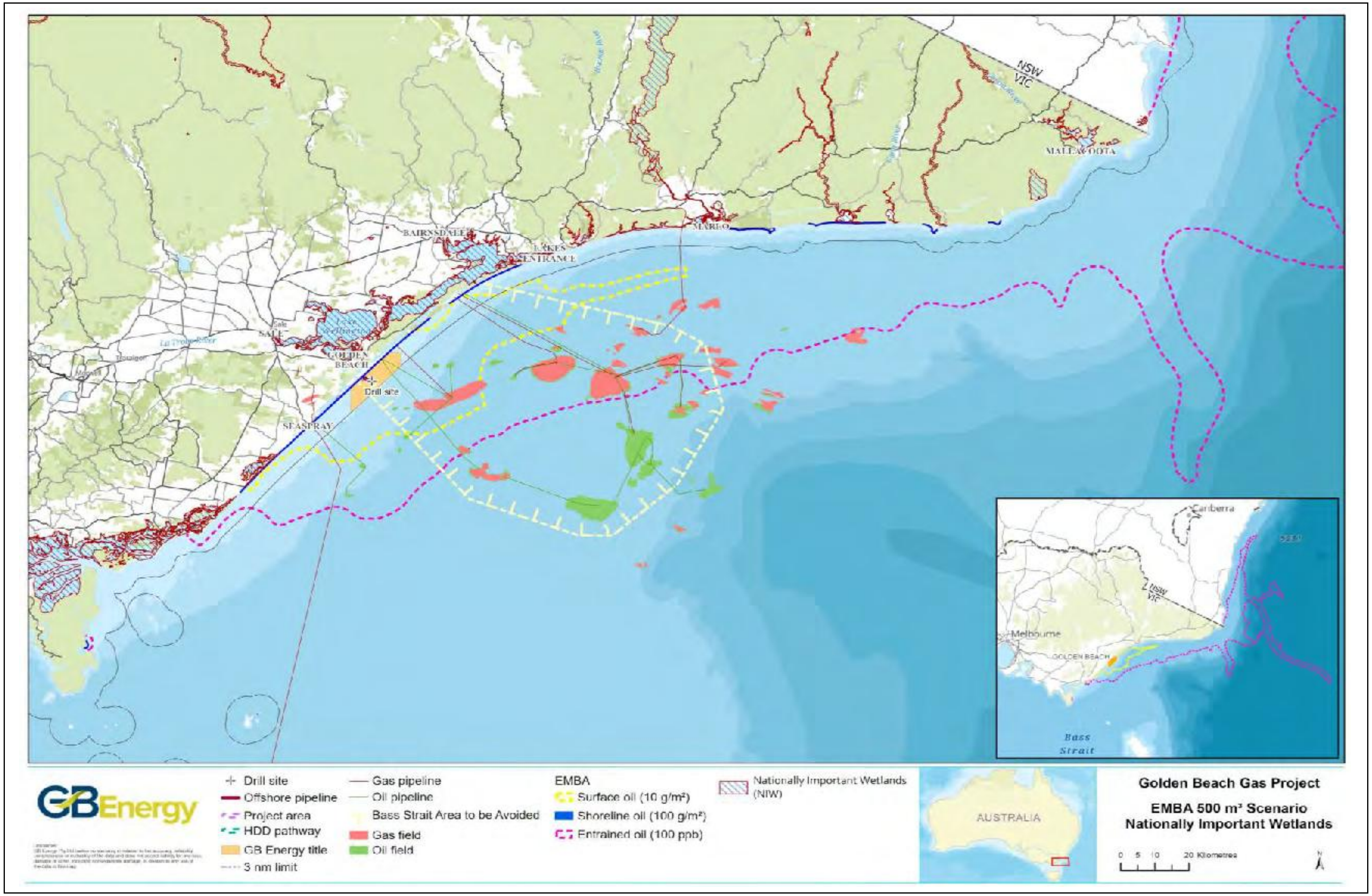


Figure 6.32b. NIWs intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.4.9. Victorian Protected Areas

Under the *National Parks Act* 1975 (Vic), marine and terrestrial areas determined to be of particular scenic, historical, archaeological, biological, geological or other feature of scientific interest or public benefit are protected.

Victoria has 24 marine national parks and sanctuaries that are protected and managed under the *National Parks Act* 1975 (Vic) by Parks Victoria.

The six marine protected areas and six onshore protected area (i.e., reserves that extend to the low water mark) intersected by the EMBA are shown in Figure 6.33 and described in Table 6.19, moving west to east along the EMBA.

6.4.10. New South Wales Protected Areas

Under the *Nation Parks and Wildlife Act* 1974, land may be reserved as part of a national park, historical site, conservation area, nature reserve or Aboriginal area in order to meet the conservation objectives of the Act.

New South Wales has a large network of onshore and offshore protected areas that are established, protected and managed under the *National Parks and Wildlife Act* 1974 by the National Parks and Wildlife Service (NPWS).

There are two onshore reserves and no marine reserves intersected by the EMBA as shown in Figure 6.33 and described in Table 6.20, moving south to north.

Table 6.19. Victorian marine and coastal protected areas in the spill EMBA

Name	Location	Description
Marine protected areas		
Wilsons Promontory Marine Park	105 km southwest of the Project area	Wilsons Promontory Marine Park, together with the Marine Reserve and MNP, make significant contributions to Victoria's marine protected areas. The marine park includes biological communities with distinct biogeographic patterns, including shallow subtidal reeds, deep subtidal reefs, intertidal rocky shores, sandy beaches, seagrass, subtidal soft substrates and expansive areas of open water (Parks Victoria, 2006a). The marine park provides important habitat for several threatened shorebird species and islands within the park act as important breeding sites for Australian fur seals (Parks Victoria, 2006a).
Nooramunga Marine and Coastal Reserve	68 km southwest of the Project area	Nooramunga Marine and Coastal Park covers an area of 30,170 ha in Corner Inlet. The park is also protected as a Ramsar wetland (see Section 6.4.4). The park consists of shallow marine waters, intertidal mudflats and a series of over forty sand islands. The Park, along with the Corner Inlet Marine and Coastal Park to its west, contain the largest stands of white mangrove and saltmarsh areas in Victoria. The saltmarshes are dominated by beaded glasswort (*Sarcocornia quinqueflora*) and shrubby glasswort (*Tecticornia arbuscula*). Seagrass meadows also occur throughout the park. Seaward of the mangroves are extensive areas of intertidal mud and sand flats. An immense range of marine plants and invertebrates can be found here that provide food for the thousands of migratory wading birds that arrive each year from their northern hemisphere breeding grounds. The seagrass meadows provide habitat to over 300 marine invertebrates, including a range of large crabs, seastars, sea snails, iridescent squid and many fish including pipefish, stingarees, flathead, whiting and flounder. Finfish such as snapper, King George whiting, flathead, garfish and salmon are caught by recreational fishers. Thirty-two (32) migratory wader species have been recorded in the park, including the largest concentrations of bar tailed godwit (*Limosa lapponica*) and great knot (*Calidris tenuirostris*) in south-eastern Australia. In summer the ocean beaches and sand provide nesting habitat for pied oystercatchers (*Haematopus longirostris*), crested terns (*Thalasseus bergii*), Caspian terns (*Hydroprogne caspia*), fairy terns (*Sternula nereis*) and hooded plovers (*Thinornis rubricollis*).
Ninety Mile Beach Marine National Park	23 km southwest of the Project area	The Ninety Mile Beach MNP covers an area of 2,750 ha and extends along approximately 5 km of coastline and offshore for 5 km from the high-water mark (Parks Victoria, 2006b). The park protects an internationally significant sandy environment, recognised for its exceptionally high diversity of marine invertebrates. The park's key natural values are listed as: • Very high diversity of marine invertebrates, including the large endemic southern Australian seastar (*Coscinasterias muricata*) and the soft coral *Pseudogorgia godeffroyi*; • Scattered low calcarenite reefs providing habitat for a distinctive marine invertebrate fauna, especially sponges, with sparse flora communities of small red algae; and

Name	Location	Description
		• Important habitat for threatened shorebird species, including species listed under international migratory bird agreements. The low sub-tidal calcarenite reefs scattered throughout the park support a unique invertebrate biota, including colourful sponge gardens. The long sandy beach (the area between the high water and low water marks are included in the park) provide extensive habitat for shorebirds, including international migratory waders and the threatened hooded plover (Parks Victoria, 2006b). The Ninety Mile Beach MNP supports four distinct marine ecological communities; these being intertidal sandy beach, subtidal sandy sediment, subtidal reef and open waters. More than 800 different species were found within 10 m^2 of Ninety Mile Beach subtidal sand (compared to 300-400 per 10 m^2 in comparable habitats), making it one of the most biologically diverse marine environments in the world (Parks Victoria, 2006b). Intertidal sand communities along the Ninety Mile Beach are species-poor, which is typical of coarse-grained, steep-faced, high-energy beaches. The sub-tidal reefs support a community dominated by invertebrates, particularly sponges and sea squirts. Seaweeds are largely absent, possibly because of frequent scouring by shifting sand. The reefs themselves are likely to be periodically covered and uncovered by sand (Parks Victoria, 2006b). The waters of the park have aggregations of juvenile white shark (*Carcharodon carcharias*), snapper (*Pagrus auratus*), Australian salmon (*Arripis* spp.), long-finned pike (*Dinolestes lewini*) and short-finned pike (*Sphyaena novaehollandiae*). The southern right whale, Australian fur seals and New Zealand fur-seals are known to frequent the park. The Ninety Mile Beach is a potentially important area for the endangered hooded plover (listed as vulnerable in Victoria). However, their numbers between McLoughlins Point and Seaspray on biannual counts between 2000 and 2006 declined markedly from 40 to three, with none observed during the 2004 and 2006 survey. The loss of roosting and nesting areas due to beach erosion may be a major factor. The area is also used by other threatened shorebirds, including crested terns, Caspian terns, pied oystercatchers and sanderlings (Parks Victoria, 2006b).
Beware Reef Marine Sanctuary	128 km northeast of the Project area	The Beware Reef Marine Sanctuary covers 220 ha and lies 5 km offshore southeast of Cape Conran, in water depths ranging from 0 to 40 m. The park's key natural values are listed as: • A diversity of habitats, including subtidal and intertidal reefs, exposed reefs and subtidal soft sediment. • A haul-out area for Australian fur seals and New Zealand fur seals. • A diversity of invertebrates and fish species. • A reef environment, including shipwrecks, rich in marine biota.

Name	Location	Description
		• Threatened fauna, including several bird species and marine mammals. • Outstanding landscapes, seascapes and spectacular underwater scenery. • Excellent opportunities for scientific investigation and learning. • Opportunities to build knowledge of marine protected areas and their management and to further understand marine ecological function and changes over time. It is composed of a permanently exposed granite reef that emerges from the sandy floor approximately 28 m deep. The reef is 70 m long above water and continues for 1 km below the water to the southeast. The reef is characterised by numerous bisecting subtidal gutters. There are also three shipwrecks within the park. Beware Reef Marine Sanctuary supports five known marine ecological communities, these being subtidal soft sediment, subtidal reef, intertidal reef, exposed reef and pelagic communities. Subtidal soft sediment communities are the most widespread within the sanctuary, likely to support (though unconfirmed through surveys) various polychaete, isopod, amphipod, cumacean and cephalopod species. Species such as spotted stingaree (*Urolophus gigas*), gurnard, flathead, common gurnard perch (*Neosebastes scorpaenoides*), banded stingaree (*Urolophus cruciatus*) and school whiting (*Sillago flindersi*) may have a seasonal presence in and around the sanctuary. Thick stands of bull kelp (*Nereocystis spp.*) dominate lower intertidal reef communities of the sanctuary, with the cunjevoi sea squirt (*Pyura stolonifera*) being the dominant invertebrate on the intertidal reef. A variety of brown algae occupy waters less than 10 m deep, along with red coralline turf algae and bull kelp on the edges of the reef. In deeper waters (13–20 m), long striped *Ecklonia* dominates the flora. There are mixed stands of the canopy-forming brown algae crayweed (*Phyllospora comosa*) and common kelp. Australian fur seals and New Zealand fur seals use the reef platform as a haul-out site for most of the year. Little penguins rest on the platform throughout the year, and it is a common roosting and feeding area for seabirds. Marine mammals such as southern right whales, humpback whales, killer whales), bottlenose dolphins and common dolphins are transient visitors to the sanctuary.
Point Hicks Marine National Park	165 km northeast of the Project area	The Point Hicks MNP covers 3,810 ha and extends along 9.6 km of coastline and offshore from the high-water mark to the 3 nm state waters limits to water depths of 88 m. The reefs directly below Point Hicks, Whaleback Rock and Satisfaction Reef are the best-known geological features of the park. Point Hicks itself is a granite headland with a wide rocky and bouldery shore formed up to 10,000 years ago. The park's key natural values are listed as: • A diversity of habitats, including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches; • A very high diversity of fauna, including intertidal and subtidal invertebrates; • Co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters;

Name	Location	Description
		• A range of rocky habitats; • Mammals such as dolphins, whales and fur-seals; • Transient reptiles from northern waters, including turtles and sea snakes; • Threatened fauna, including whales and several bird species; • Outstanding landscapes, seascapes and underwater scenery; • Outstanding active coastal landforms, such as granite reefs and mobile sand dunes; • Excellent opportunities for scientific investigation and learning; and • Outstanding opportunities to build knowledge of marine protected areas and their management and to further understand marine ecological function and changes over time. A prominent biological component of the subtidal reef areas is kelp and other seaweeds. Large species of brown algae, such as common kelp and crayweed, are present along the open coast in dense stands. Giant species of seaweeds such as string kelp (*Macrocystis pyrifera*) and bull kelp also occur (Parks Victoria, 2006c). The front reefs and Whaleback Reef, which have high relief gutters of up to 15 m have high sessile invertebrate diversity and abundance on the vertical walls. An important characteristic of Point Hicks MNP is its canopy-forming algae (a mixture of crayweed and common kelp *Ecklonia radiata*) and small understorey algae. The reef beneath the canopy varies from encrusting and erect sponges to small fleshy red algae. The invertebrate community includes moderate abundances of blacklip abalone (*Haliotis rubra*) and the red bait crab (*Plagusia chabrus*).
Cape Howe Marine National Park	233 km northeast of the Project area	The Cape Howe MNP covers 4,060 ha and extends along 4.8 km of coastline and offshore from the high-water mark to the 3 nm state waters limit to water depths of 105 m (Parks Victoria, 2006d). The waters of the park contain both high-profile granite and low-profile sandstone reefs. The park's key natural values are listed as: • Diversity of habitats including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches; • Co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters; • Marine mammals such as whales, dolphins, Australian fur seals and New Zealand fur seals; • Transient reptiles such as green turtles from northern waters; • Threatened fauna including whales and birds; • Foraging area for a significant breeding colony of little penguins from neighbouring Gabo Island; • Outstanding active coastal landforms within and adjoining the park, such as granite and sandstone reefs;

Name	Location	Description
		• Outstanding landscapes, seascapes and spectacular underwater scenery; • Victoria's most easterly Marine National Park abutting one of only three wilderness zones on the Victorian coast; • Excellent opportunities for scientific investigation and learning; • Outstanding opportunities to build knowledge of marine protected areas and their management, and to further understand marine ecological function and changes over time. Subtidal soft sediment communities are the most widespread communities in the park, with the diversity of invertebrates expected to be high. Common fish are herring cale (*Odax cyanomelas*), leatherjacket (*Meuschenia freycineti*), striped mado (*Atypichthys strigatus*), banded morwong (*Cheilodactylus spectabilis*) and damselfishes (*Parma microlepis* and *Chromis hypsilepis*). Its deep (30 to 50 m) sandstone reefs are heavily covered with a diverse array of sponges, ascidians and gorgonians. Transient mammals such as southern right whales, humpback whales, killer whales, Australian fur-seals, New Zealand fur-seals, bottlenose dolphins and common dolphins are transient visitors to the park.
Coastal protected areas		
McLoughlins Beach – Seaspray Coastal Reserve	30 km southwest of the Project area	This park encompasses the foreshore between McLoughlins Beach and Seaspray, including a narrow portion of the sea. There is no management plan for this coastal reserve and a paucity of information about the reserve's values. The sandy foreshore provides habitat for hooded plover nesting, and is popular with recreational fishers (with salmon, flathead, snapper and tailor being the main catch species).
Gippsland Lakes Coastal Park	600 m northwest of the Project area (at its closest point)	The Gippsland Lakes Coastal Park is a narrow coastal reserve, covering 17,584 ha along the Ninety Mile Beach (including the beach itself) from Seaspray to Lakes Entrance. The park supports valuable remnant vegetation including Coast Banksia Woodland, Heath Tea-Tree Heathland and Hairy Spinifex Grassland. The Park takes in extensive coastal dune systems, woodlands and heathlands, as well as water bodies such as Lake Reeve and Bunga Arm. These water bodies (listed as Ramsar wetlands) are protected from ocean processes via the dune barrier system that ranges in height between 5 and 8 m. The coastal vegetation strip is identified as containing Littoral Rainforest and Coastal Vine Thickets of Eastern Australia). The park's key natural values are listed as (use of the term 'parks' in this section references the adjacent Lakes National Park): • Supports valuable remnants of vegetation communities that have been disturbed throughout much of their range, including Coast Banksia Woodland, Heath Tea-tree Heathland and Hairy Spinifex Grassland; • Lake Reeve is of international significance and is a site of special scientific interest. This long, shallow lagoon is fringed by salt marsh with a number of plant species 'relatively uncommon in Victoria east of Seaspray';

Name	Location	Description
		• Six threatened flora and over 20 threatened fauna species listed under the EPBC Act or FFG Act have been recorded within the Park; • Lake Reeve provides important breeding habitat for a number of waterfowl species and is one of Victoria's five most important areas for waders; • The wetlands are important nursery areas for many fish species; and • The Parks contain sites of National, State and regional geological and geomorphological significance mainly associated with the evolution of the barrier system that formed the Gippsland Lakes. More than 190 species of birds have been recorded on Sperm Whale Head. Although there have been few dedicated fauna surveys, 26 species of native mammals, 17 of reptiles and 11 of amphibians have been recorded in the parks. Gippsland Lakes Coastal Park is considered the most important site in Victoria for the endangered New Holland mouse (*Pseudomys novaehollandiae*).
Ewing Morass Wildlife Reserve	82 km northeast of the Project area	Location and area The Ewing Morass Wildlife Reserve adjoins the Lake Tyers State Park and extends from Pettman Road to Corringle Creek, extending from the high water mark north into heavily forested hinterland, half way between the coastline and the Princes Highway. This reserve is primarily reserved for the purposes of duck hunting, with the species normally present including the Pacific black duck (*Anas superciliosa*), grey teal (*Anas gracilis*), mountain duck (*Tadorna tadornoides*) and chestnut teal (*Anas castanea*). The shoreline of this park consists of wide sandy beaches, part of the Ninety Mile Beach.
Marlo Coastal Reserve	104 km northeast of the Project area	There is no publicly available formal written information regarding the Marlo Coastal Reserve. Information from the Draft Marlo Foreshore Management Plan (DSE, 2013b) indicates that the reserve covers the Marlo River and adjacent banks, extending seawards only so far as the sand dunes.
Cape Conran Coastal Park	125 km northeast of the Project area	Cape Conran Coastal Park covers an area of 11,700 ha and is bounded by Marlo Coastal Reserve to the west, Croajingolong National Park to the east (eastern shore of Sydenham Inlet), State forest and private property to the north, and the Tasman Sea, at low water mark, to the south. The park forms part of the Gippsland Lakes Ramsar site (see Section 6.4.4). The park's key natural values are listed as: • Rich and diverse vegetation, including damp and lowland forest, woodlands, various types of heathland, swamp, coastal and riparian communities; • The Dock Inlet catchment, a pristine example of a coastal stream system with Cape Conran Coastal Park and associated wetlands terminating in a freshwater coastal lagoon; • The undisturbed Yeerung River supporting predominantly native fish is one of only two entirely lowland rivers in the region draining directly to the sea;

Name	Location	Description
		• Almost 50 species of threatened fauna including six endangered nationally, and 14 bird species listed under international migratory bird agreements; • At least 40 species of threatened flora, including the Bonnet Orchid (*Cryptostylis erecta*) and Leafless Tongue-orchid (*Cryptostylis hunteriana*) which are both vulnerable nationally; • Extensive heathland areas in excellent condition harbouring populations of threatened fauna, including the Eastern ground parrot (*Pezoporus wallicus*) and Smoky mouse (*Pseudomys fumeus*); • Sydenham Inlet, part of the Bemm Heritage River corridor, supporting expansive seagrass meadows that provide important habitat for fish and waterbirds; • High scenic values associated with the diverse geological formations of the park's headlands, its coastal estuaries and heathy plains; and • Excellent examples of coastal dynamics such as sand movement, wave action and river outflows. The seagrass beds within Sydenham Inlet sustain a diverse range of native fish and are critical to the maintenance of regional fish populations.
Croajingolong National Park	151 km northeast of the Project area	Croajingolong National Park covers an area of 88,355 ha and extends along 100 km of the coast, from Sydenham Inlet in the west to the NSW border in the east, with the mean low water mark of the coast forming the park's southern boundary (Parks Victoria, 1996). Two major physiographic units are represented in the park, these being coastal tablelands and coast dune complexes (some vegetated and some mobile). The ocean beaches of the park attract migratory seabirds and waders, including little terns (*Sternula albifrons*), crested terns, fairy terns and the hooded plover, while the wetlands provide habitat for a rich assemblage of waterfowl and native fish such as spotted galaxias (*Galaxias truttaceus*), gudgeon, bass and the Australian grayling. The park's key natural values are listed as: • A wide variety of highly significant coastal landforms including tidal inlets, estuaries and lagoons, dune-blocked lake and swamp systems, freshwater interdune lakes, extensive sand dunes and sand sheets, and prominent rocky cliffs; • Many sites recognised for their geological and geomorphological significance; • Habitats supporting over 1,000 recorded native plant species, 87 of which are listed as threatened in Victoria and have their primary stronghold in the Park; • Ninety species of orchids, including all five of Australia's lithophytic and epiphytic orchids; • Significant and well-developed sites of Warm Temperate Rainforest in the lower reaches of a number of rivers;

Name	Location	Description
		• Coastal Heathland, a community considered to be extremely species rich, and covering up to 10% of the park; • Habitats supporting 43 species of threatened native fauna, including the little tern, ground parrot, eastern bristle-bird (*Dasyornis brachypterus*), eastern broad-nosed bat (*Scotorepens orion*), and Australian fur-seal; • The Skerries, one of only four Australian fur-seal colonies in Victoria and an important breeding site for little penguins and other seabirds; • Records of one third of Victoria’s, and one quarter of Australia’s, bird species; • Some of the richest amphibian habitats in Victoria; • Highly significant coastal streams and catchments that are relatively undisturbed, with an absence of introduced fish species and good populations of native fish species; and • Localities with among the highest wilderness quality in the State, outside the Mallee, and two of the three coastal wilderness areas in Victoria.

Table 6.20. New South Wales marine and coastal protected areas in the spill EMBA

Name	Location	Description
Coastal protected areas		
Nadgee Nature Reserve	240 km northeast of the Project area	The park's key natural values are listed by NPWS (2003) as: • The only coastal wilderness area in NSW; • A variety of coastal landforms, including dissected low tablelands, coastal plain, estuaries and lagoons, cliffs and sea caves; • Coastline has national significance for its diversity of geology and geomorphological features; • Contains several NSW-listed threatened plant species listed; • Contains 48 species of native mammal, 216 bird species, 28 reptile species and 16 amphibians; • Intertidal rock platforms have a rich, well-developed littoral fauna and Nadgee Point/Black Head has the most diverse biota of any headland in NSW south of Narooma; and • Contains some extensive Aboriginal shell middens in sand dunes.
Ben Boyd Nature Reserve	250 km northeast of the Project area	The park's key natural values are listed by NPWS (2010): • Contains some of the oldest rocks on the NSW coast. The barrier sand in Merimbula Bay in the northern section of the park are regionally significant as one of only four major stationary barriers in southern NSW; • A diverse array of coastal habitats including forest, woodland, heathland, sandy and rocky coastline and estuaries. A concentration of significant species occurs at Saltwater Creek. Saltmarsh and mangrove woodland are also present in the estuaries; • Contains 30 threatened fauna species. Nearly 150 bird species have been recorded, with 48 of these being waterbirds; and • Contains more than 50 Aboriginal sites, mostly shell middens.

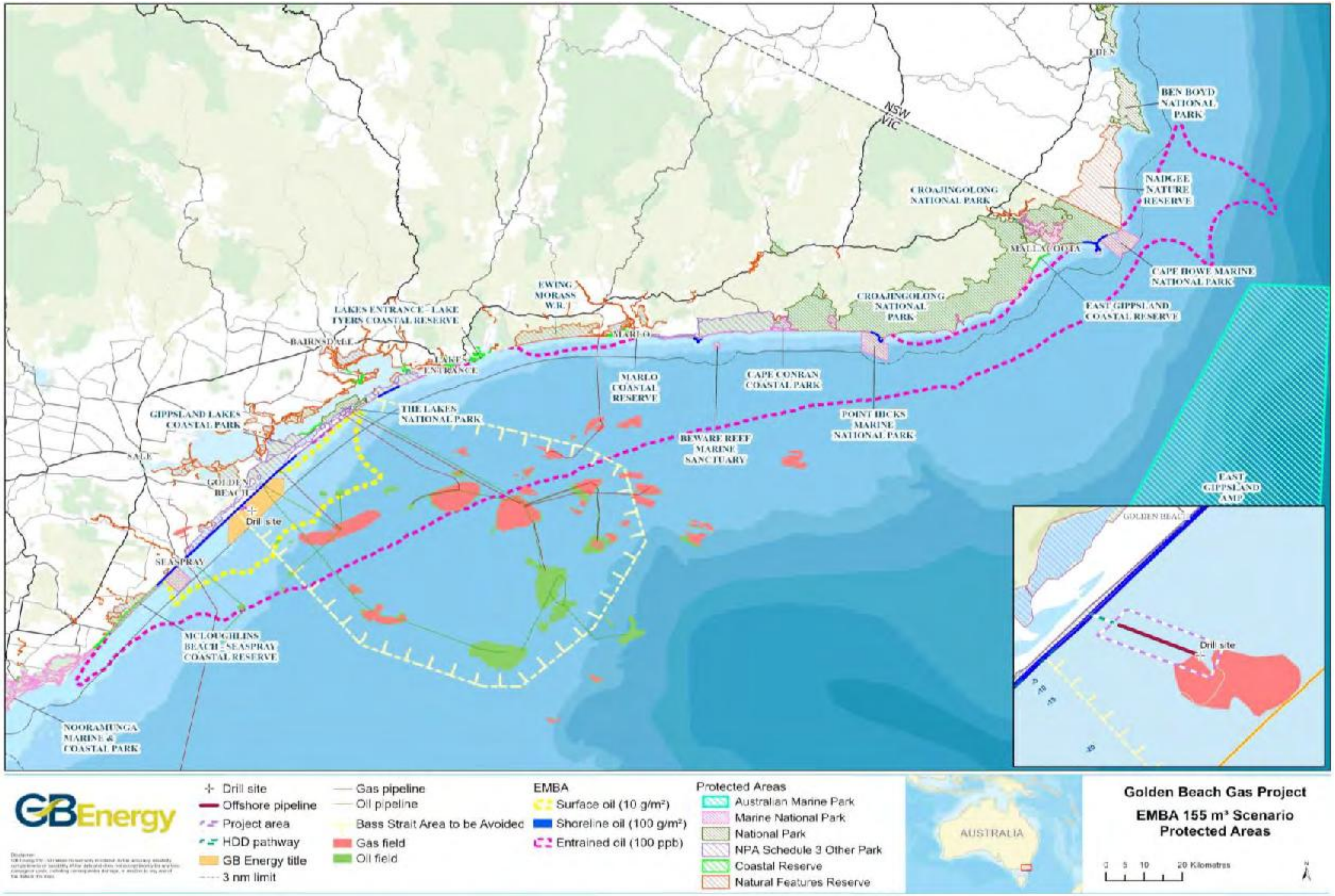


Figure 6.33a. Protected areas intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

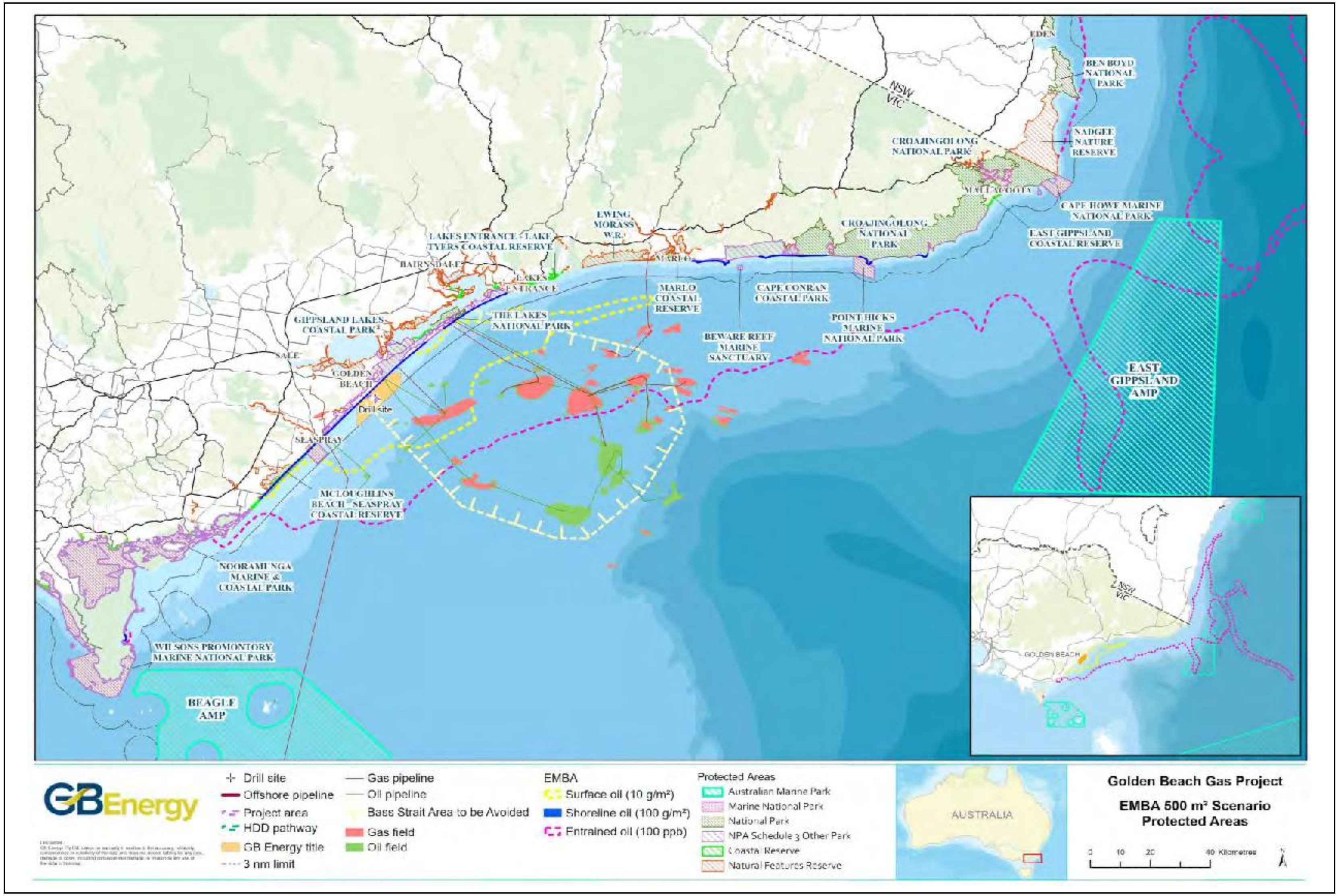


Figure 6.33b. Protected areas intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.5. Cultural Heritage Values

Cultural heritage can be broadly defined as the legacy of physical science artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations. Cultural heritage includes tangible culture (such as buildings, monuments, landscapes, books, works of art, and artefacts), intangible culture (such as folklore, traditions, language, and knowledge) and natural heritage (including culturally significant landscapes).

This section describes the cultural heritage values of the EMBA (which includes the coastline up to the high-water mark), which are broadly categorised as Aboriginal and non-Aboriginal (maritime archaeology).

6.5.1. Aboriginal Heritage

Aboriginal people have occupied Gippsland for at least 18,000 years and probably for over 40,000 years (OMV, 2003). The coastline adjacent to the Project area is occupied by the *Gunaikurnai* language group, which comprises five distinct clans; the Brataualung, the Brayalaulung, the Tatungalung, the Brabalung and the Krautungalung (Basslink, 2001). Estimates of the number of clanspeople in the Gunaikurnai are between 3,000 and 5,000 prior to European contact (Basslink, 2001).

The Gippsland coastline is of significant Aboriginal cultural heritage significance. Coastal fishing is an important part of Aboriginal culture, with fishing methods including hand gathering, lines, rods and reels, nets, traps and spears (DoE, 2015a). The Victorian Aboriginal Heritage Register contains details of Aboriginal cultural heritage places and objects areas along the coastline, however this is not publicly accessible as it contains culturally sensitive information.

Crustaceans (e.g., rock lobster, crab) and shellfish formed an important part of the diet of Aboriginals living along the coast. There are numerous areas containing Aboriginal shell middens (i.e., the remains of shellfish eaten by Aboriginal people) along the sand dunes of the Gippsland coast. Coastal shell middens are found as layers of shell exposed in the side of dunes, banks or cliff tops or as scatters of shell exposed on eroded surfaces. These areas may also contain charcoal and hearth stones from fires, and items such as bone and stone artefacts, and are often located within sheltered positions in the dunes, coastal scrub and woodlands. Other archaeological sites present along the Gippsland coast include scar trees and assorted artefact scatters (Basslink, 2001).

6.5.2. Maritime Archaeological Heritage

Shipwrecks (together with their associated relics) over 75 years old are protected within Commonwealth waters under the Historic *Shipwrecks Act 1976* (Cth) and in Victorian waters under the *Victorian Heritage Act 1995* (Vic).

Shipwrecks

There are no shipwrecks mapped as occurring in the Project area (Figure 6.34) (DAWE, 2020j). There are 70 shipwrecks within the EMBA, the closest are stranded on the shoreline, these being:

- *Trinculo* (VHR S680) – an iron-hulled, three-masted sailing ship, wrecked in 1879 and driven ashore at Ninety Mile Beach east of Seaspray. The wreck is visible on the beach. This wreck is the nearest to the Project area (24 km to the west).
- *Julius* (VHR S376) – a schooner wrecked in 1892 between Refuge Cove and Lakes Entrance, 26 km northeast of the Project area.
- *Norfolk* (VHR S493) – a screw steamer that caught fire off the Ninety Mile Beach in December 1914 and was beached in an attempt to save the vessel. However,

the vessel was completely burnt out. The wreck is variously reported to be onshore and lie in 28 m water depth, about 30 km northeast of the Project area.

The Australian National Shipwreck and Relic Database (DAWE, 2020j) lists four shipwrecks occurring nearby but outside the EMBA and are therefore not described here.

Shipwreck Protection Zones

Of the 650 shipwrecks in Victoria, nine have been placed within protected zones (a no-entry zone of 500-m radius [78.5 ha] around a particularly significant and/or fragile shipwreck) (DAWE, 2020h). Five of these are located within Port Phillip Bay, and two along the west Gippsland coast, these being the *PS Clonmel* (just outside Corner Inlet, outside the EMBA) and the *SS Glenelg* (60 km southeast of the Project area, within the EMBA).

SS Glenelg (1900) is one of the worst maritime disasters in Victorian history with the deaths of 38 people and only three survivors. After the wreck was discovered, it was subject to heavy looting and was placed in a protected zone to help prevent further theft. Maritime archaeologists also want to study the remains of the hull as the may provide unknown technical details of iron ship building, details of the refit the vessel underwent in 1898 and information pertaining to life on board a typical cargo/passenger vessel at the turn of the century (DAWE, 2020h).

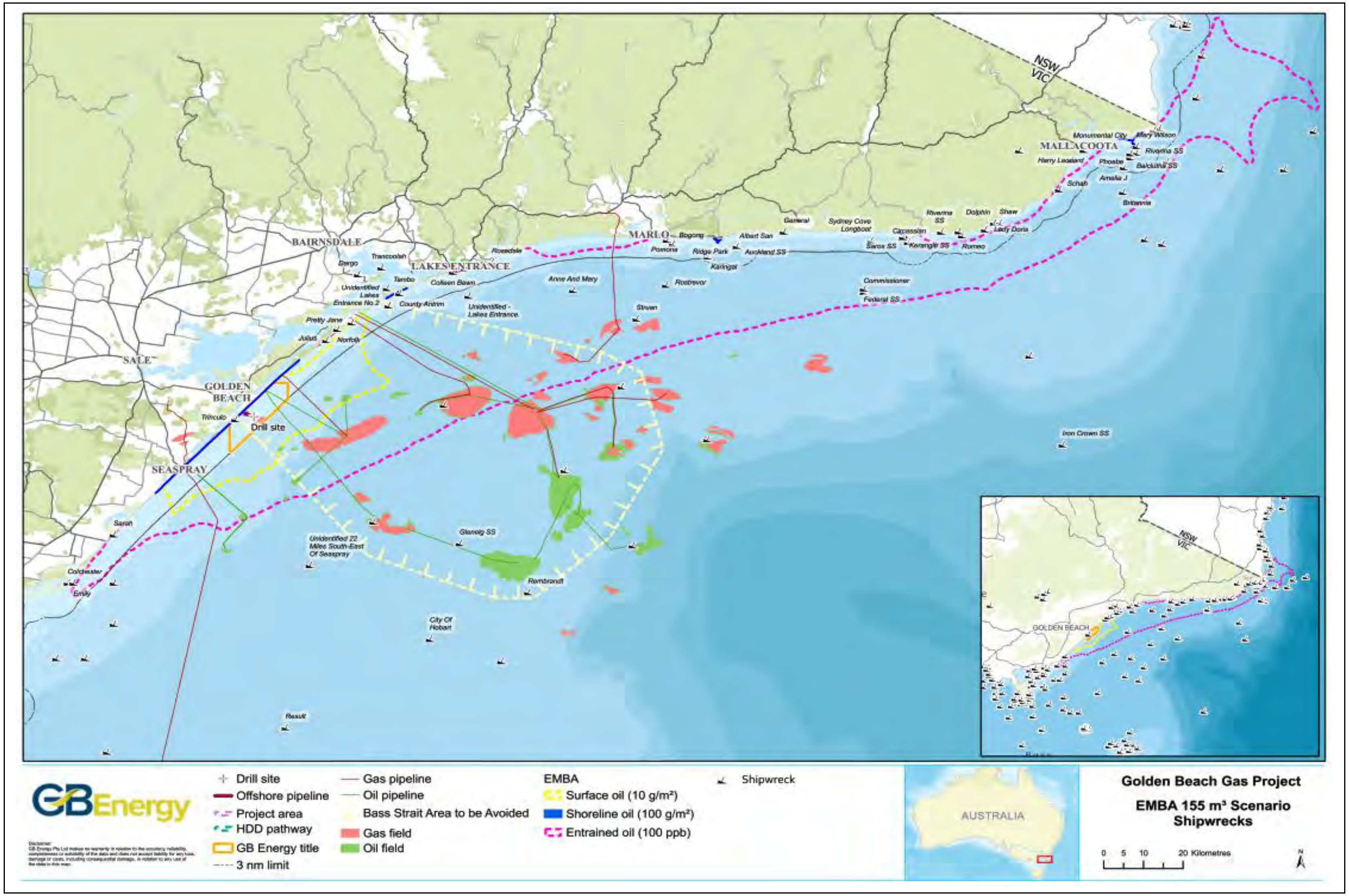


Figure 6.34a. Shipwrecks intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

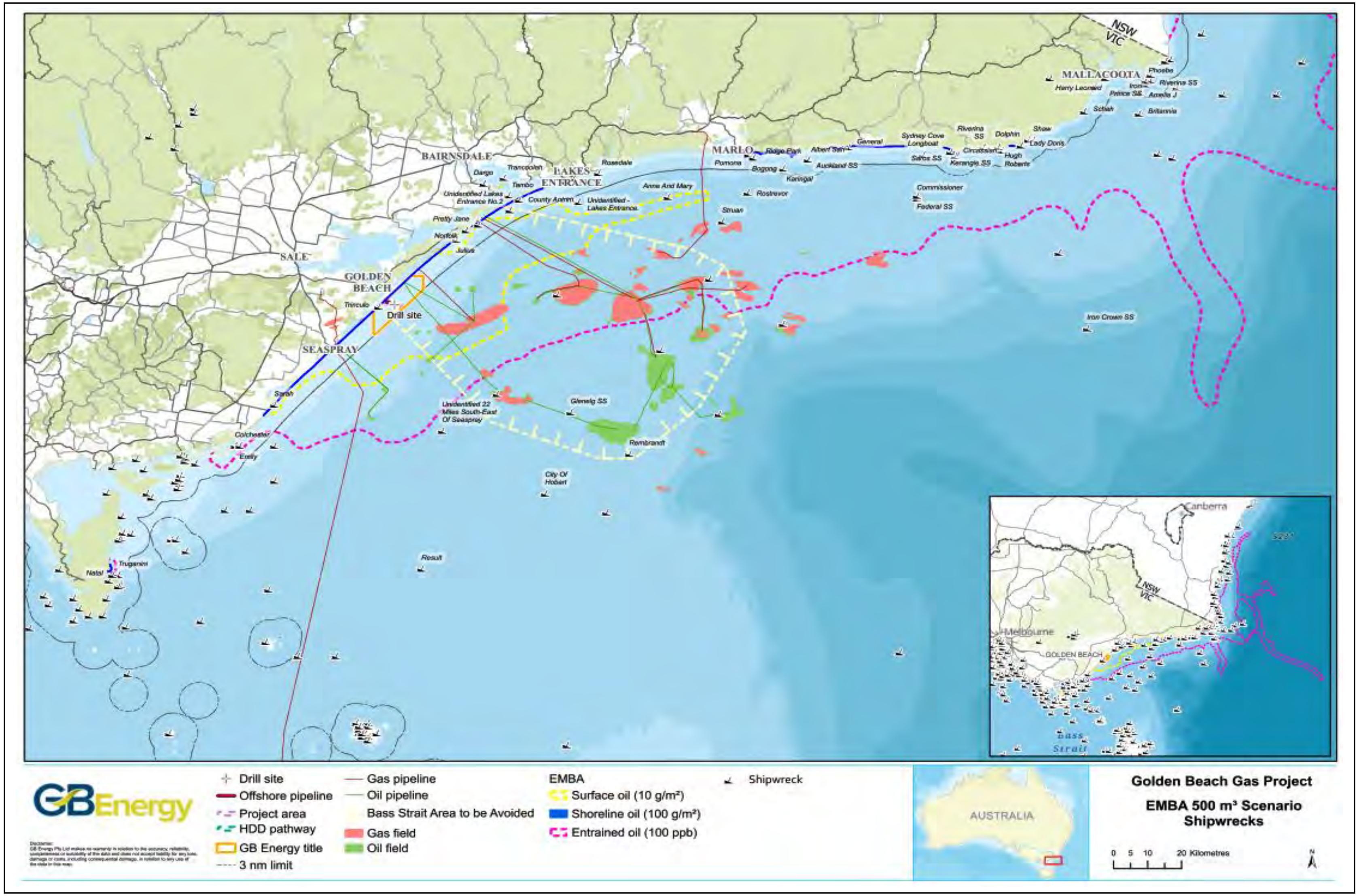


Figure 6.34b. Shipwrecks intersected by the pipeline installation phase EMBA (500 m³ spill scenario)

6.6. Socio-economic Environment

This section describes the social and economic environment of the Project area and the EMBA.

6.6.1. Coastal Settlements

The coastline adjacent to the Project area is sparsely populated, with the adjoining townships of Golden Beach and Paradise Beach being the closest. These towns are located within the Wellington Shire Council.

Wellington Shire Council

Australian Bureau of Statistics (ABS) data for the Wellington Shire Council indicates that it has a population of 44,019 in 2018, with a median age of 43.2 years, with Aboriginal people comprising 1.4% of the population in 2011.

Managers and professionals comprise 33% of the workforces, technicians and trade works occupy 16% and community workers 10.4% (ABS, 2020).

In 2018, the total number of businesses in the Wellington Shire Council numbered 4,012, with most of these employing 1-4 people, and the median personal income in 2016 was $41,816. The largest industries in 2016 were healthcare and social assistance (13.2%), agriculture, forestry and fishing (13%) and construction (9.3%) (ABS, 2020).

Many residents from the hinterland town of Sale (and surrounding townships) work at the Longford Gas Plant, which processes oil and gas from the offshore Gippsland oil and gas fields (see Section 6.6.6).

Towns

The ABS statistics available for Golden Beach and Paradise Beach indicate that the populations of both towns are 293 and 160, respectively. In Golden Beach, 68% of the 461 private dwellings are unoccupied, while 72% of the 308 private dwellings in Paradise Beach are unoccupied.

These towns have very small resident populations, with housing catering primarily to the holiday market, with shacks used by holidaymakers, along with the many vacant blocks used for camping. Camping among the sand dunes is also available along this section of coastline. Golden Beach has a small group of retail shops, a community hall, church, caravan park, football oval, bowling green and 9-hole golf course.

The area between The Honeysuckles and Paradise Beach Ninety Mile was subdivided into about 11,800 small urban sized lots from 1955 to 1969 without planning controls. The developer only provided a main sealed road along the coast (Shoreline Drive) and very little of the promised facilities or services were ever built. Only the main settlements of Golden Beach and Paradise Beach and The Honeysuckles are now serviced with electricity and no reticulated water or sewerage was provided. Some dwellings were built without services on the primary sand dunes and on flood-prone land (Wellington Shire, 2017). As such, the Victorian government has been in the process of buying out these properties.

The towns of Seaspray and The Honeysuckles are located further west on the coastline adjacent to the Project area. Similar to Golden Beach and Paradise Beach, these are essentially tourism-focused towns. Photo 6.18 presents the Golden Beach township.

	
Golden Beach Community hall	Golden Beach RV rest stop
	
Tourists enjoying Golden Beach, as viewed from the viewing platform	Golden Beach convenience store, as viewed through the park and playgroup beside the community hall

Photo credits: G. Pinzone.

Photo 6.18. Photos of Golden Beach facilities

6.6.2. Native Title

Victoria

A search of the National Native Title Tribunal (NNTT) database identifies that there is Native Title Determination registered over much of the coastline adjacent to the Project area, this being for the Gunai/Kurnai People (VCD2010/001).

There are no other Native Title Claims over the Project area or adjacent coastline (NNTT, 2020).

There are no Indigenous Land Use Agreements (ILUA) registered by the NNTT along the coastline adjacent to the Project area (NNTT, 2020).

New South Wales

In 2017, the South Coast People lodged a native title claim in the Federal Court of Australia that was registered on 31 January 2018. The South Coast people's claim covers 16,808 km^2, extending south from Sydney to Eden, along the south coast of NSW and west towards Braidwood and extends 3 nm seaward (NNTT, 2020).

6.6.3. Commercial Fishing

Several Commonwealth and Victorian commercial fisheries are licensed to operate in and around the Project area and the EMBA. These are described in the following sections.

Commonwealth-managed Fisheries

Commonwealth fisheries are managed by the AFMA under the *Fisheries Management Act 1991* (Cth). Their jurisdiction covers the area of ocean from 3 nm from the coast out to the 200 nm limit (the extent of the Australian Fishing Zone [AFZ]). Commonwealth commercial fisheries with jurisdictions to fish the EMBA are the:

- Bass Strait Central Zone Scallop Fishery;
- Eastern Tune and Billfish Fishery;
- Eastern Skipjack Tuna Fishery;
- Southern Bluefin Tuna Fishery;
- Small Pelagic Fishery (eastern sub-area);
- Southern Squid Jig Fishery; and
- Southern and Eastern Scalefish and Shark (SESS), incorporating;
    - Gillnet and Shark Hook sector.
    - South East Trawl sector.
    - Scalefish Hook sector.

Table 6.21 summarises the key facts and figures of each of these fisheries, and indicates that only the Southern Squid Jig Fishery, Eastern Tuna and Billfish Fishery and the SESS are likely to fish within the EMBA.

Table 6.21. Commonwealth-managed commercial fisheries with jurisdictions to fish in and around the Project area and EMBA

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Bass Strait Central Zone Scallop Fishery (Figure 6.35)	Commercial scallop (*Pecten fumatus*) and minimal quantities of doughboy scallop (*Mimachlamys asperrima*)	The central Bass Strait area that lies within 20 nm of the Victorian and Tasmanian coasts. Fishing effort is normally concentrated east of King Island, off Apollo Bay and north of Flinders Island.	**Project area – No** based on 2018 fishing intensity data. *Project area intersects 0% of the fishery.* **EMBA (both scenarios) – No** based on 2018 fishing activity data, fishing effort is concentrated east of King Island (outside the EMBA). *Drilling and operations phase EMBA intersects 0.04% of the fishery.* *Pipeline installations phase EMBA intersects 1.62% of the fishery.*	1st April to 31st December.	Towed scallop dredges that target dense aggregations ('beds') of scallop. 65 fishing permits are in place. 12 vessels were active in the fishery in 2018, a decrease from 26 active vessels in 2009, reflecting the 'boom or bust' nature of the fishery.	2018 – 3,253 tonnes. The real economic value data was not available at time of writing report. 2017 – 2,929 tonnes. The real economic value data was not available at time of writing report. 2016 - 2,885 tonnes worth $4.6 million. 2015 - 2,260 tonnes worth $2.8 million. 2014 - 1,418 tonnes worth $0.5 million. Scallop spawning occurs from winter to spring (June to November), with timing dependent on environmental conditions such as wind and water temperature.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Eastern Tuna and Billfish Fishery (Figure 6.36)	Albacore tuna (*Thunnus alulunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*), broadbill swordfish (*Xiphias gladius*), striped marlin (*Tetrapturus audux*)	South Australia/Victoria border, around east coast of Australia to Cape York, including waters around Tasmania. Fishing occurs in both the AFZ and adjacent high seas.	**Project area – No** based on 2018 fishing intensity data. *Project area intersects 0% of the fishery.* **EMBA (both scenarios) – Yes** based on 2018 fishing intensity data. *Drilling and operations phase EMBA intersects 0.21% of the fishery*. *Pipeline installation phase EMBA intersects 0.55% of the fishery.*	12-month season, beginning 1st of March.	Pelagic longline is the key fishing method, with small quantities taken using minor line methods (such as handline, troll, rod and reel). Active vessel numbers were 40 in 2018 (down from about 150 in 2002). No Victorian or Tasmanian ports are used to land catches.	2018 – 4,046 tonnes worth $38.4 million 2017 – fishery was closed. 2016 – 5,139 tonnes worth $47.1 million. 2015 - 5,408 tonnes worth $33 million. 2014 - 4,368 tonnes worth $30.7 million. Spawning occurs through most of the year in water temperatures greater than 26°C (Wild Fisheries Research Program, 2012).

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Eastern Skipjack Tuna Fishery (Figure 6.37)	Skipjack tuna (*Katsuwonus pelamis*)	Extends from the border of Victoria and South Australia to Cape York, Queensland.	**Project area – No**. Eastern seaboard not fished since 2008-09. *Project area intersects 0% of the fishery.* **EMBA (both scenarios) – No**. Eastern seaboard not fished since 2008-09. *Drilling and operations phase EMBA intersects 0.21% of the fishery.* *Pipeline installation phase EMBA intersects 0.55% of the fishery.*	Not currently active.	Purse seine fishing gear is used in this fishery. There are 19 permits in the eastern zone, though no vessels currently work the fishery. Port Lincoln was the main landing port until its tuna cannery closed down.	No recent fishing effort in the Project area and EMBA.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Southern Bluefin Tuna (Figure 6.38)	Southern bluefin tuna *(Thunnus maccoyii)*	The fishery extends throughout all waters in the AFZ. AFMA manages Southern Bluefin Tuna stocks in Victorian State waters. The nearest fishing effort to the Project area is concentrated along the NSW south coast around the 200 m depth contour.	**Project area – No** based on longline catch in 2018. *Project area intersects 0% of the fishery.* **EMBA (both scenarios) – Yes** based on longline catch in 2018. *Drilling and operations phase EMBA intersects 0.09% of the fishery.* *Pipeline installation phase EMBA intersects 0.23% of the fishery.*	12-month season, beginning 1st of December.	Purse sein catch in the Great Australian Bight for transfer to aquaculture farms off Port Lincoln in South Australia (five to eight vessels consistently fish this area). Port Lincoln is the primary landing port. On the east coast, pelagic longline fishing is the key fishing method. 2017-18 – 38 active vessels. 2016-17 – 22 active vessels. 2015-16 - 25 active vessels. 2014-15 - 24 active vessels.	No recent fishing effort in Bass Strait. The latest data for the east coast pelagic longline catches are: 2017-18 – 6,159 tonnes worth $39.73 million 2016-17 – 5,334 tonnes worth $38.57 million. 2015-16 – 5,636 tonnes worth $37.29 million. 2014-15 – 5,519 tonnes worth $37.29 million. 2013-14 – 5,420 tonnes worth $39.5 million.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Small Pelagic Fishery (eastern sub-area) (Figure 6.39)	Australian sardine (*Sardinops sagax),* Jack mackerel (*Trachurus declivis*), blue Mackerel (*Scomber australasicus*), redbait (*Emmelichthys nitidus*)	Operates in Commonwealth waters (3-200 nm) extending from southern Queensland around southern Western Australia. There is no fishing near the Project area.	**Project area – No** (based on fishing footprint in 2017-18). *Project area intersects 0% of the fishery.* **EMBA (500 m^3 spill scenario) – Yes** (based on fishing footprint in 2017-18). *Drilling and operations phase EMBA intersects 0.19% of the fishery.* *Pipeline installation phase EMBA intersects 0.60% of the fishery.*	12-month season, beginning 1st of May.	Purse seine and mid-water trawl, with the latter being the main method. Thirty (30) entities held licences in 2017-18 using three active vessels. The main landing ports are in Tasmania, South Australia and New South Wales, along with Geelong in Victoria.	2018-19 – 9,424 tonnes. 2017-18 – 5,713 tonnes, with the value being confidential. 2016-17 – 8,038 tonnes, with the value being confidential. 2015-16 – 10,394 tonnes, with the value being confidential due to the small number of fishers. No recent fishing effort in the Project area and EMBA.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Southern Squid Jig Fishery (Figure 6.40)	Arrow squid (*Nototodarus gouldi*)	The fishery extends from the SA/WA border east to southern Queensland. AFMA does not control squid fishing in Victorian state waters. There is no fishing near the Project area, with most fishing takes place off Portland, southwest Victoria.	**Project area – No** (based on 2018 fishing intensity data). *Project area intersects 0% of the fishery.* **EMBA (500 m^3 spill scenario) – Yes** (based on 2018 fishing intensity data). *Drilling and Operations phase EMBA intersects 0.25% of the fishery.* *Pipeline installation phase EMBA intersect 0.77% of the fishery.*	Starts in February and ends in June. The season starts off the Port Phillip Bay heads and slowly moves westwards to Portland as the season progresses, following the natural migration of the squid (SIV, 2016).	Squid jigging is the fishing method used, mainly at night time and in water depths of 60 to 120 m. High-powered lamps are used to attract squid. In 2018 there were 9 active vessels. Hobart, Portland and Queenscliff are the primary landing ports.	The species' short life span, fast growth and sensitivity to environmental conditions result in strongly fluctuating stock sizes. 2018 – 1,649 tonnes worth $5.26 million. 2017 – 828 tonnes worth $2.24 million. 2016 – 981 tonnes worth $2.57 million. 2015 – 824 tonnes worth $2.33 million.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Southern and Eastern Scalefish and Shark Fishery						
Shark Gillnet and Shark Hook Sector (Figure 6.41)	Gummy shark (*Mustelus antarcticus*) is the key target species, with bycatch of elephant fish (*Callorhinchus milii*), sawshark (*Pristiophorus cirratus, P. nudipinnis*), and school shark (*Galeorhinus galeus*).	Waters from the NSW/Victorian border westward to the SA/WA border, including the waters around Tasmania, from the low water mark to the extent of the AFZ. Most fishing occurs in waters adjacent to the coastline in Bass Strait.	**Project area – Yes** based on 2018-19 fishing intensity data. *Project area intersects 0% of the fishery.* **EMBA (both) – Yes** based on 2018-19 fishing intensity data. *Drilling and operations phase EMBA intersects 0.41% of the fishery.* *Pipeline installation phase EMBA intersects 0.79% of the fishery.*	12-month season, beginning 1st May.	Demersal gillnet and a variety of line methods. Landing ports in Victoria are Lakes Entrance, San Remo and Port Welshpool. 2018-19 – 74 permits and 78 active vessels. 2017-18 – 74 permits and 76 active vessels. 2016-17 – 74 permits and 62 active vessels. 2015-16 – 74 permits and 61 active vessels.	2018-19 – 2,126 tonnes with no value assigned. 2017-18 – 2,216 tonnes worth $19.1 million. 2016-17 – 2,118 tonnes worth $18.3 million. 2015-16 – 2,233 tonnes worth $18.4 million. 2014-15 – 2,005 tonnes worth $16.9 million.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Common-wealth Trawl Sector (CTS) (Figure 6.42)	Key species targeted are eastern school whiting (*Sillago flindersi*), flathead (*Platycephalus richardsoni*) and gummy shark (*Mustelus antarcticus*).	Covers the area of the AFZ extending southward from Barrenjoey Point (north of Sydney) around the New South Wales, Victorian and Tasmanian coastlines to Cape Jervis in South Australia. Effort increasingly concentrated on the continental shelf, rather than historical areas of the slope.	**Project area – No** based on 2018-19 fishing intensity data. *Project area intersects 0% of the fishery.* **EMBA (both scenarios) – Yes** based on 2018-19 fishing intensity data. *Drilling and operations phase EMBA intersects 0.54% of the fishery.* *Pipeline installation phase EMBA intersects 1.68% of the fishery.*	12-month season, beginning 1st May. Highest catches from September to April.	Multi gear fishery, but predominantly demersal otter trawl and Danish-seine methods. Primary landing ports in NSW, and Lakes Entrance and Portland in Victoria. For 2017-2018, there were 57 trawl fishing rights with 50 active trawl and Danish-seine vessels.	Logbook catches have been gradually declining since 2001. 2018-19 – 7,574 tonnes with no value assigned. 2017-18 – 8,631 with no value assigned. 2016-17 – 8,691 tonnes, worth $46.42 million. 2015-16 – 9,025 tonnes, worth $41.5 million. 2014-15 – 8,264 tonnes worth $37.7 million.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Scalefish Hook Sector	Key species targeted are gummy shark (*Mustelus antarcticus*), elephantfish (*Callorhinchus milii*) and draughtboard shark (*Cephalo-scyllium laticeps*).	Includes all waters off South Australia, Victoria and Tasmania from 3 nm to the extent of the AFZ. Effort increasingly concentrated on the continental shelf, rather than historical areas of the slope. There is no fishing near the proposed activity area.	**Project area – No** based on 2018-19 fishing intensity data. *Project area intersects 0% of the fishery.* **EMBA (both scenarios) – Yes** based on 2018-19 fishing intensity data. *Drilling and operations phase EMBA intersects 0.24% of the fishery.* *Pipeline installation phase EMBA intersects 0.55% of the fishery.*	12-month season, beginning 1st May. Effort highest from January to July.	Multi gear fishery, using different gear types in different areas or depth ranges. Predominantly demersal longline fishing methods, some of which are automated, and demersal gillnets. For 2017-18, there were 37 fishing rights 29 active vessels. Primary landing ports in NSW, and Lakes Entrance and Portland in Victoria.	Logbook catches have been gradually declining since 2006 and are now less than 2,000 t/yr. Catch data is combined with that for the CTS.

Sources: Patterson et al (2019, 2018; 2017; 2016), AFMA (2017a), Status of Australian Fish Stocks reports (2019).

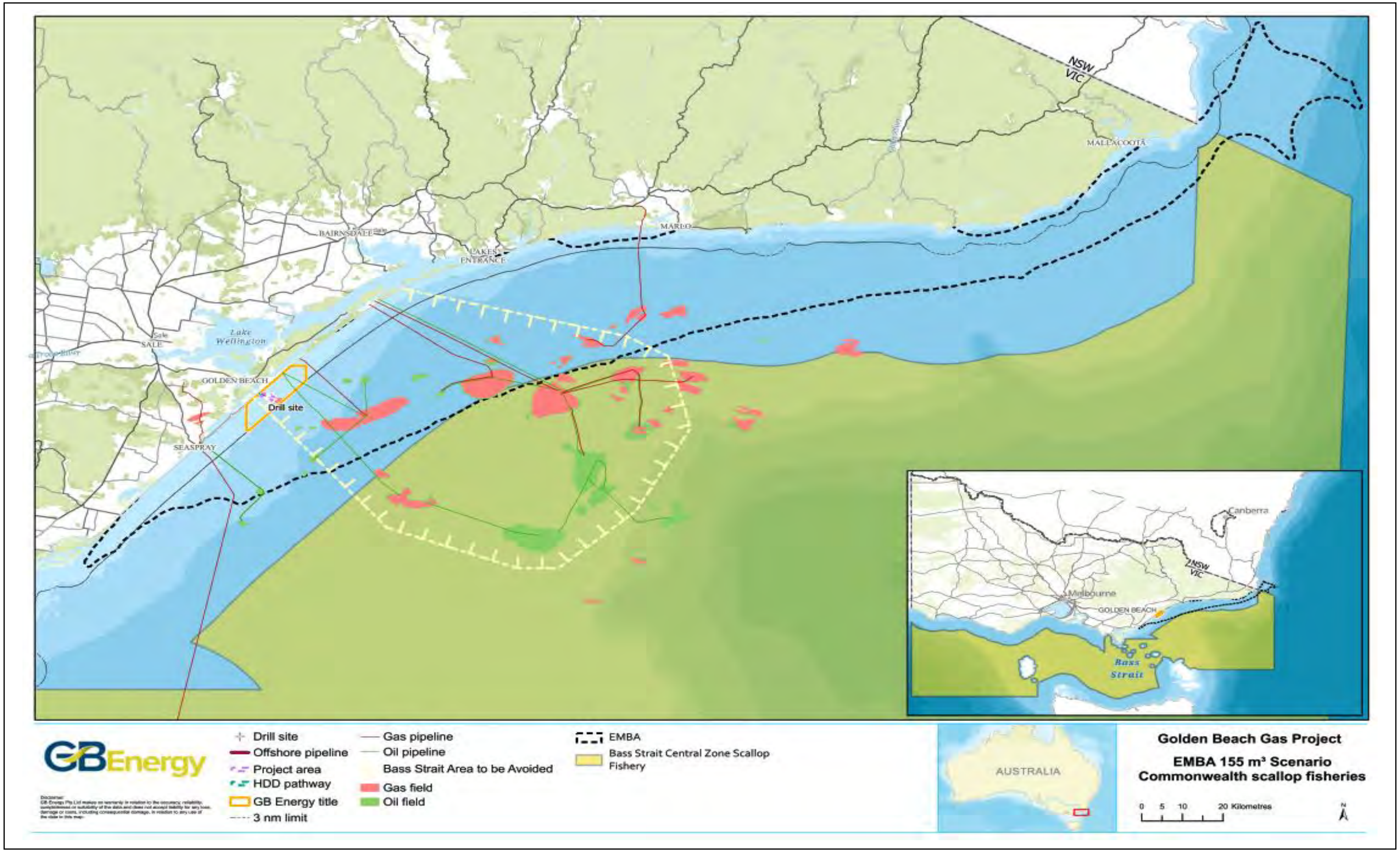


Figure 6.35a. Commonwealth Bass Strait central zone scallop fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

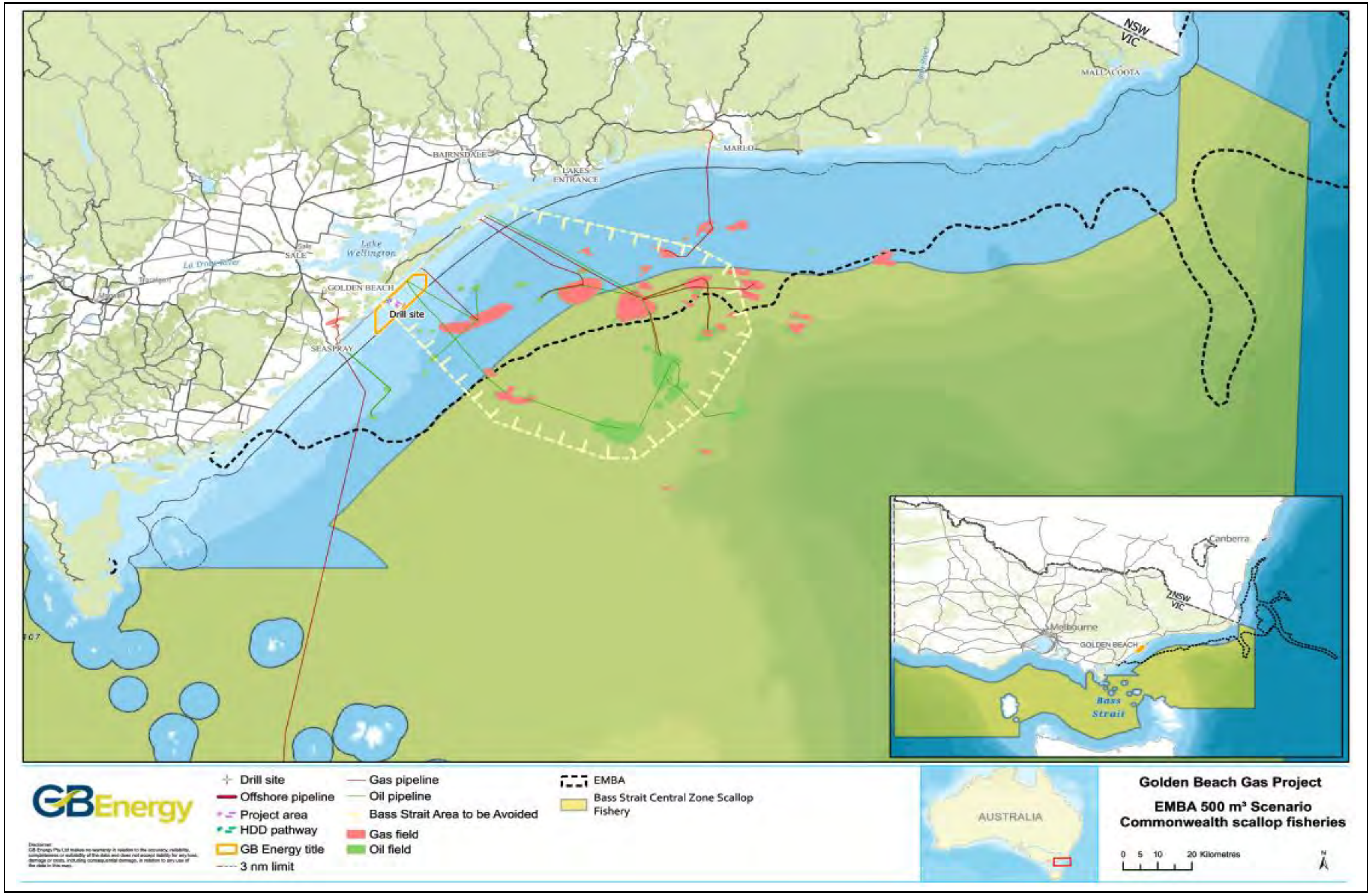


Figure 6.35b. Commonwealth Bass Strait central zone scallop fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

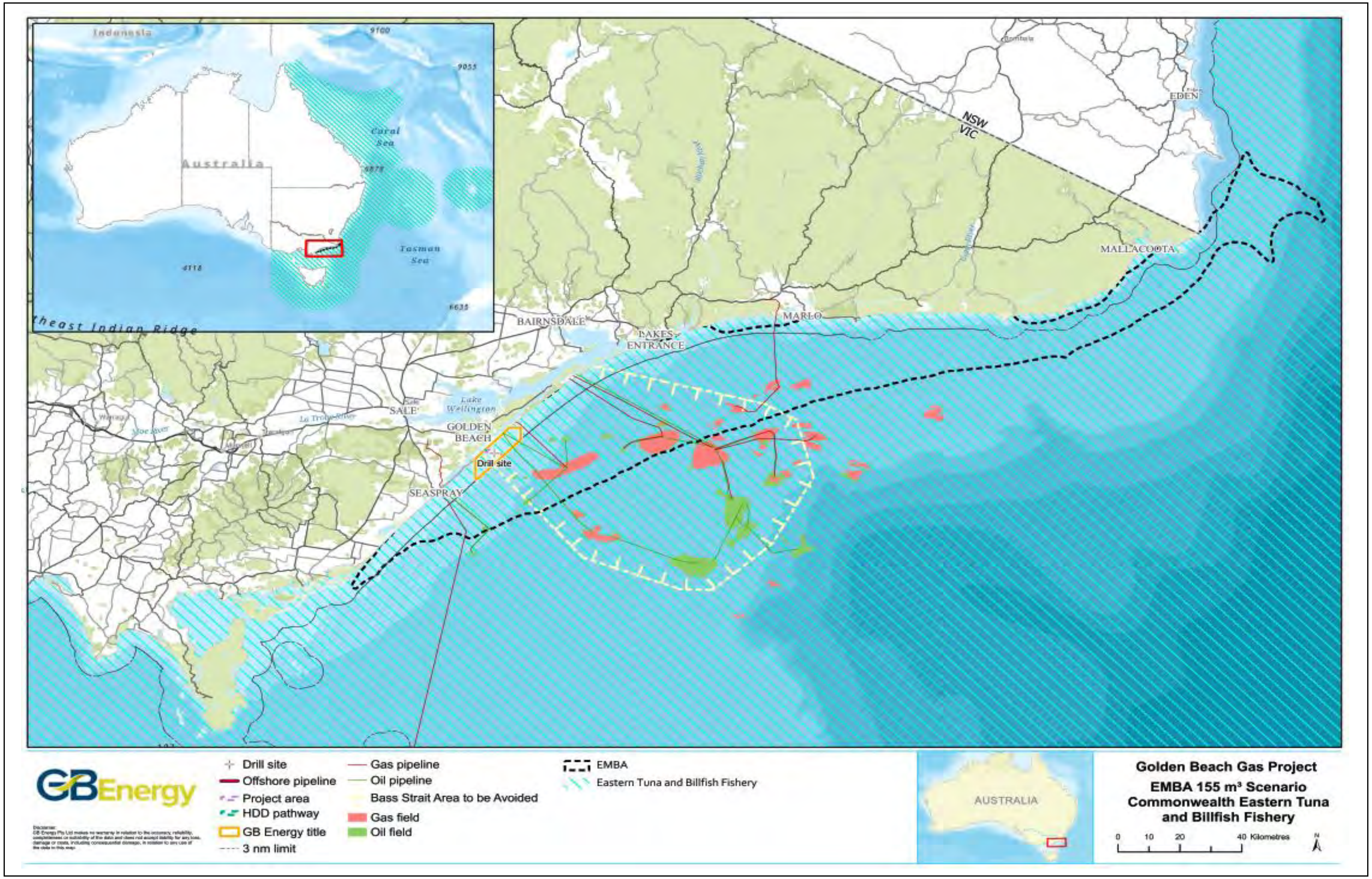


Figure 6.36a. Commonwealth Eastern Tuna and Billfish Fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

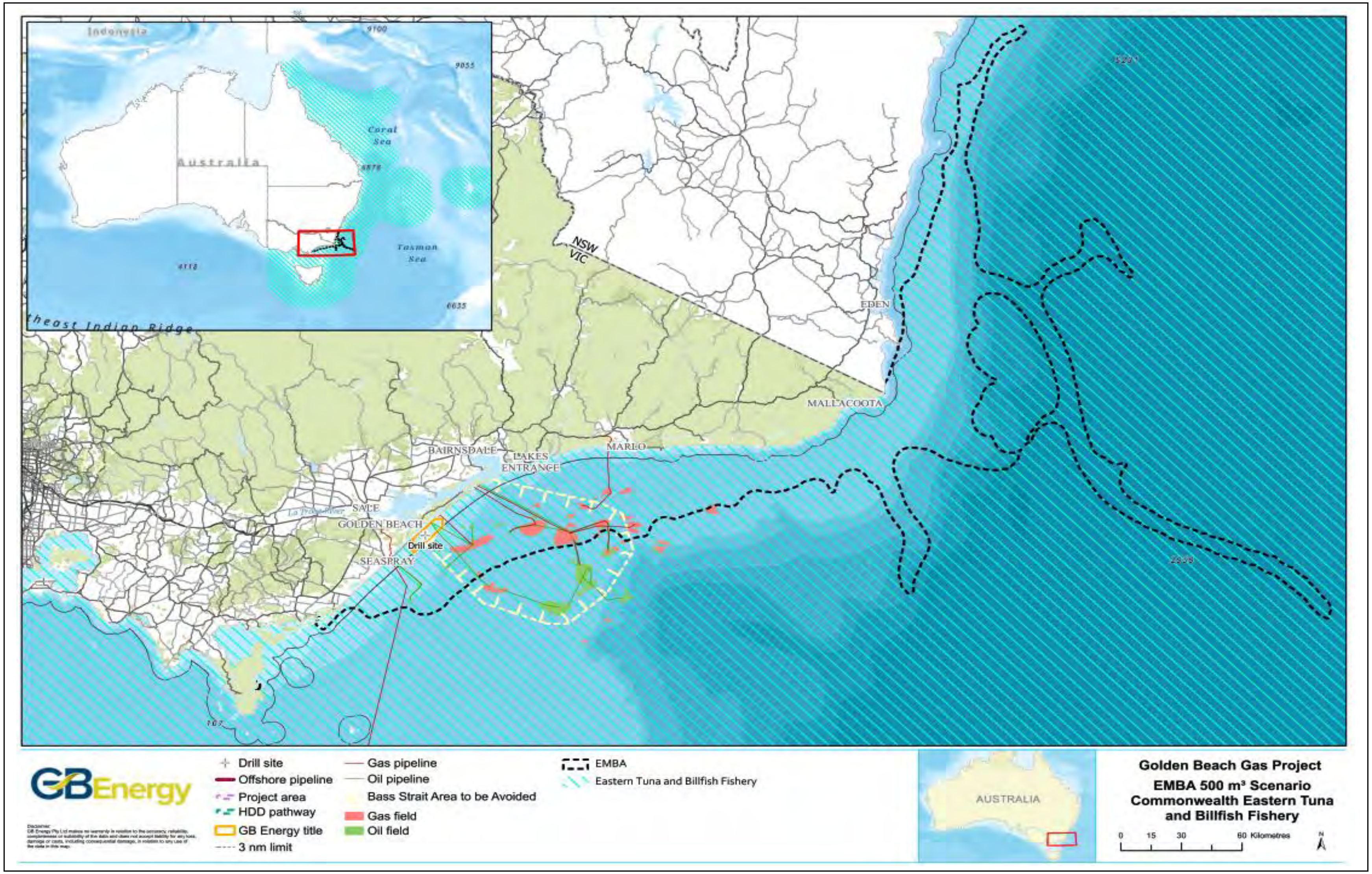


Figure 6.36b. Commonwealth Eastern Tuna and Billfish Fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

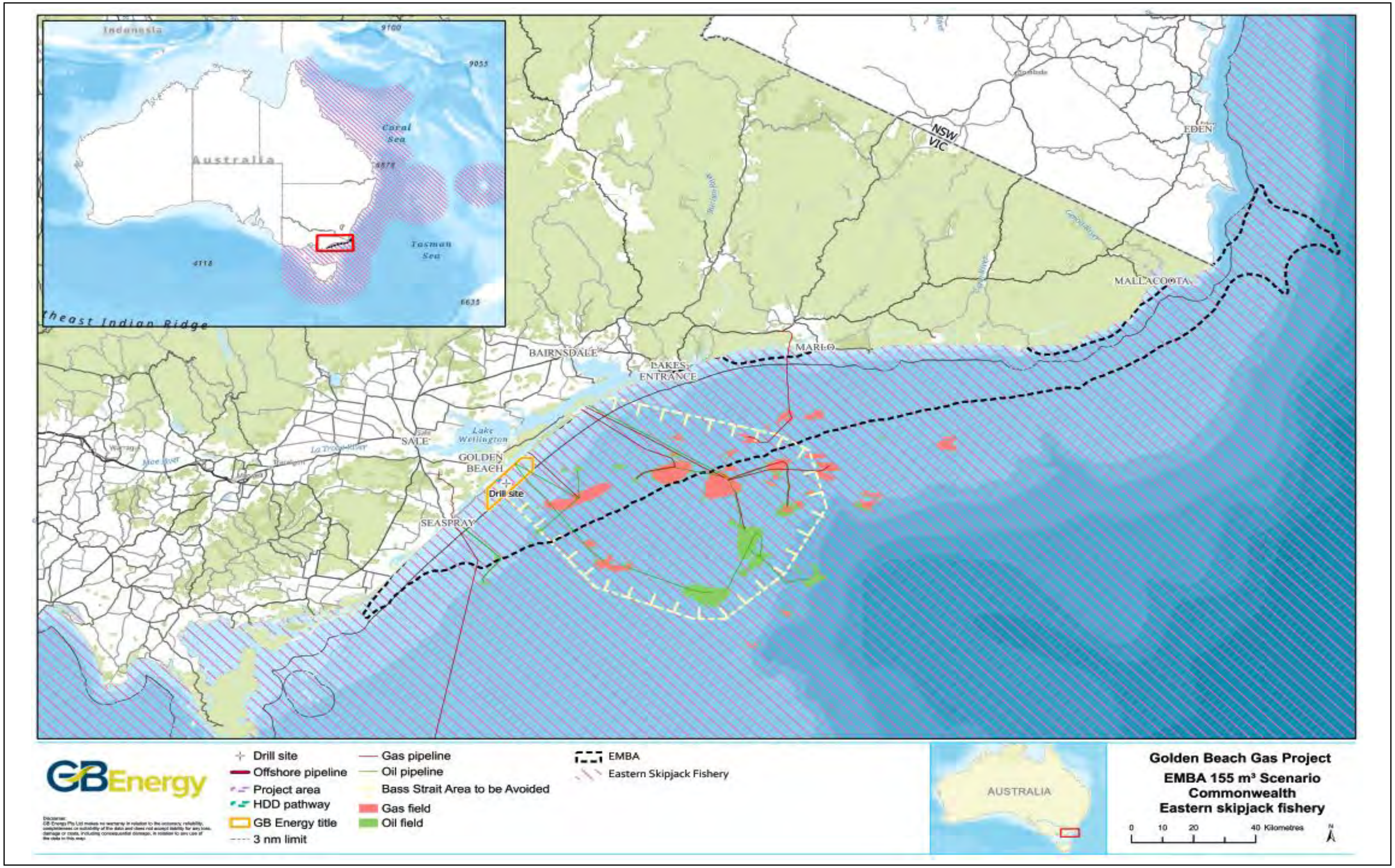


Figure 6.37a. Commonwealth Skipjack (eastern) fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

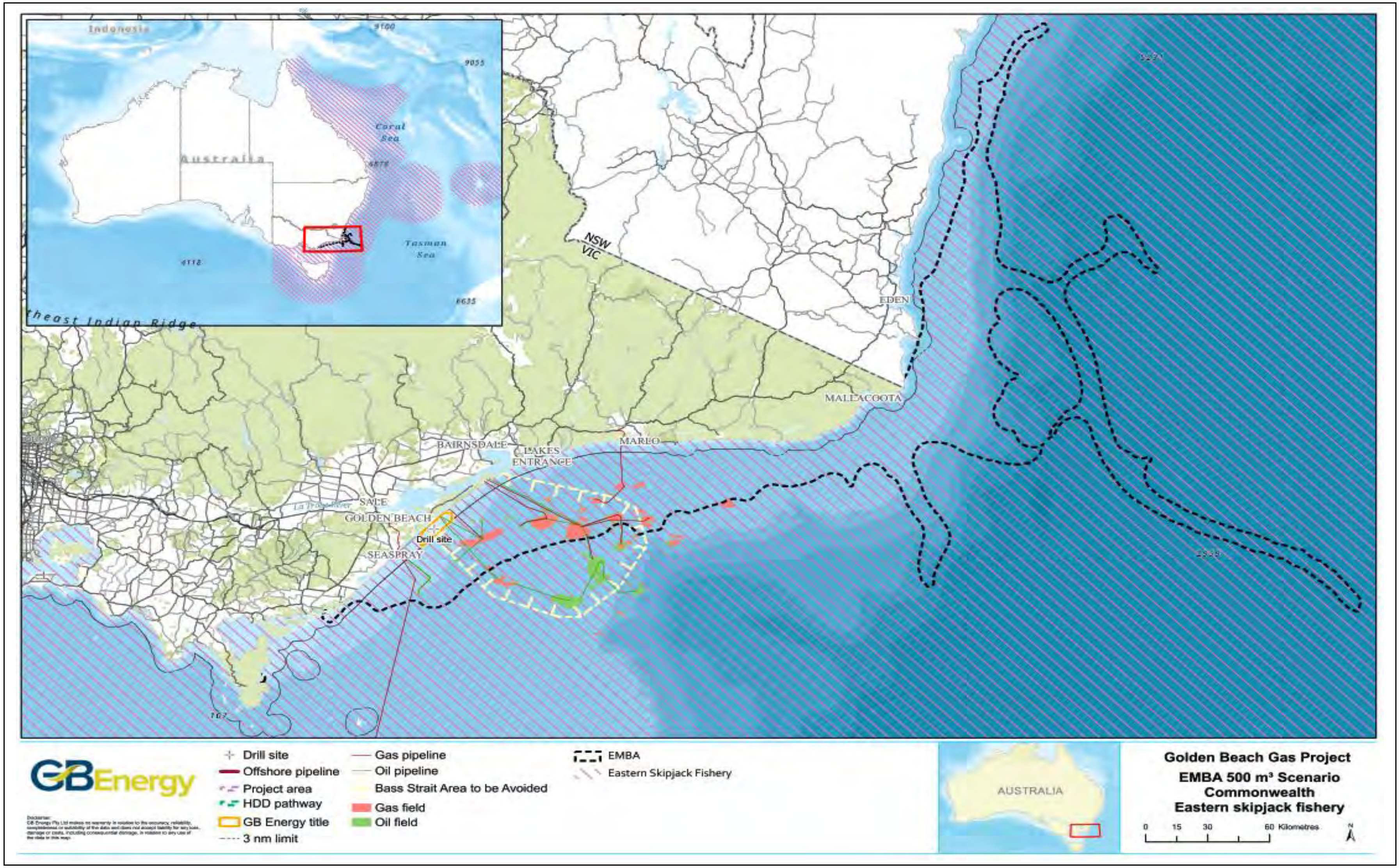


Figure 6.37b. Commonwealth Skipjack (eastern) fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

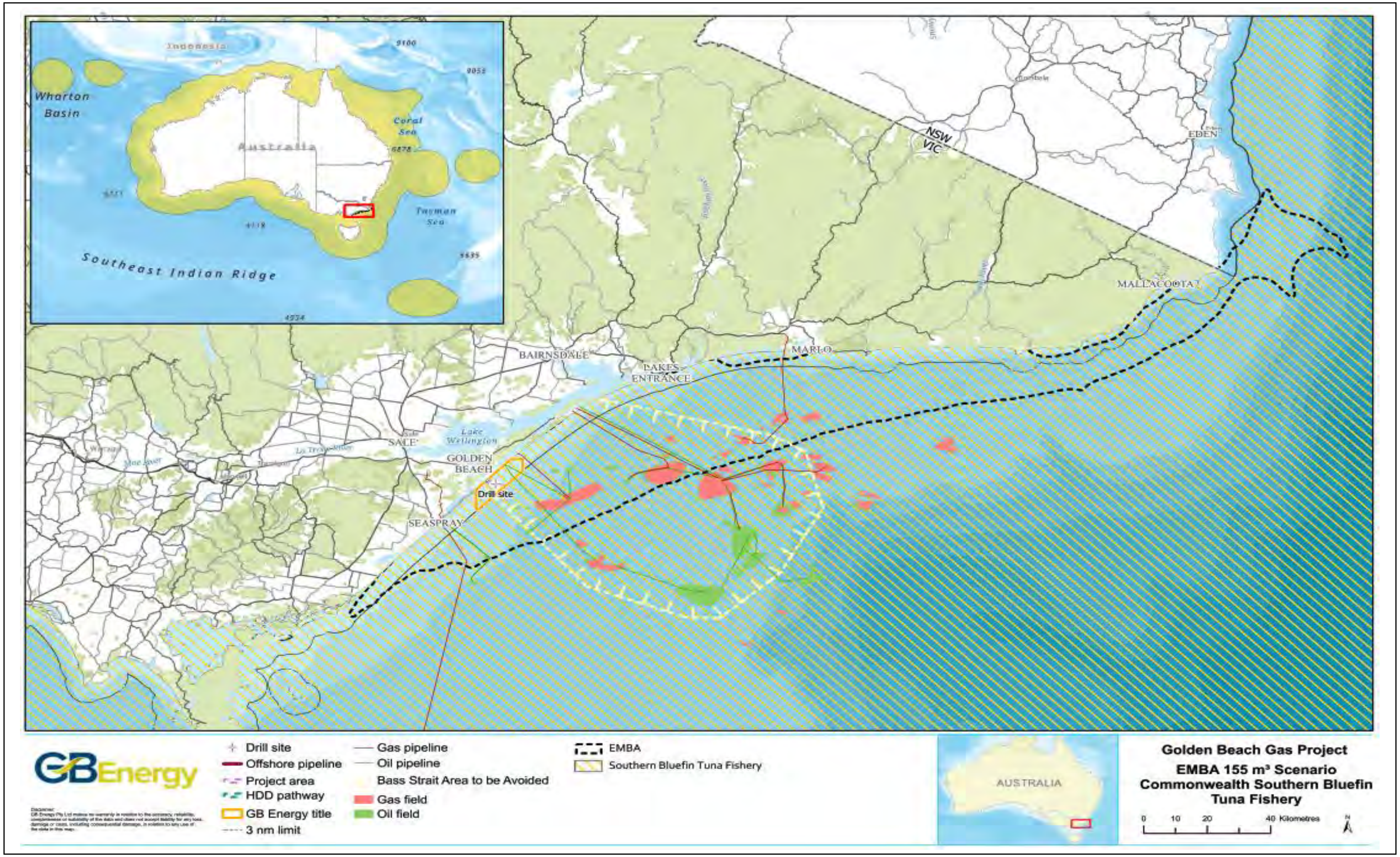


Figure 6.38a. Commonwealth Southern bluefin tuna fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

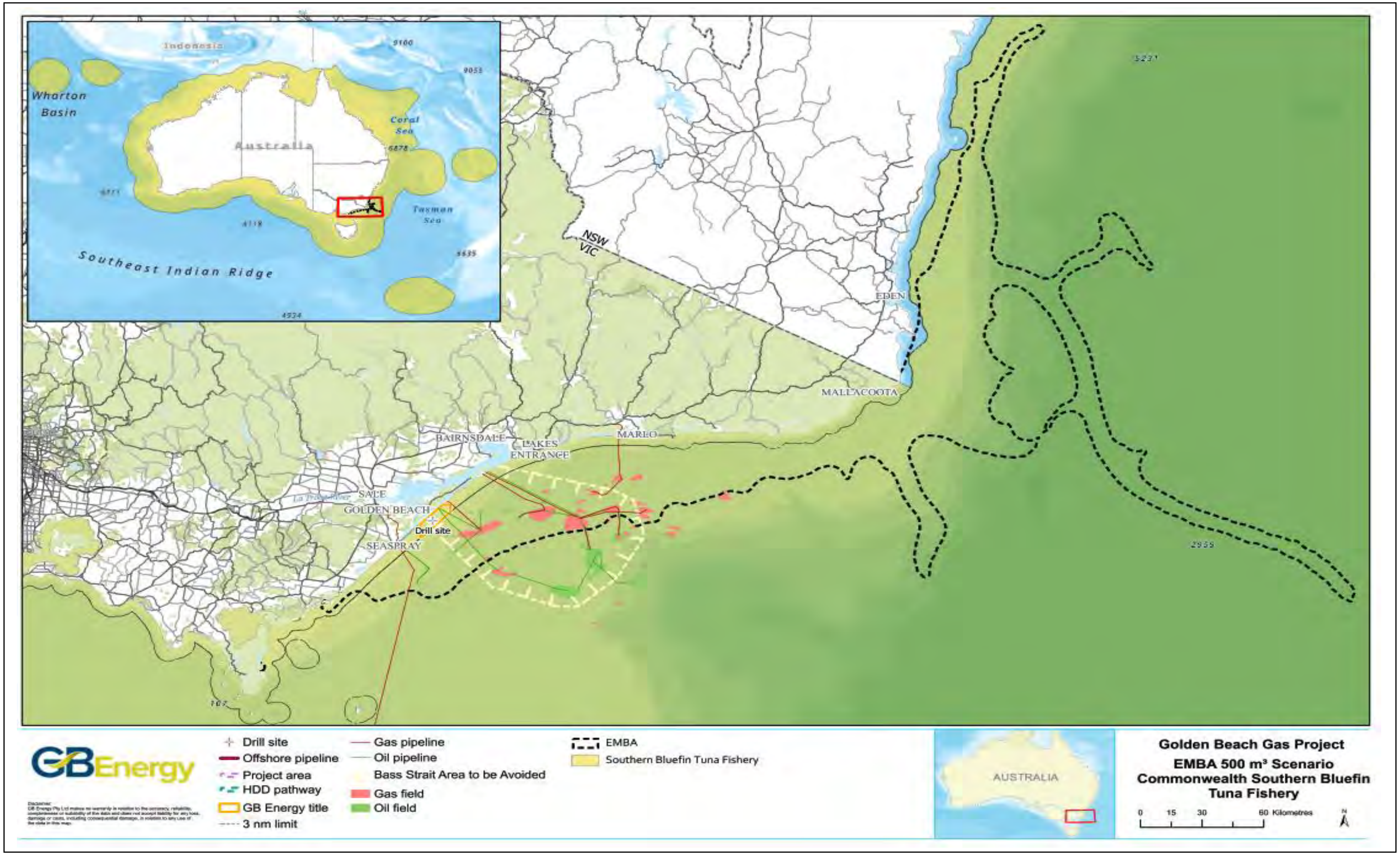


Figure 6.38b. Commonwealth Southern bluefin tuna fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

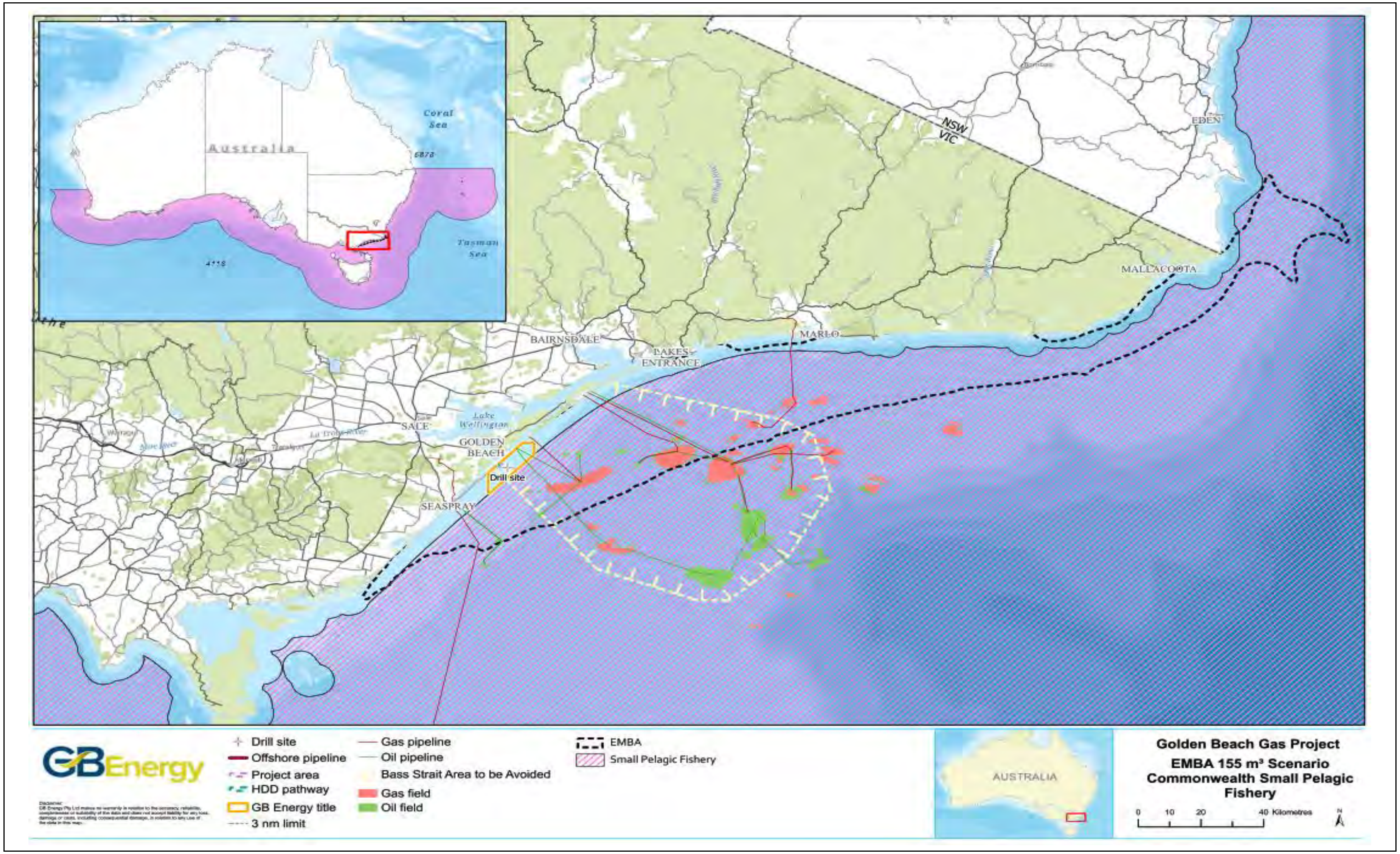


Figure 6.39a. Commonwealth Small pelagic fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

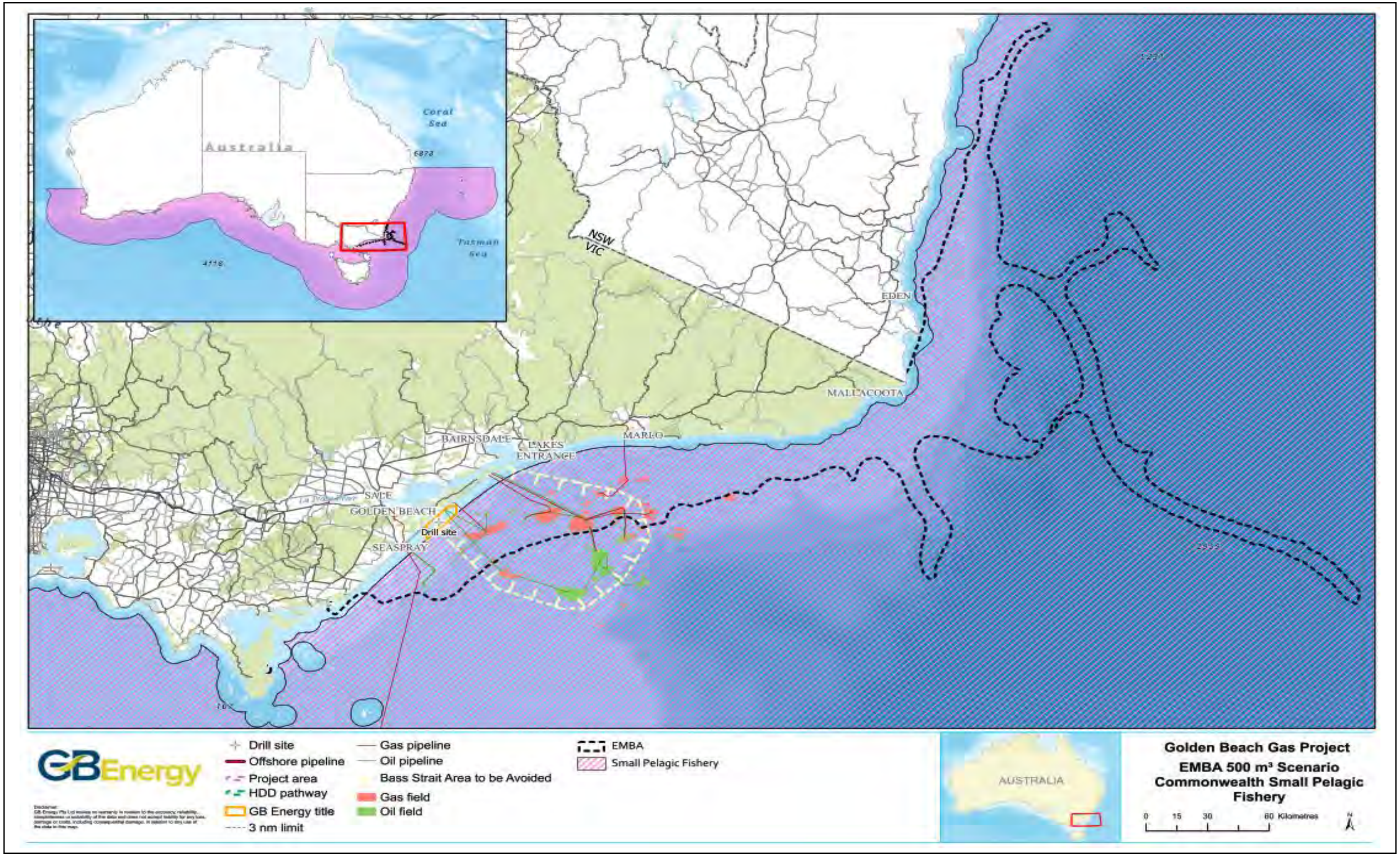


Figure 6.39b. Commonwealth Small pelagic fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

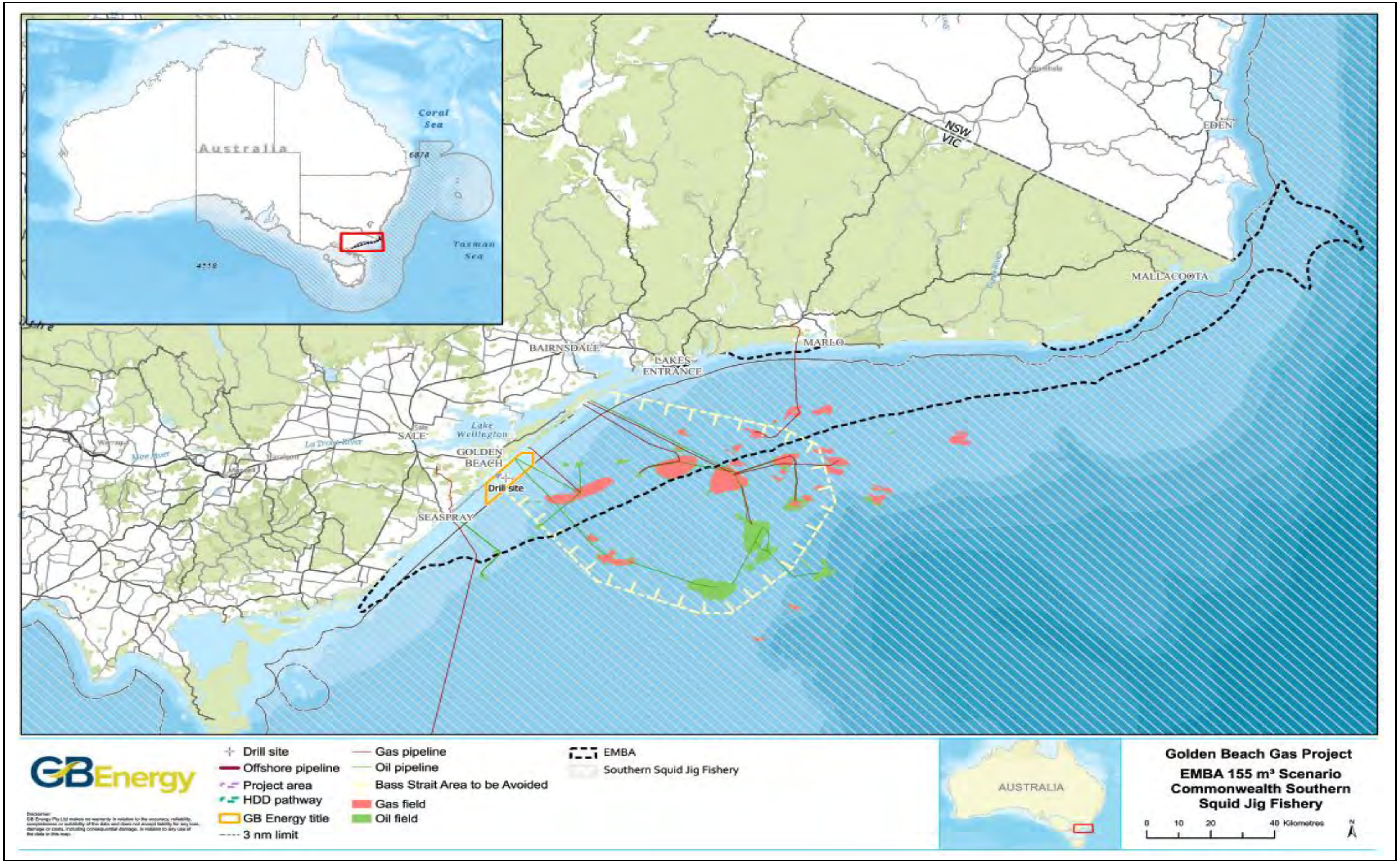


Figure 6.40a. Commonwealth southern squid jig fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

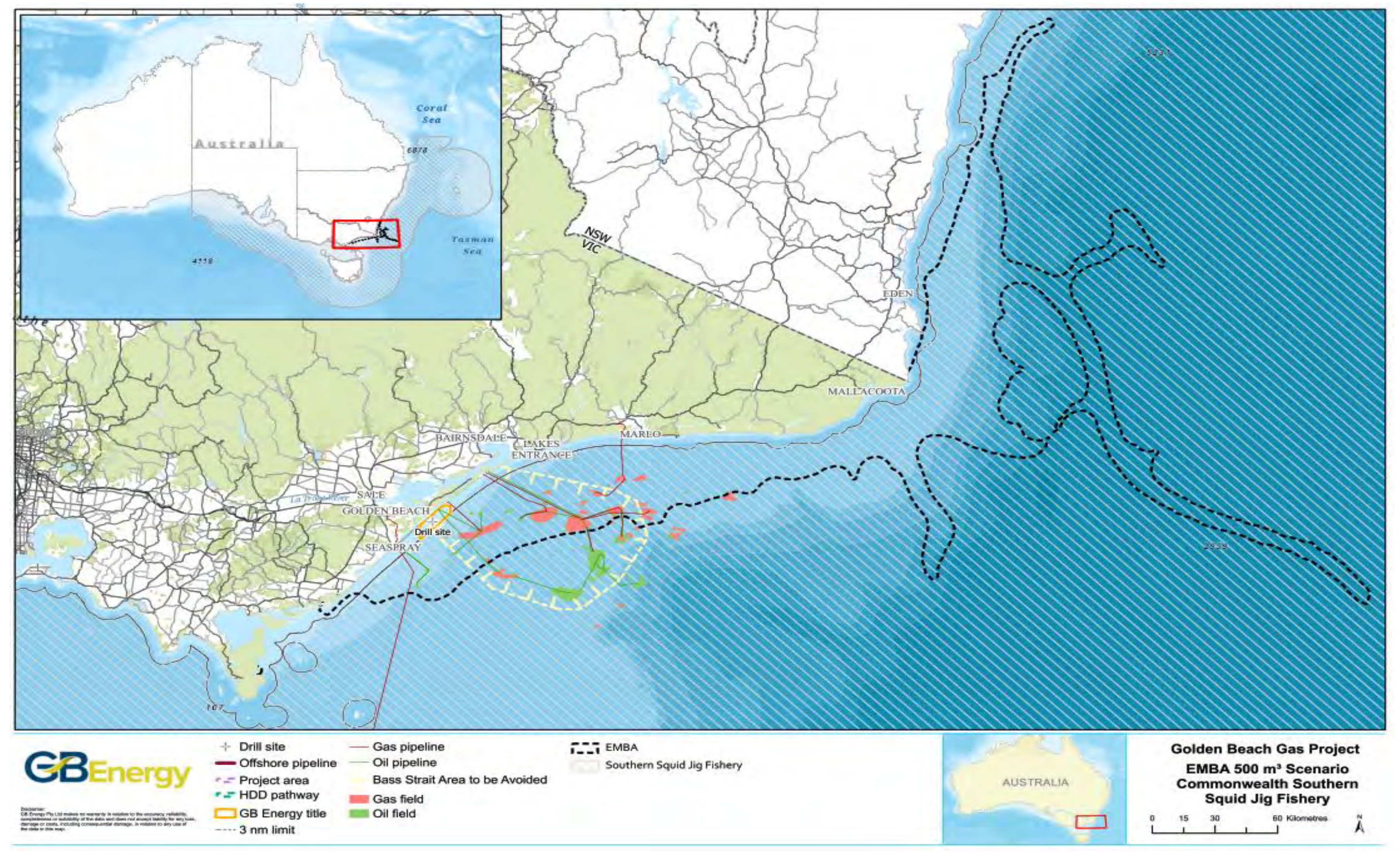


Figure 6.40b. Commonwealth southern squid jig fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

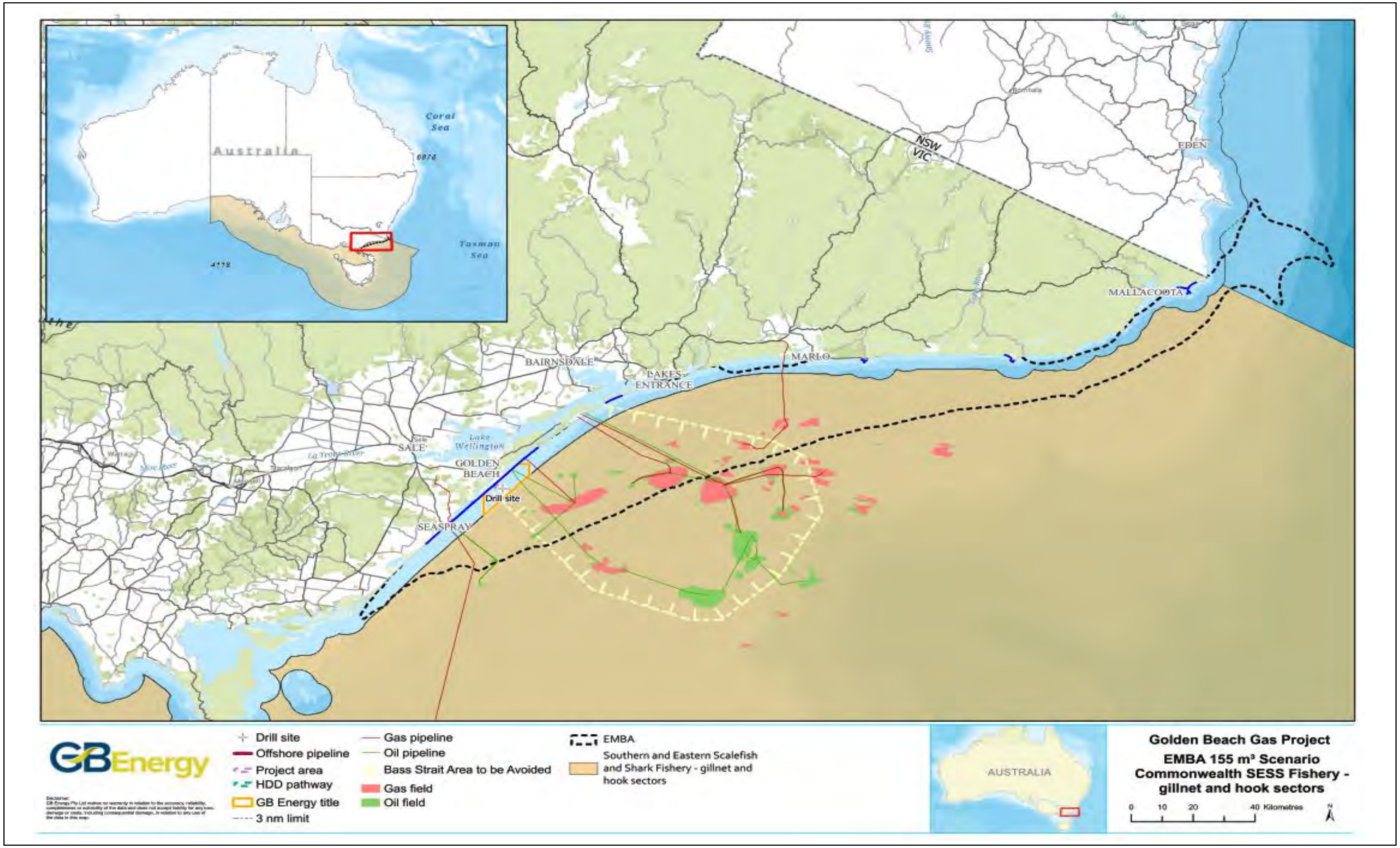


Figure 6.41a. Commonwealth SESS fishery (shark gillnet and hook sector) intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

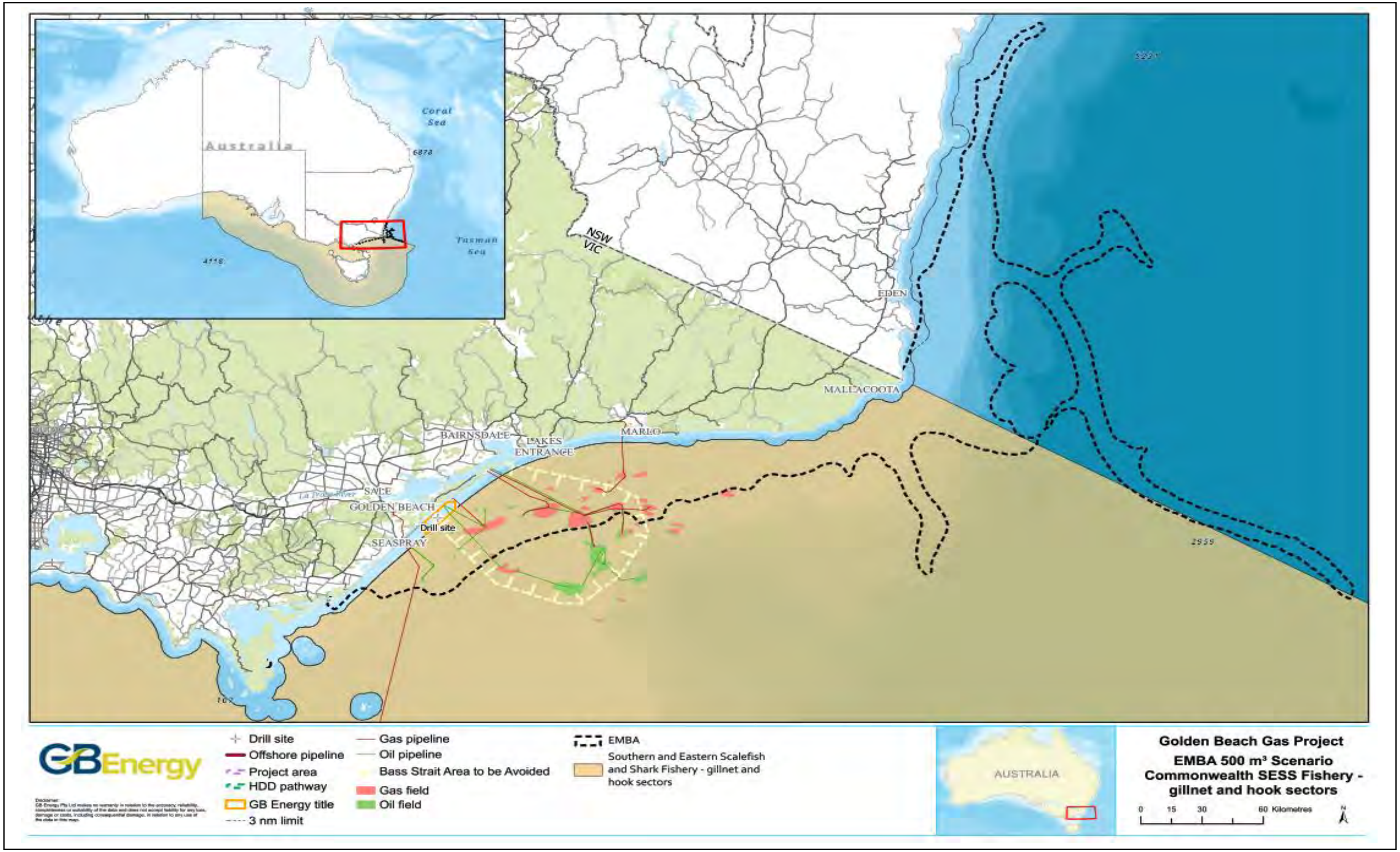


Figure 6.41b. Commonwealth SESS fishery (shark gillnet and hook sector) intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

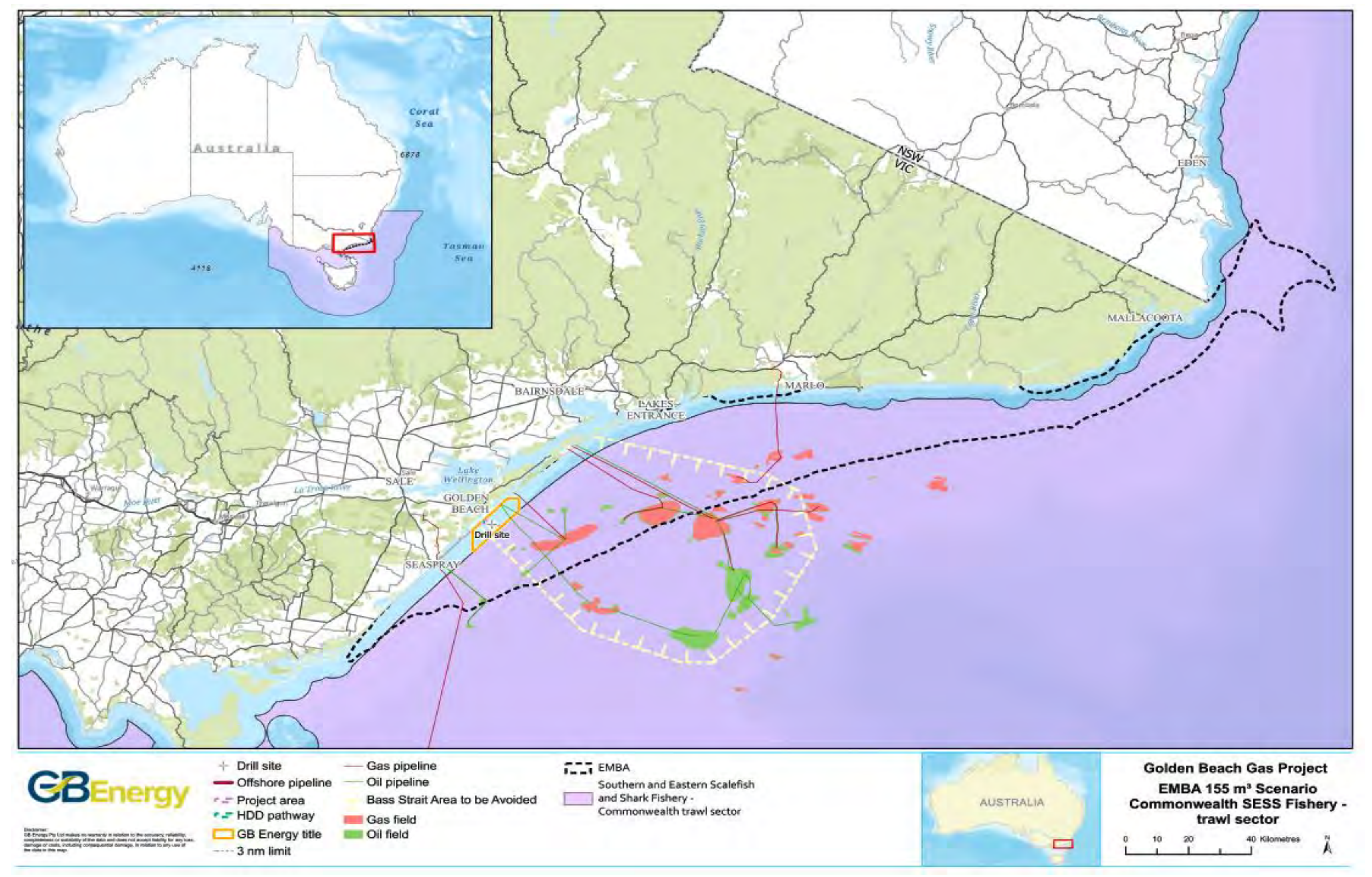


Figure 6.42a. Commonwealth SESS fishery (trawl sector) intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

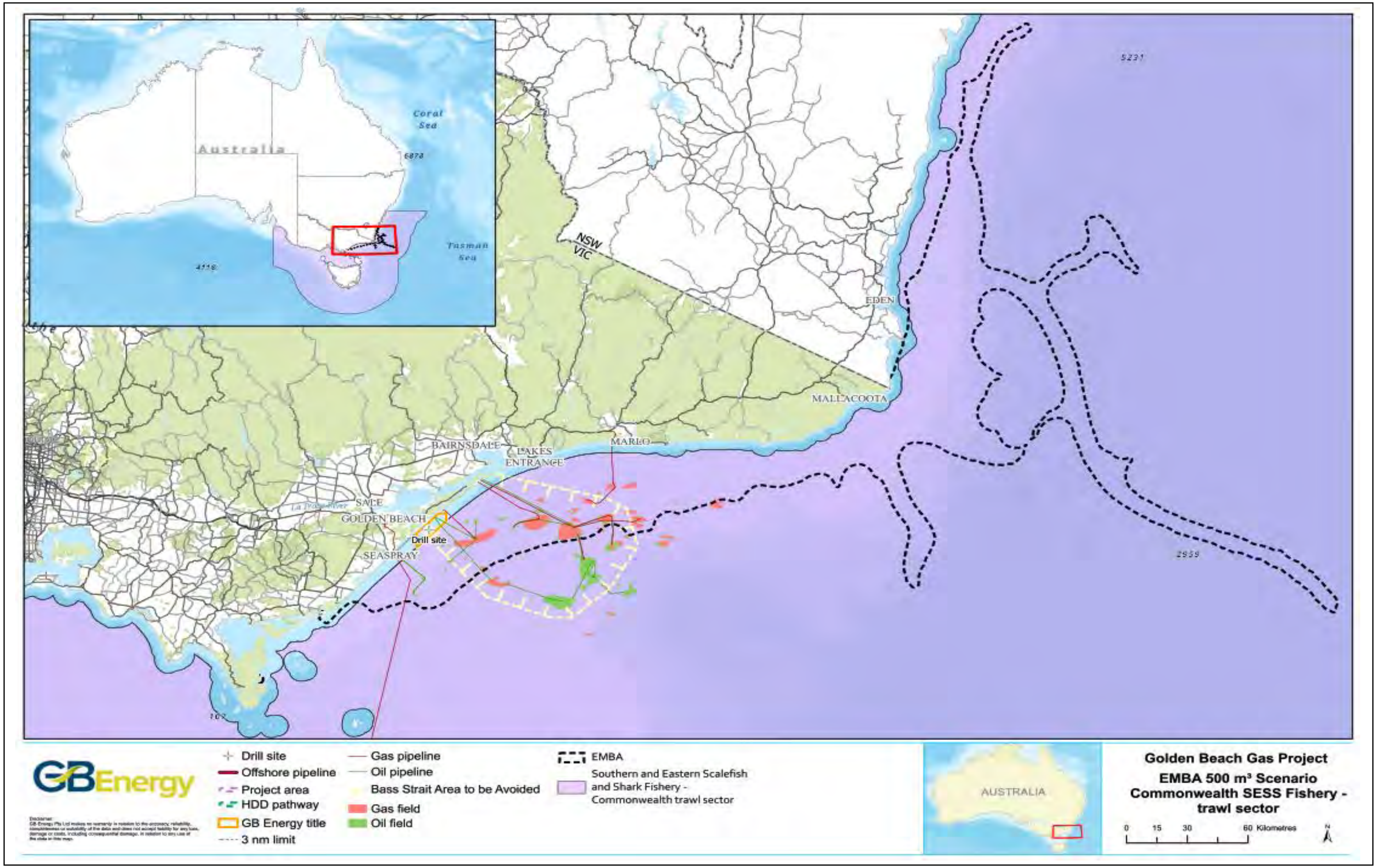


Figure 6.42b. **Commonwealth SESS fishery (trawl sector) intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)**

Victorian-managed Fisheries

Victorian-managed commercial fisheries with access licences that authorise harvest in the waters of the Project area and the EMBA include the following (noting that not all actually operate in the area):

- Ocean Scallop;
- Rock Lobster (Eastern zone);
- Ocean Access (general, all species);
- Ocean Purse Seine (noted by VFA as being the most active fishery in the region);
- Trawl (inshore);
- Abalone (central zone) (does not operate in the Project area);
- Wrasse (does not operate in the Project area); and
- Banded Morwong (by permit) (does not operate in the Project area).

Through its consultation process, GB Energy identified Mitchelson Fisheries (Mitchelson) as the key operator in the waters of, and adjacent to, the Project area. Mitchelson primarily catches sardines and other pelagic species such as salmon, mackerel, sandy sprat, anchovy and white bait. The Mitchelson vessel is 26 m long and mainly fishes using purse seine. Mitchelson operates year-round and generally provides fish to the small fish market areas including:

- Melbourne and Sydney fresh fish markets;
- Wet and dry pet foods;
- Aquaculture feed for southern bluefin tuna operations in South Australia; and
- Cray fish bait for the southern rock lobster and giant crab fisheries.

Mitchelson has advised GB Energy that there is very limited rock lobster fishing in the waters around the Project area and that they are the only fishery holding a license in the Victorian waters around the Project area.

The Project area overlaps a small portion of the VFA catch and effort grid cell E39 (Figure 6.43). Victorian fishing grid cells are based on divisions of 10' latitude (approximately 10 nm) and 12.1' longitude (approximately 12.1 nm).

Table 6.22 presents information of the relevant fisheries with jurisdiction to operate in the Project area.

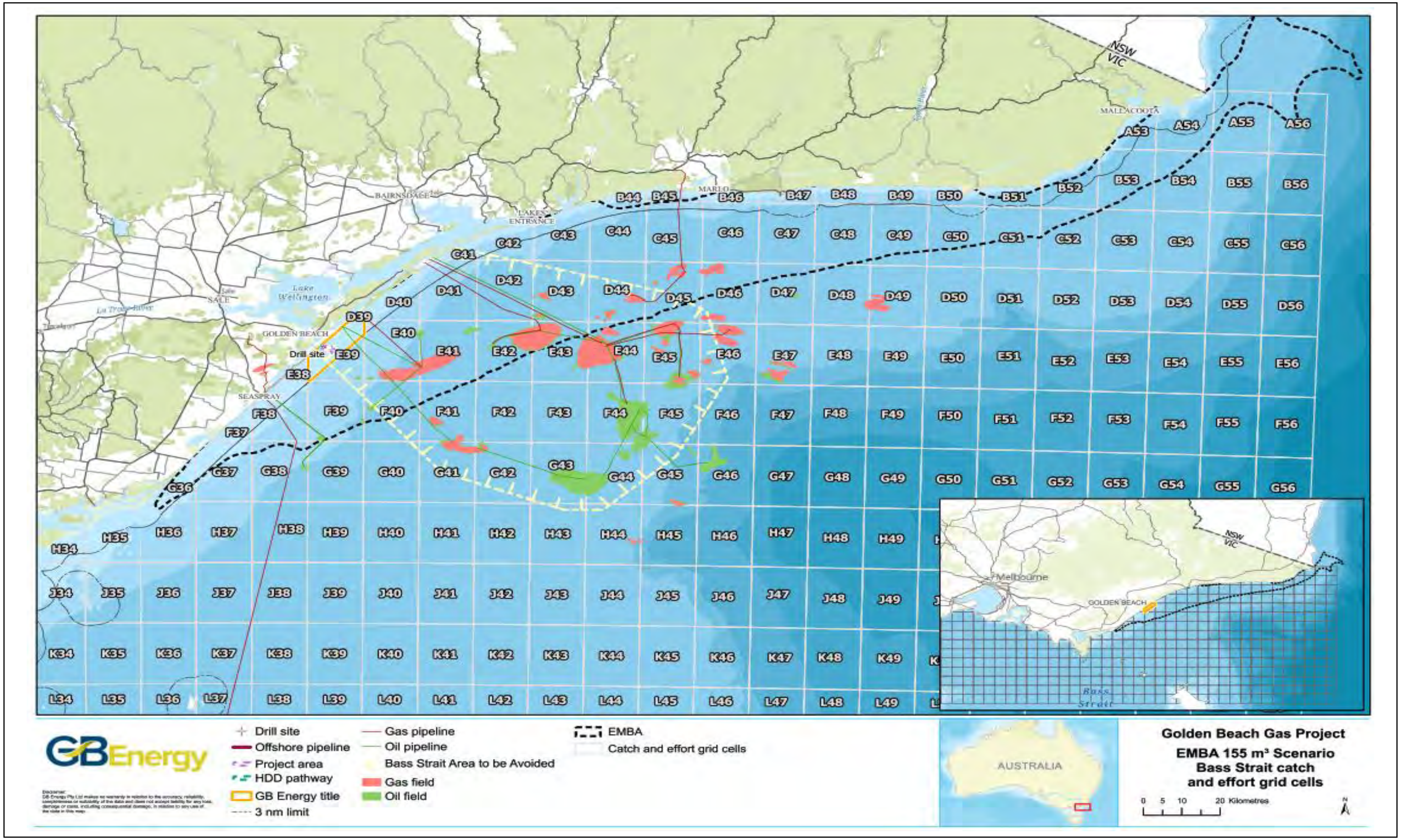


Figure 6.43a. VFA catch and effort grid cells intersected intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

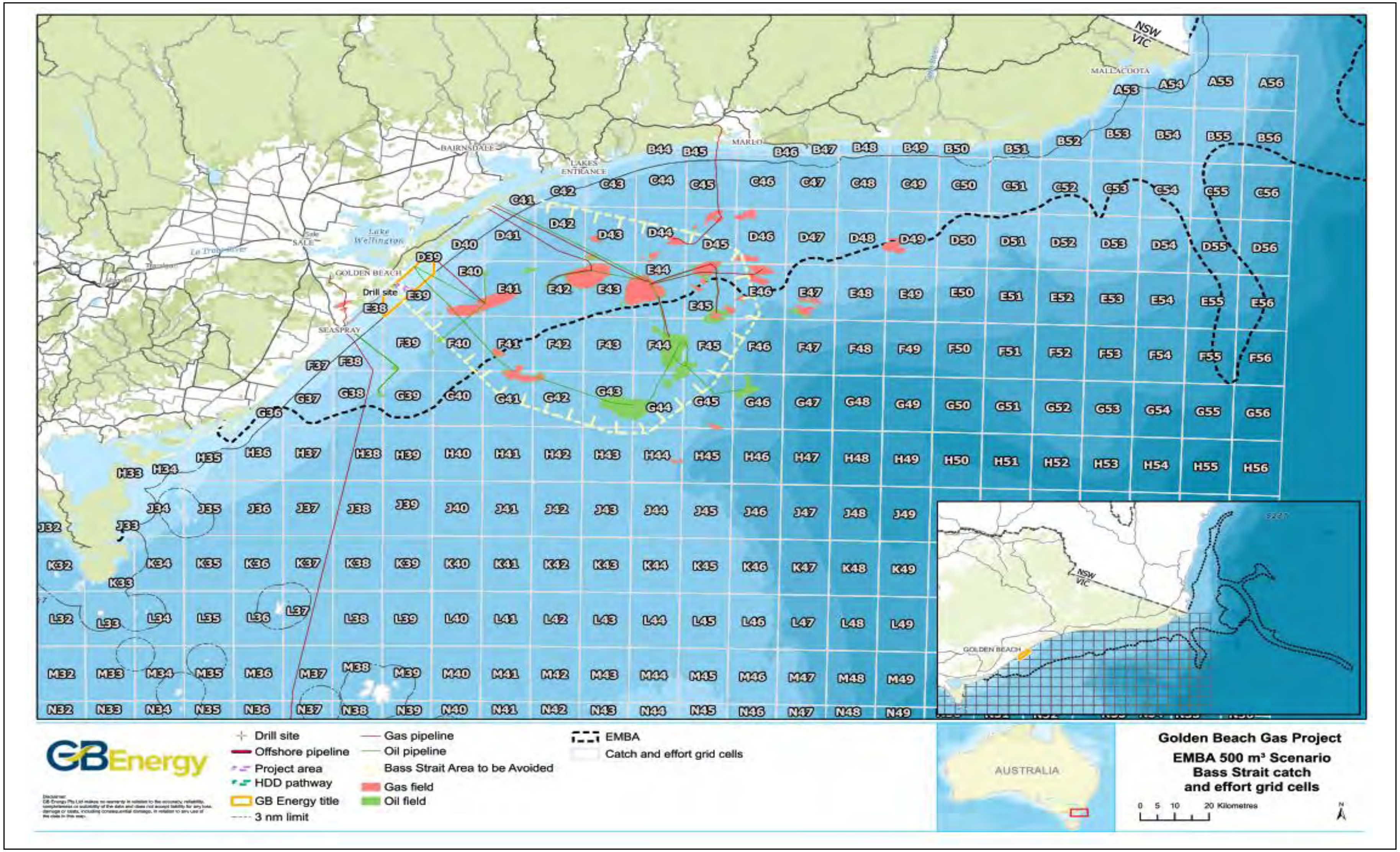


Figure 6.43b. VFA catch and effort grid cells intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

Table 6.22. Victorian-managed commercial fisheries with jurisdictions to fish within the Project area and EMBA

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Bass Strait Scallop Fishery (Victorian zone) (Figure 6.44)	Commercial scallop (*Pecten fumatus*).	Extends 20 nm from the high tide water mark of the entire Victorian coastline (excluding bays and inlets where commercial scallop fishing is prohibited). Management of the Bass Strait Scallop fishery was split between the Commonwealth, Victoria and Tasmania in 1986, whereby Commonwealth central, Victorian and Tasmanian zones were created.	**Project area – Yes.** *Project area intersects 0.008% of the fishery.* **EMBA (both scenarios) – Yes.** *Drilling and operations phase EMBA intersects 18.96% of the fishery.* *Pipeline installation phase EMBA intersects 26.26% of the fishery.* The 2017-18 VFA stock assessment found no scallops within the Project area or EMBA in commercial quantities (see Section 6.3.1), so it is unlikely that the EMBA will be fished for many years. Fishing activity in the area is currently low.	12-month season, beginning 1st of April. Fishing usually occurs during the winter months, but can occur from May to the end of November. The 2017/18 scallop stock assessment found that they are present in much lower numbers than historically. Scallops have highly variable levels of natural mortality, with an historical 'boom' or 'bust' nature.	Towed scallop dredges (typically 4.5 m wide) that target dense aggregations ('beds') of scallop. A tooth-bar on the bottom of the mouth of the dredge lifts scallops from the seabed and into the dredge basket. There are a maximum of 90 licences available. Only a few vessels fishing these licenses operate in any one year (generally between 12 and 20). Vessels are typically based out of Lakes Entrance or Port Welshpool, although licence holders may fish the entire coastline. Some licence holders also have entitlements to fish the Commonwealth scallop fishery, inshore trawl, Commonwealth SESS fishery and the southern squid jig fishery.	Zero quotas were in place for the 2010-11, 2011-12 and 2012-13 seasons due to a lack of commercial scallop quantities. The TACC has been set at 135 tonnes for the 2013-14, 2014-15, 2015-16, 2016-17 and 2017-18 fishing seasons, and is likely to remain at this level for the foreseeable future. Scallop spawning normally occurs from late winter to early spring, with larvae drifting as plankton for up to six weeks before first settlement. Juvenile scallops reach marketable size within 18 months.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Rock Lobster Fishery (eastern zone; Lakes Entrance region) (Figure 6.45)	Southern rock lobster (*Jasus edwardsii*). Very small bycatch of species including southern rock cod (*Lotella* and *Pseudophycis* spp), hermit crab (family Paguroidea), leatherjacket (*Monacanthidae* spp) and octopus (*Octopus* spp).	The eastern zone stretches from Apollo Bay in southwest Victoria to the Victorian/NSW border. Rock lobster abundance decreases moving from western Victoria to eastern Victoria. Larval release occurs across the southern continental shelf, which is a high-current area, facilitating dispersal. The pelagic phyllosoma larval phase lasts around 12–18 months.	**Project area** – **Yes** based on fishing data for 2012/13 to 2016/17 for the catch & effort cell E39. May be fished from rocky reef in the vicinity of the Project area. *Project area intersects 0.01% of the fishery (eastern zone).* **EMBA (both scenarios)** – **Yes**, where rocky reefs occur. *Drilling and operations phase EMBA intersects 11.86% of the fishery (eastern zone).* *Pipeline installation phase EMBA intersects 20.17% of the fishery (eastern zone).*	Closed season for: • Female lobsters – 1 June to 15 November to protect females in berry during spawning period. • Male lobsters – 15 September to 15 November to protect males during their moulting period when soft shells increase their vulnerability. Catches are generally highest from August to January.	Fished from coastal rocky reefs in waters up to 150 m depth, with most of the catch coming from inshore waters less than 100 m deep. Baited pots are generally set and retrieved each day, marked with a surface buoy. As of June 2019, there were 33 fishery access licences in the eastern zone. Only one lobster fisher operates in the EMBA, fishing a small section of mapped reef in water depths between 15-20 m.	The Rock Lobster Fishery is Victoria's most valuable fishery. In the eastern zone, catches for the last five seasons with available data were: 2018/19 – 45 tonnes values at $4.04 million. 2017/18 – 57 t valued at $4.67 million. 2016/17 – 52 t valued at $4.28 million. 2015/16 – 58 t valued at $5.1 million. 2014/15 – 59 t valued at $5 million.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Abalone Fishery (central zone) (Figure 6.46)	Blacklip abalone (*Haliotis rubra*) is the primary target, with greenlip abalone (*H. laevigata*) taken as a bycatch.	The Victorian Central Abalone Zone is located between Lakes Entrance and the mouth of the Hopkins River. Most abalone live on rocky reefs from the shoreline to depths of 30 m.	**Project area** – **No**, based on 2014/15 to 2018/19 catch data. *Project area intersects 0.0% of the fishery (eastern zone).* **EMBA (both scenarios)** – **Yes**, where rocky reefs and aquaculture leases occur. *Drilling and operations phase EMBA intersects 13.61% of the fishery (eastern zone).* *Pipeline installation phase EMBA intersects 26.04% of the fishery (eastern zone).*	12-month season, beginning 1st of April.	Abalone diving activity occurs close to shoreline (generally no greater than 30 m) using hookah gear (breathing air supplied via hose connected to an air compressor on the vessel). Commercial divers do not use SCUBA gear. Divers use an iron bar to prise abalone from rocks. The fishery consists of 71 fishery access licences, of which 34 and 23 operate in the central and eastern zones, respectively.	In the central zone, catches for the last five seasons were: 2018/19 – 274 t. 2017/18 – 277 t. 2016/17 – 280 t. 2015/16 – 306 t. 2014/15 – 310 t.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Wrasse Fishery (Lakes Entrance region) (Figure 6.47)	Blue-throat wrasse (*Notolabrus tetricus*), saddled wrasse (*N. fucicola*), orange-spotted wrasse *(N. parilus*).	Entire Victorian coastline out to 20 nm (excluding marine reserves, bays and inlets). In recent years, catches have been highest off the central coast (Port Phillip Heads, Western Port and Wilson's Promontory) and west coast (Portland).	**Project area** – **No**, based on 2012/13 to 2016/17 catch data. *Project area intersects 0.01% of the fishery.* **EMBA (both scenarios)** – **Unknown**, as licences were made transferrable from 1st April 2017, so fishing effort could be activated in the area. *Drilling and operations phase EMBA intersects 18.96% of the fishery.* *Pipeline installation phase EMBA intersects 26.21% of the fishery.*	Year-round.	Handline fishing (excluding longline), rock lobster pots (if in possession of a rock lobster access fishing licence). Preferred water depths for blue-throat wrasse is 20-40 m, while saddled wrasse prefer depths of 10-30 m. As of June 2018, there were 22 fishery access licences.	Catches of all wrasse species for the last five seasons were: 2018/19 – 33 tonnes valued at $672,000. 2017/18 – 38 t valued at $767,0000. 2016/17 – 24 t valued at $557,000. 2015/16 – 30 t valued at $627,000. 2014/15 – 29 t valued at $490,000. Prior to this time, catches varied from 30-40 tonnes per annum from 2005-09, and 40-50 tonnes per annum from 2000-04.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Ocean Access (or Ocean General) Fishery	Gummy shark (*Mustelus antarcticus*), school shark (*Galeorhinus galeus*), Australian salmon (*Arripis trutta*), snapper (*Pagrus auratus*). Small bycatch of flathead (*Platycephalidae* spp).	Entire Victorian coastline, excluding marine reserves, bays and inlets.	**Project area** – **Yes**, based on 2012/13 to 2016/17 catch data. **EMBA (both scenarios)** – **Yes**, based on 2012/13 to 2016/17 catch data. *Insufficient data to calculate the percentage intersect of the EMBA with the fishery.*	Year-round. Most fishing undertaken off Lakes Entrance occurs between April and July.	Utilises mainly longlines (200 hook limit), but also haul seine nets (maximum length of 460 m) and mesh nets (maximum length of 2,500 m per licence). As of June 2019, there are 157 fishery access licences. Fishing usually conducted as day trips from small vessels (<10 m in length).	There is insufficient catch data (catch data is combined with other fisheries and therefore unable to be distinguished on a stand-alone basis).

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Ocean Purse Seine Fishery	Australian sardine (*Sardinops sagax*), Australian salmon (*Arripis trutta*) and sandy sprat (*Hyperlophus vittatus*) are the main species. Southern anchovy (*Engraulis australis*) caught in some years.	Entire Victorian coastline, excluding marine reserves, bays and inlets.	**Project area** – **Yes**, based on 2012/13 to 2016/17 catch data. **EMBA (both scenarios)** – **Yes**, based on 2012/13 to 2016/17 catch data. *Insufficient data to calculate the percentage intersect of the EMBA with the fishery.*	Year-round.	Purse seine, which is generally a highly selective method that targets one species at a time, thereby minimising bycatch. Purse seines do not touch the seabed. A lampara net may also be used. Only one licence is active in Victorian waters (based out of Lakes Entrance), with fishing focused close to shore and during the day. This licence is held by Mitchelson Fisheries Pty Ltd, a family business that catches primarily sardines, salmon, mackeral, sandy sprat, anchovy and white bait using the *Maasbanker* purse seine vessel.	Confidential data (due to operation of only one fisher).

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Inshore Trawl Fishery	Key species are eastern king prawn (*Penaeus plebejus*), school prawn (*Metapen-aeus macleayi*) and shovelnose lobster/Balmain bug (*Ibacus peronii*). Minor bycatch of sand flathead (*Platce-phalus bassensis*), school whiting (*Sillago bassensis*) and gummy shark (*Mustelus antarcticus*).	Entire Victorian coastline, excluding marine reserves, bays and inlets. Most operators are based at Lakes Entrance.	**Project area** – **No**, based on 2012/13 to 2016/17 catch data. **EMBA (both scenarios)** – **Yes**, based on 2012/13 to 2016/17 catch data. *Insufficient data to calculate the percentage intersect of the EMBA with the fishery.*	Year-round, although the majority of prawn fishing occurs in the warmer months up until Easter.	Otter-board trawls with no more than a maximum head-line length of 33 m, or single mesh nets are used. As of June 2019, there were 54 fishery access licences, with only about 15 active to various degrees.	The catch of eastern school prawn in 2015 was 75 t, the largest for the previous 10 years.

Fishery	Target species	Geographic extent of fishery	Does fishing activity intersect Project area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Banded Morwong Fishery	Banded morwong *(Cheilo-dactylus spectabilis).* Some fish are also landed as by-product from the Ocean Access Fishery.	Extent is uncertain. The banded morwong is a temperate reef species. The absence of reef in the Project area suggests fishing may be limited or non-existent.	**Project area – Unlikely**, based on lack of reef habitat and on distribution of reported catch (south of Wilsons Promontory). **EMBA (both scenarios) – Unlikely**, based on distribution of reported catch (south of Wilsons Promontory). *Insufficient data to calculate the percentage intersect of the EMBA with the fishery.*	Unknown.	Uses large-mesh gillnets.	The most recent stock assessment (undertaken in 2012) has not been published because of the limited number of operators and concerns about confidentiality. Catch data examined from 2002–12 concluded that there was a clear downward trend in biomass since the mid-2000s (catch per unit effort may have fallen by up to 48% from the peak). The total catch is currently less than 2.5 tonnes/year (catches are now limited to 625 fish per operator).

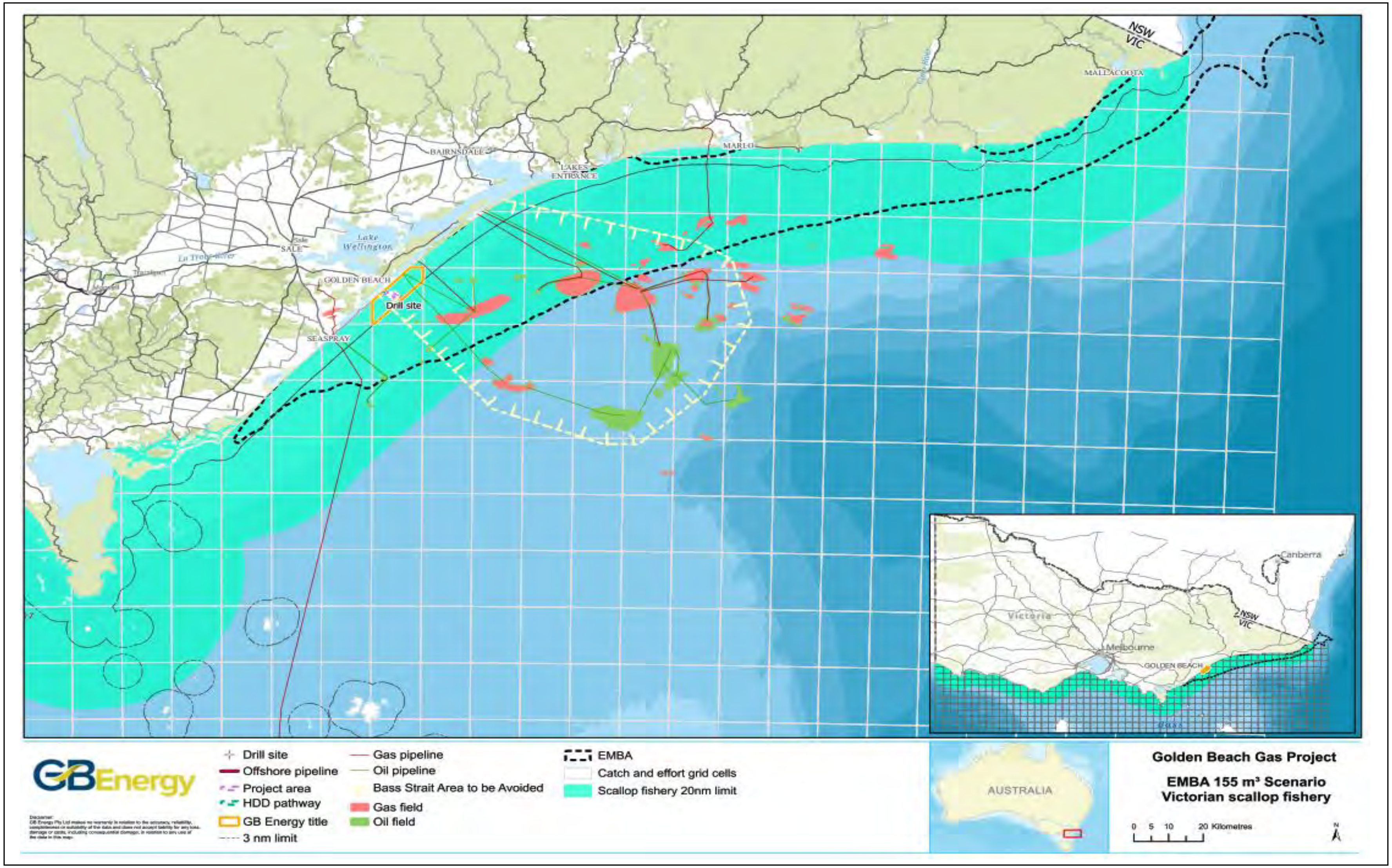


Figure 6.44a. Victorian scallop fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

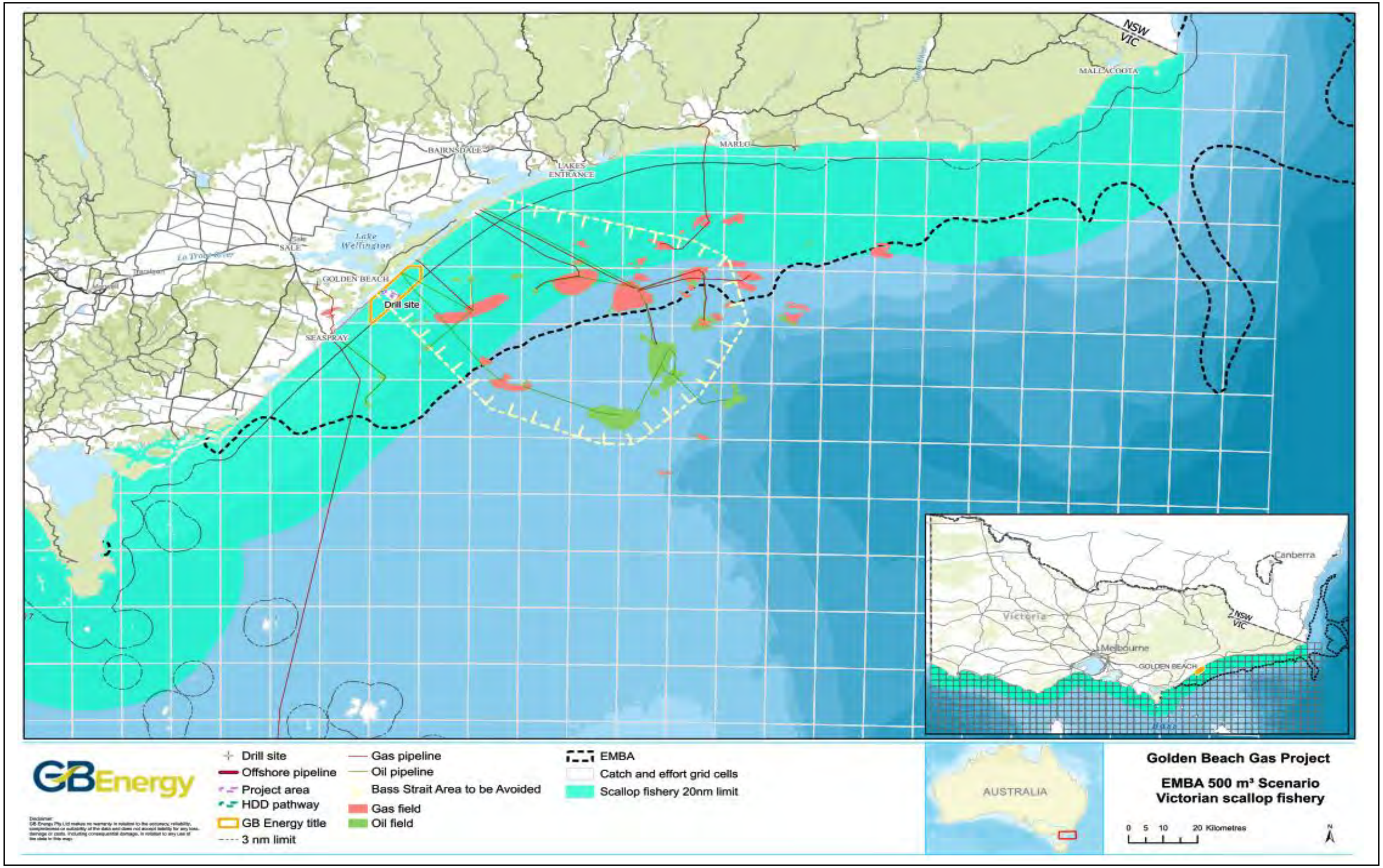


Figure 6.44b. Victorian scallop fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

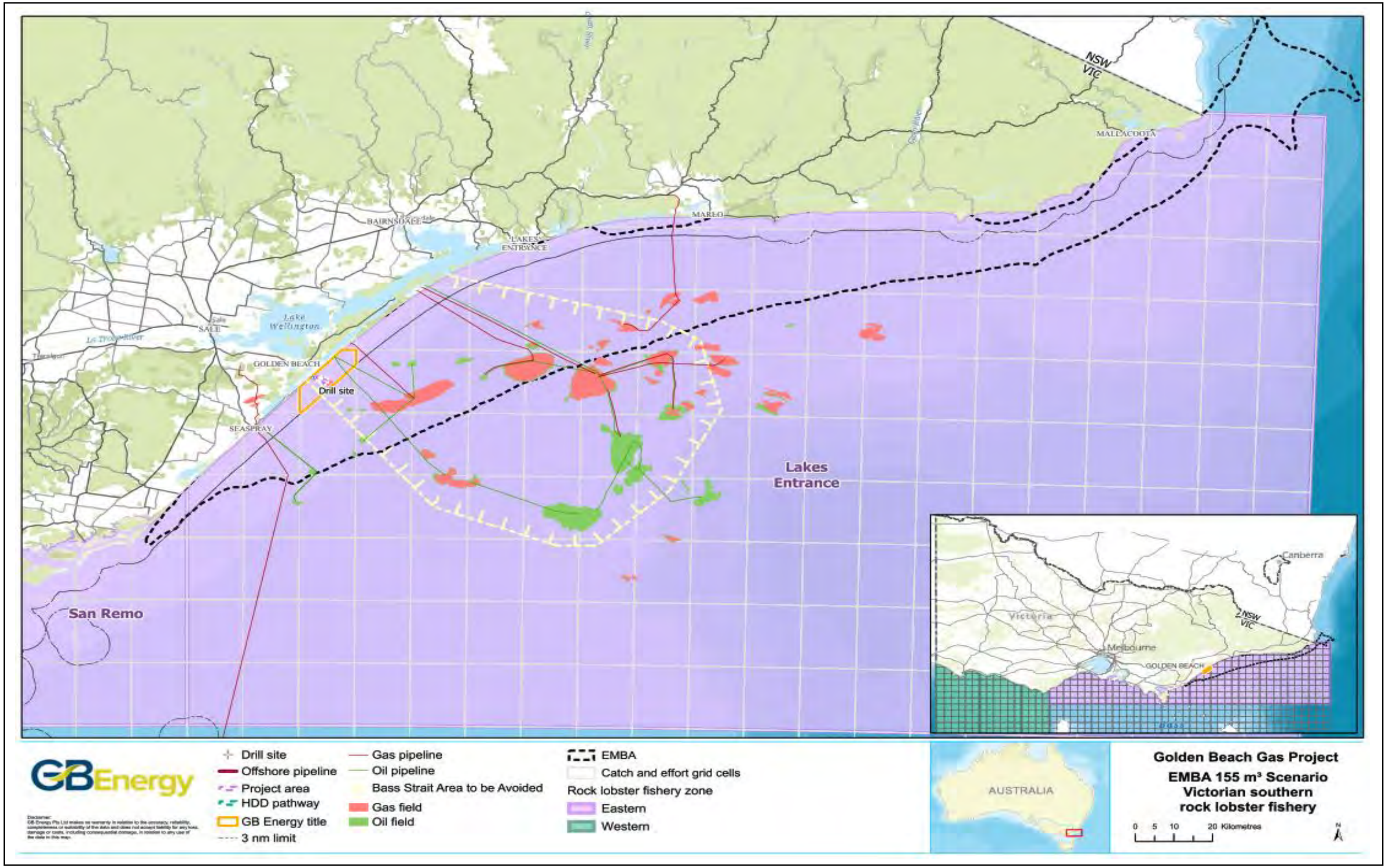


Figure 6.45a. Victorian southern rock lobster fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

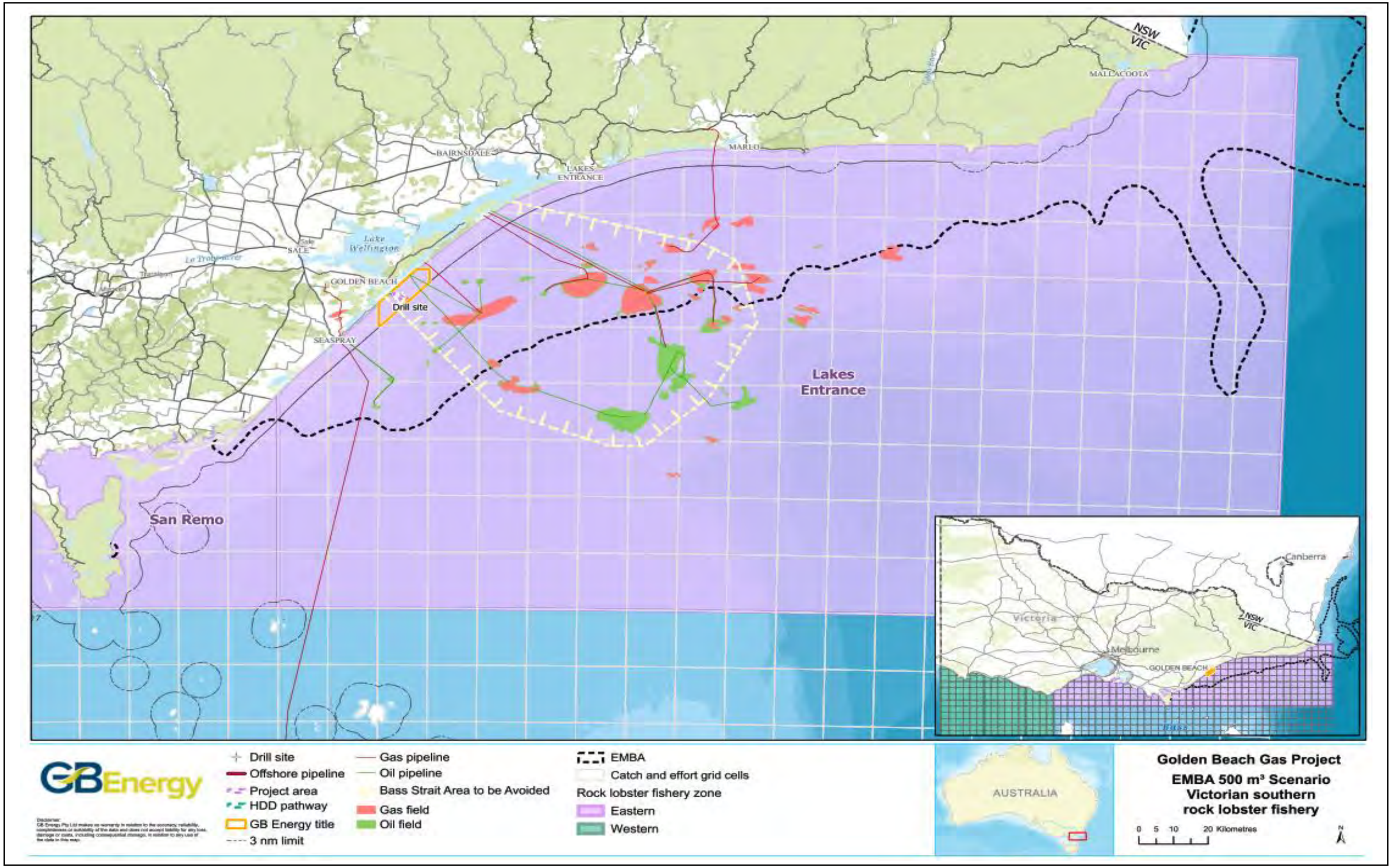


Figure 6.45b. Victorian southern rock lobster fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

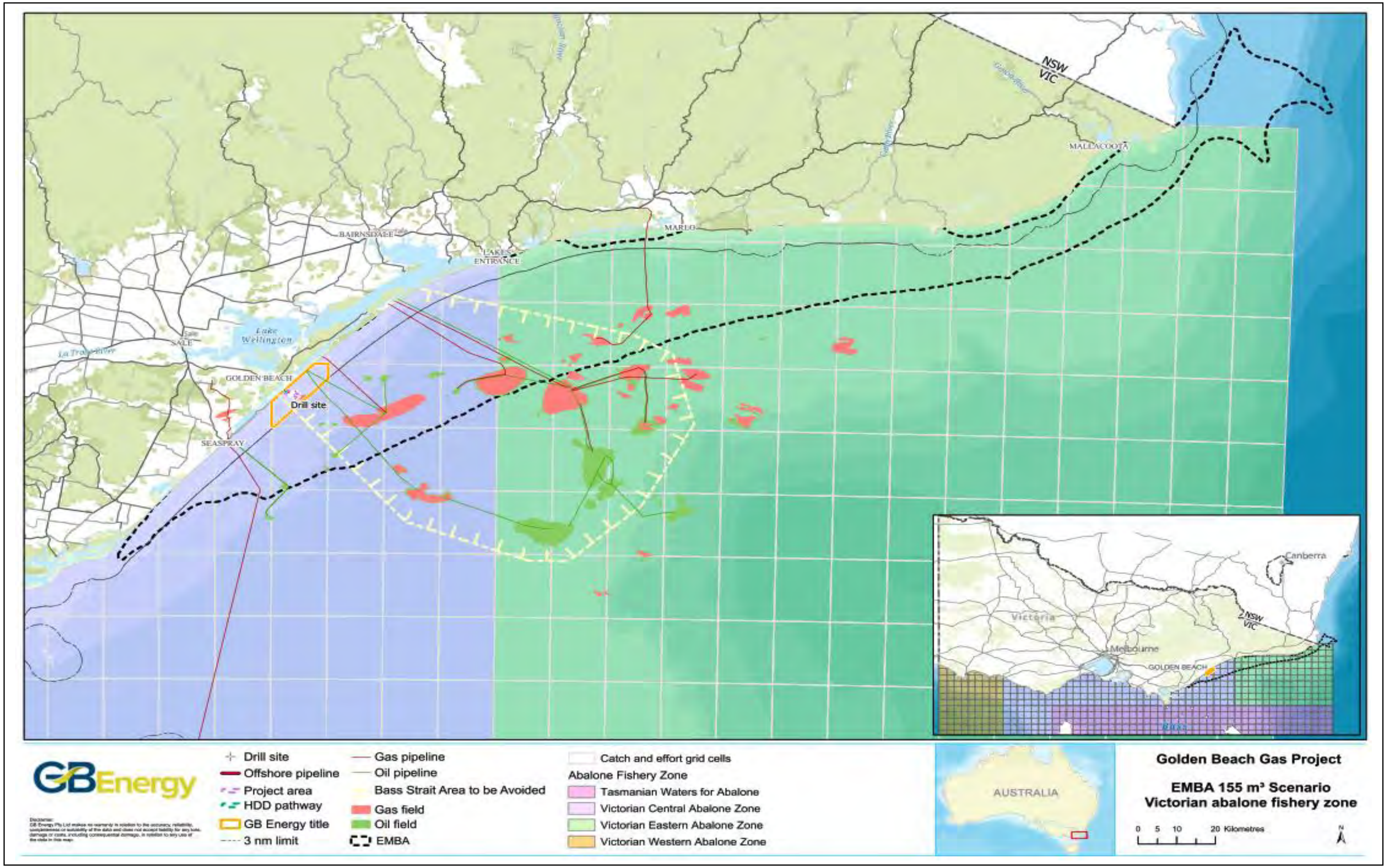


Figure 6.46a. Victorian abalone fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

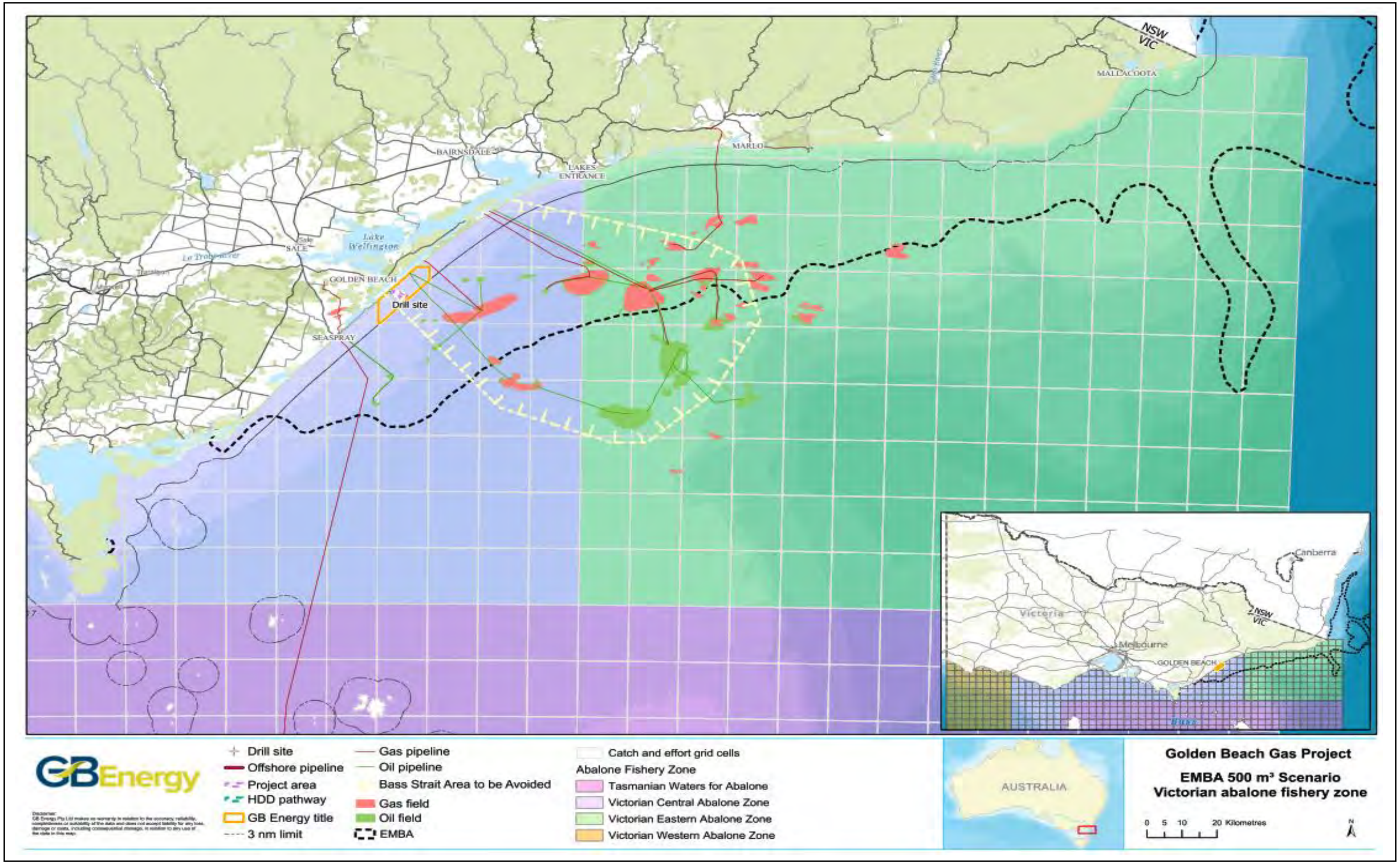


Figure 6.46b. Victorian abalone fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

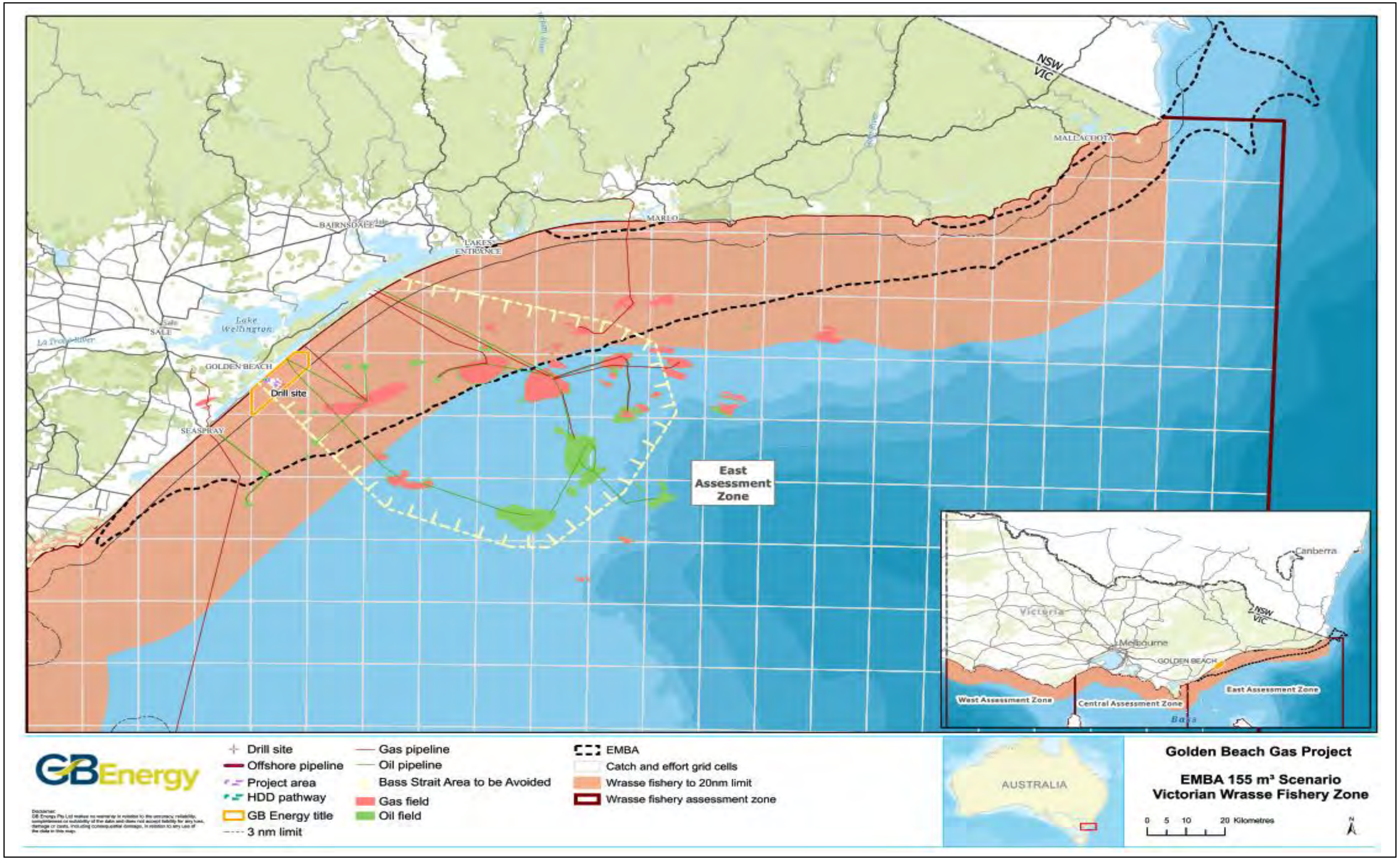


Figure 6.47a. Victorian wrasse fishery intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

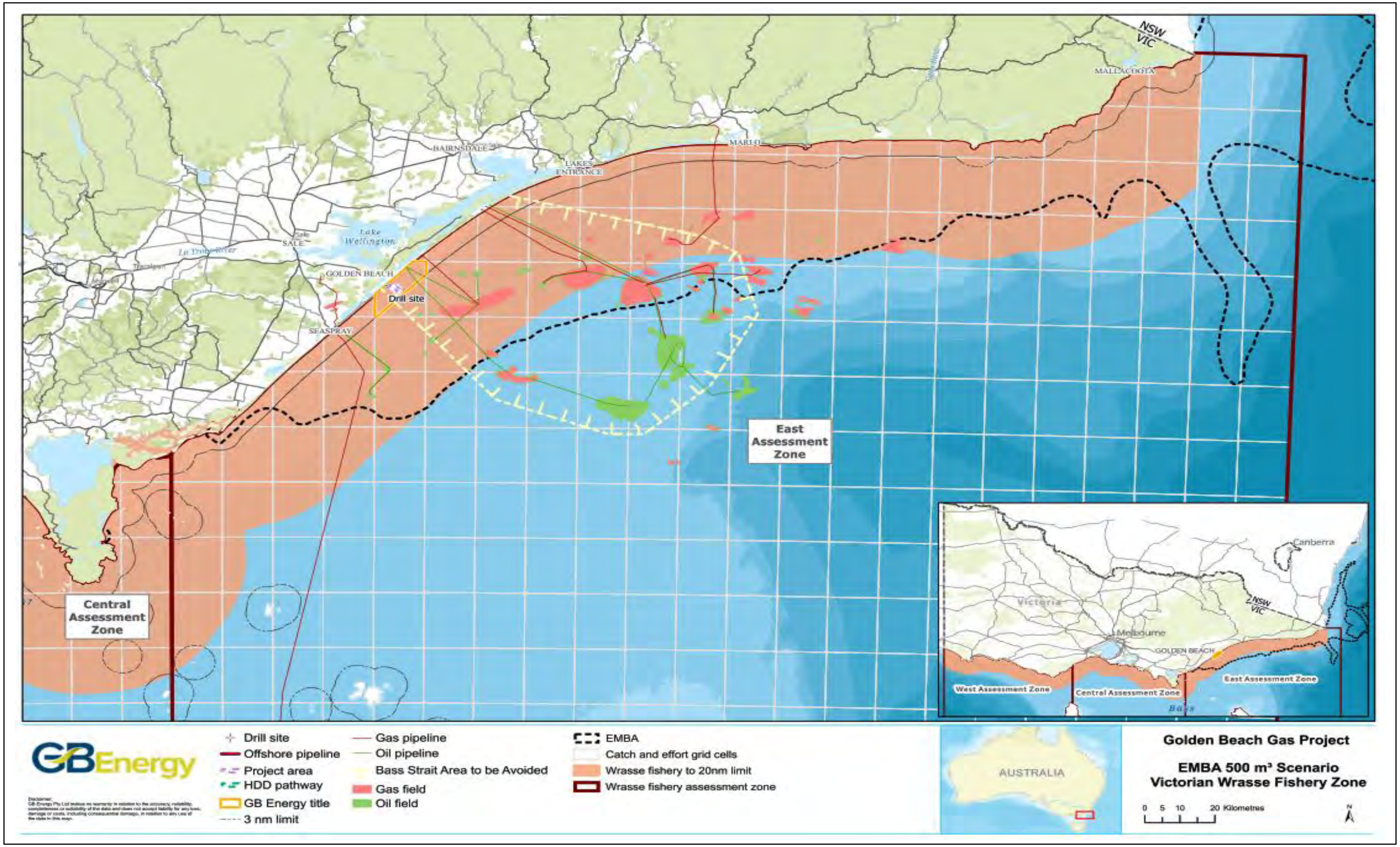


Figure 6.47b. Victorian wrasse fishery intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.6.4. Recreational Fishing

Recreational fishing along the Gippsland coast typically targets snapper, King George whiting, flathead, bream, sharks, tuna, calamari, and Australian salmon.

Recreational fishing and boating are largely confined to the Gippsland Lakes and nearshore coastal waters, though surf fishing does occur along the beaches adjacent to Golden Beach. As Bass Strait is relatively shallow, the water currents through the Bass Strait can create unpredictable seas, reducing the numbers of recreational boats from venturing long distances into the Bass Strait from shore. Victorian Recreational Fishing (VRFish) has stated that small boats are likely to fish around the nearshore reef area, while larger game fishing boats are likely to fish further out to sea and use nearby ports and boat ramps for launching.

There are no boat ramps adjacent to the Project area, though stakeholder consultation indicates that recreational fishers often carry small 'tinnies' (aluminium-hulled boats) over the sand dunes in order to access the beach, with the sand dune clearing for the ROS at Delray Beach providing one of the more suitable access points.

The Golden Beach Surf Fishing Competition takes place over the weekend nearest Australia Day and during the Easter long weekend (midnight Good Friday to midnight Easter Sunday) each year between Seaspray and Loch Sport. It is estimated that up to 1,000 extra people are in the region during these competitions, which provides an important economic contribution to local towns. The period of time between Christmas and Australia Day weekend are generally the busiest for recreational fishing.

The Gippsland Lakes Fishing Club Inc. and Lakes Entrance Game & Sport Fishing Club Inc. (formed in 2015) are active recreational fishing clubs in the region. These clubs host regular club competitions, with flathead being a key fishing target.

6.6.5. Tourism

Marine-based tourism and recreation in the Bass Strait is primarily associated with recreational fishing and boating (see previous section).

The Gippsland Lakes (comprising Lake Victoria, Lake King, and Lake Wellington, together with other smaller lakes, marshes and lagoons) are the primary tourist attraction in the region. The communities adjacent to this network of lakes are popular tourist towns for their boating and fishing activities, along with bushwalking, bird watching and other nature-focused activities. Towns including Lakes Entrance, Metung, Loch Sport, Golden Beach and Lake Tyers are especially popular in summer.

In 2013-14, the tourism industry contributed an estimated $1.2 billion to the Gippsland economy and employed about 12,400 people, representing 3.7% of the total Gippsland economy (DEDJTR, 2016). Intrastate visitors (i.e., visitors from within Victoria) were the most economically-important sector. Cafes, restaurants and takeaway food services contributed the most to direct regional tourism employment in Gippsland (DEDJTR, 2016).

6.6.6. Offshore Energy 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 liquified petroleum gas (LPG) production and 10% of Australia's conventional gas production (APPEA, 2019). Production has been trending down since it peaked in 2000.

The Project area and EMBA intersects the Gippsland oil and gas production province, which contains numerous offshore platforms, subsea wells and pipelines. Petroleum production from the offshore Gippsland Basin is centred on the EARPL operations for the Gippsland Basin Joint Venture. EARPL produces oil and gas from 23 platforms and subsea developments, hundreds of wells and some 880 km of associated pipelines, tied back to the Longford Gas Plant and Long Island Point. Production first commenced in 1969 from the Barracouta field. The latest fields to come into production were the Kipper-Tuna-Turrum oil and gas fields in 2013.

The Project area is located in proximity to several gas pipelines, these being:

- TasGas pipeline (Tasmanian Gas Pipeline Pty Ltd) – located 21 km southwest of the Project area;
- Seaspray to Dolphin to Perch pipeline (EARPL) – located 19 km southwest;
- Bream A to shore pipeline (EARPL) – 5 km northeast; and
- Barracouta to shore pipeline (EARPL) – 6.9 km northeast.

The EMBA intersects the investigation area of the Star of the South Wind Farm (51 km southwest of the Project area) (Figure 6.48), which is the first proposed offshore wind farm in Australia. The project involves installation of offshore wind turbines and offshore substations, submarine cables from the wind farm to the Gippsland coast and a transmission network of cables and substations connecting to the La Trobe Valley. The project is currently in its feasibility phase with preliminary site investigations such as metocean, geophysical, geotechnical and environmental studies currently being undertaken.

Additionally, the EMBA intersects the Basslink Interconnector (Figure 6.48), which is a 400 kV DC electricity interconnector that allows the trade of electricity between Tasmania and the National Electricity Market of the mainland. Basslink runs from Loy Yang in Gippsland, Victoria, across Bass Strait to Bell Bay in Northern Tasmania.

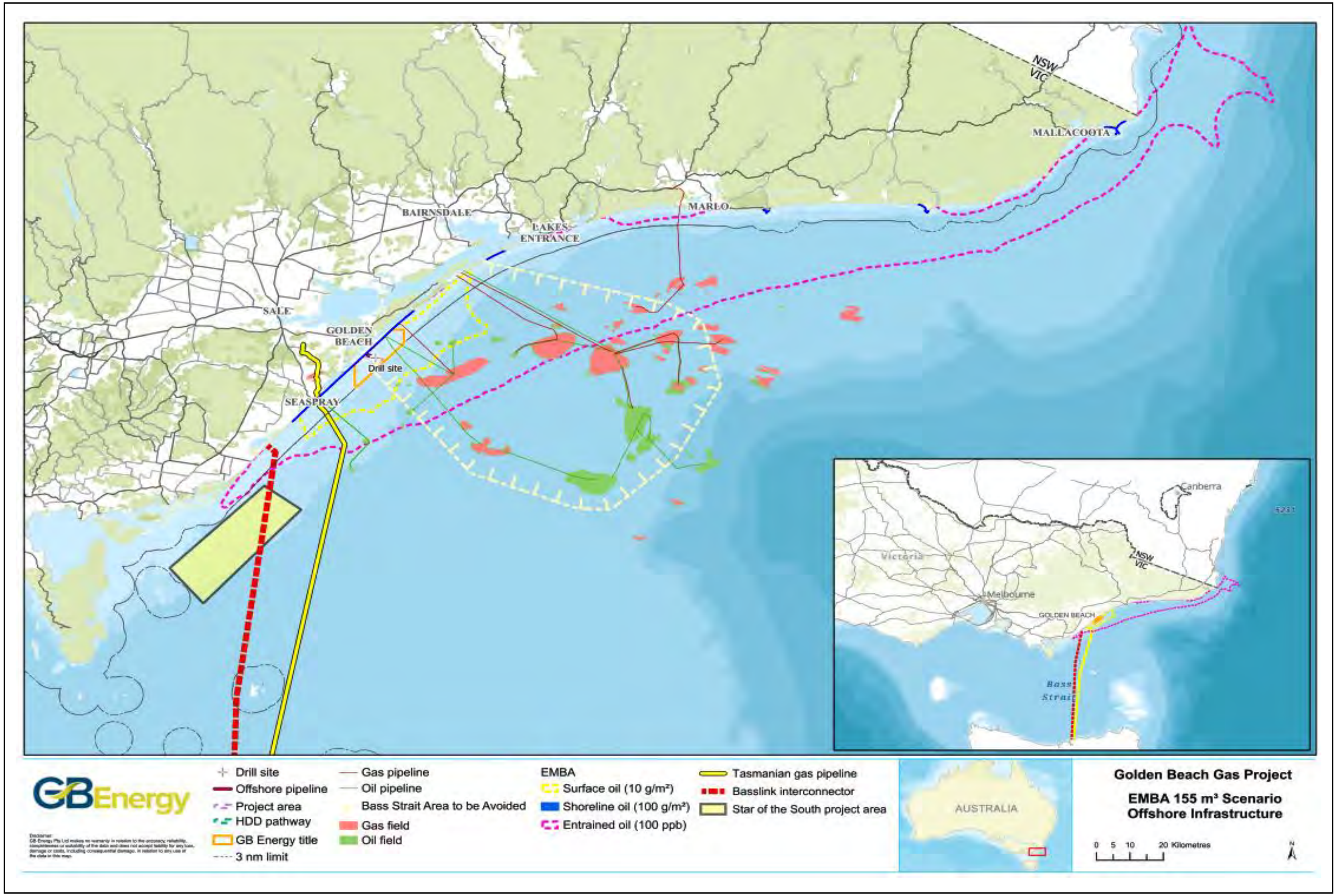


Figure 6.48a. Offshore infrastructure intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

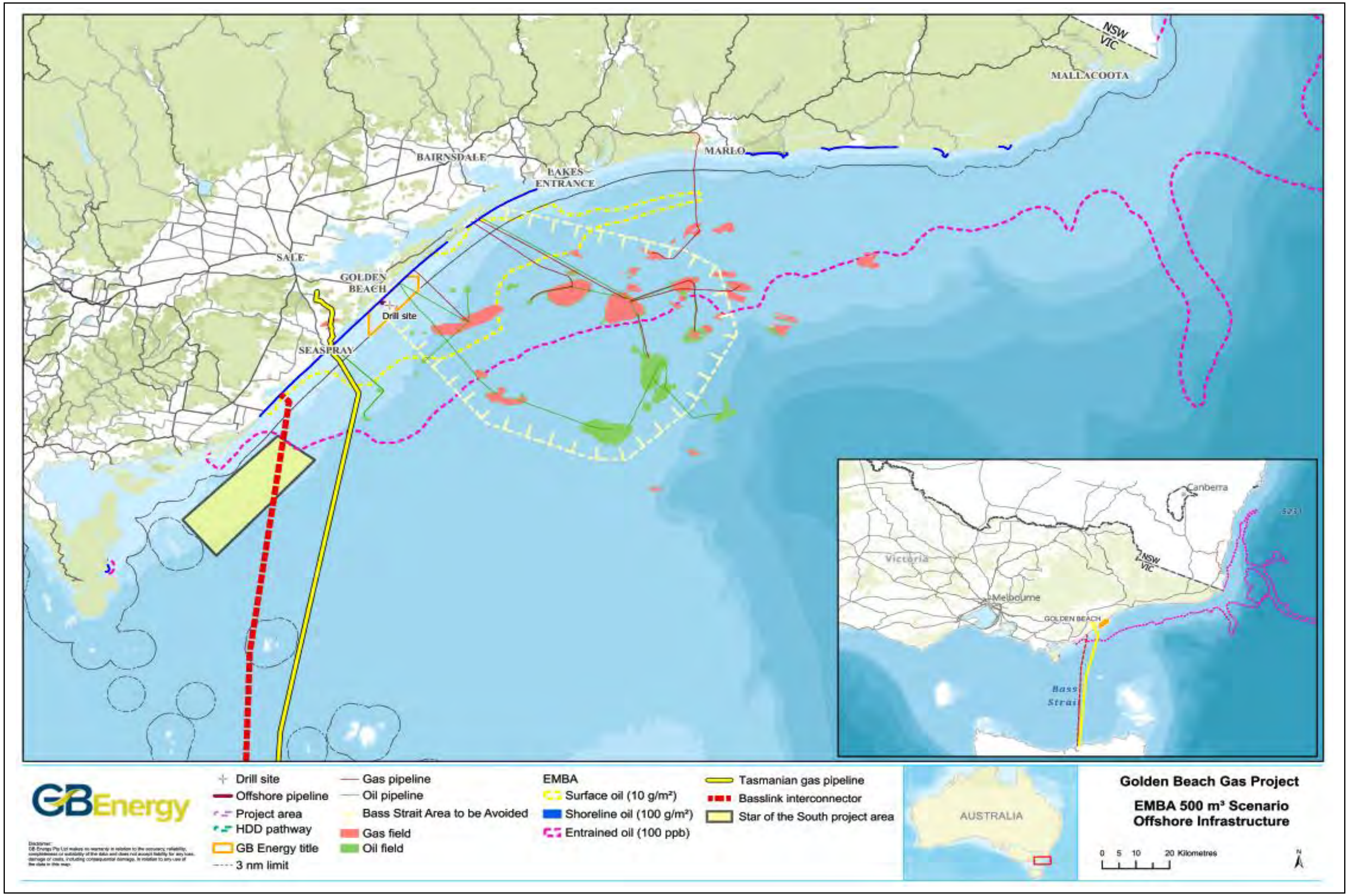


Figure 6.48b. Offshore infrastructure intersected intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.6.7. Commercial Shipping

The South-east Marine Region (which includes Bass Strait) is one of the busiest shipping regions in Australia (DoE, 2015a). Shipping consists of international and coastal cargo trade, passenger services and cargo and vehicular ferry services across Bass Strait (DoE, 2015a). Lakes Entrance is an important fishing port for the region (DoE, 2015a).

The Project area is located entirely within the ATBA. This area is a routing measure that ships in excess of 200 gross tonnes should avoid due to the high concentration of offshore petroleum infrastructure (oil and gas platforms and pipelines, as described in Section 6.6.6) that can provide a navigational hazard. The total area of the ATBA is 5,650 km^2. Operators of vessels greater than 200 gross tonnes must apply to NOPSEMA to enter and be present within the ATBA (NOPSEMA, 2016).

High traffic volume shipping areas are located south of the Project area (see Figure 6.49).

The Automatic Identification System (AIS) traffic plots indicate little to no shipping activity occurs through the Project area, with higher traffic volume shipping areas located immediately south of the ATBA. As such, interactions between the vessels using for this project and large commercial ships is expected to be minimal.

To the immediate seaward side of the ATBA exist two traffic separation schemes, implemented by AMSA to enhance safety of navigation around the ATBA by separating shipping into one-direction lanes for vessels heading northeast and those heading southwest.

One separation area is located south of Wilson’s Promontory, and the other south of the Kingfisher B platform (DIBP, 2017), 85 km southeast of the Project area.

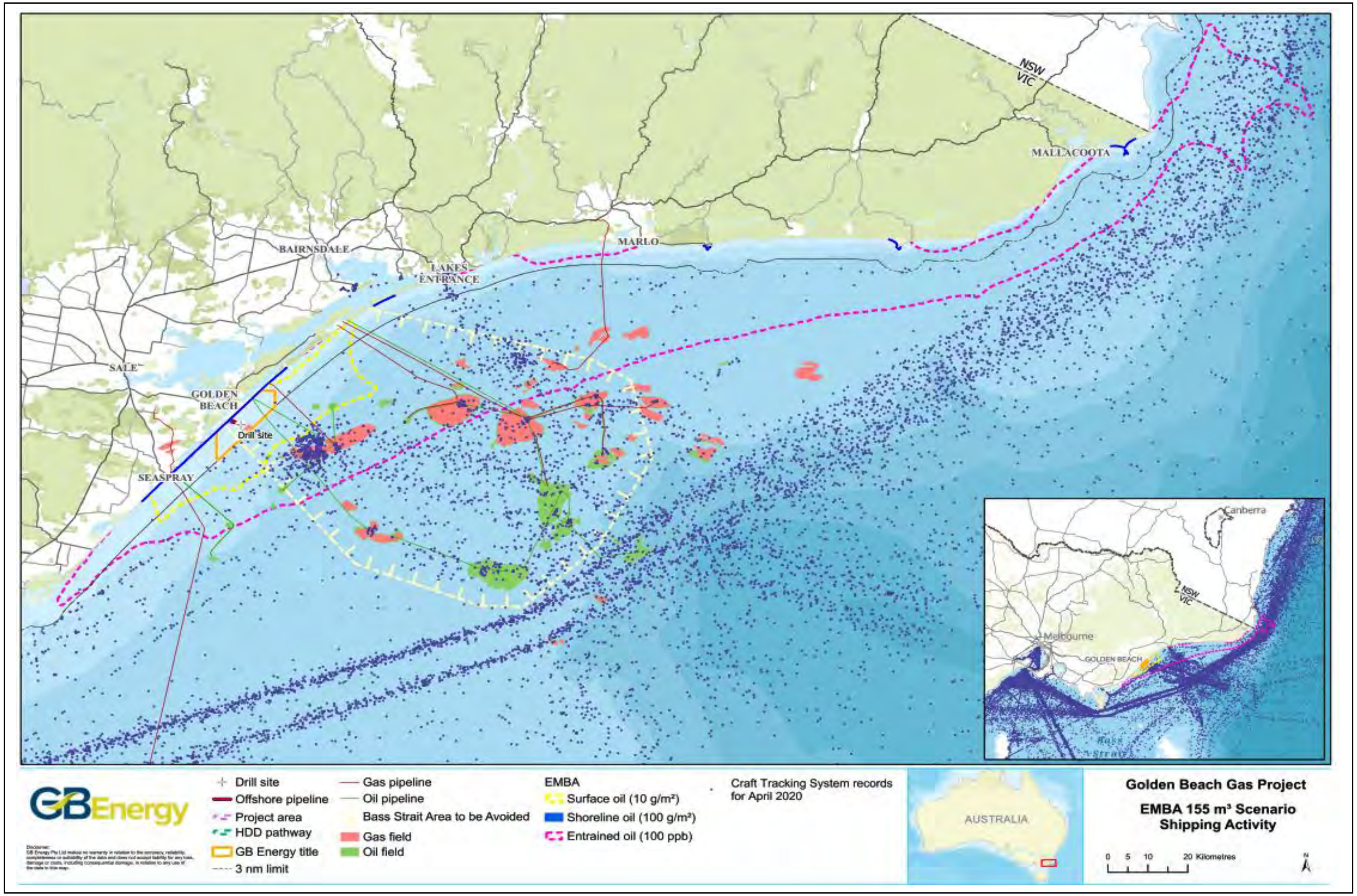


Figure 6.49a. Commercial shipping traffic intersected by the drilling and operations phase EMBA (155 m^3 spill scenario)

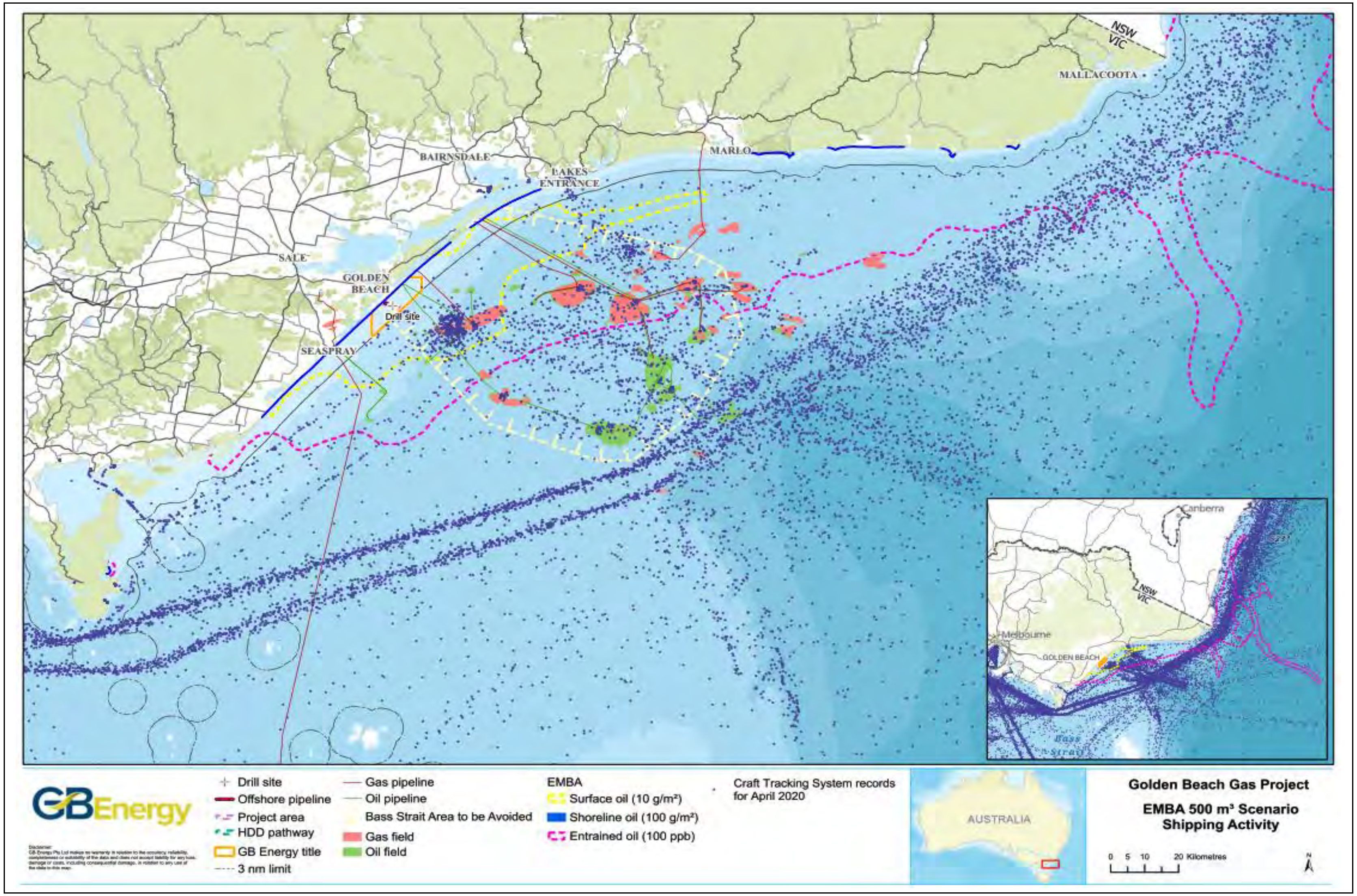
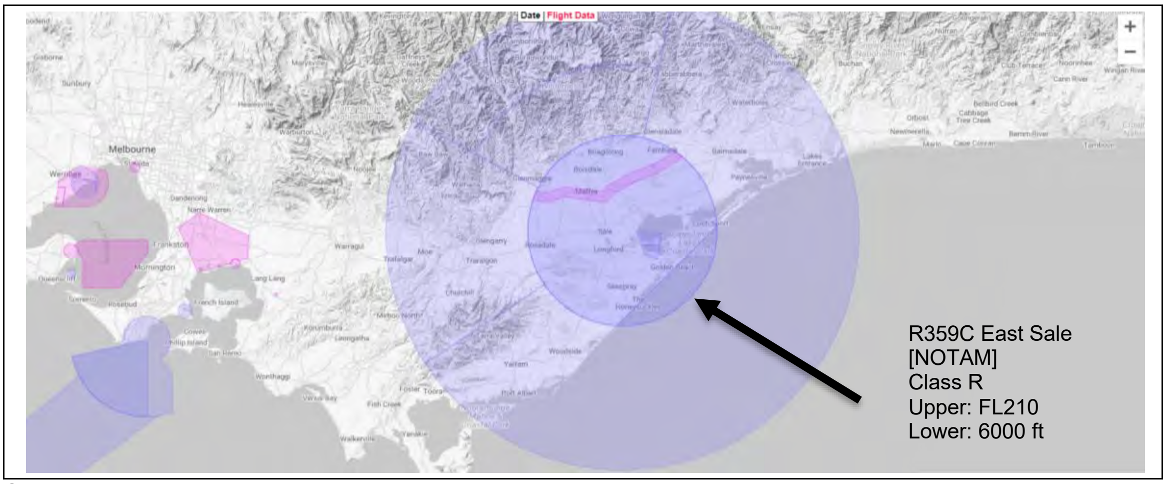


Figure 6.49b. Commercial shipping traffic intersected by the pipeline installation phase EMBA (500 m^3 spill scenario)

6.6.8. Defence Activities

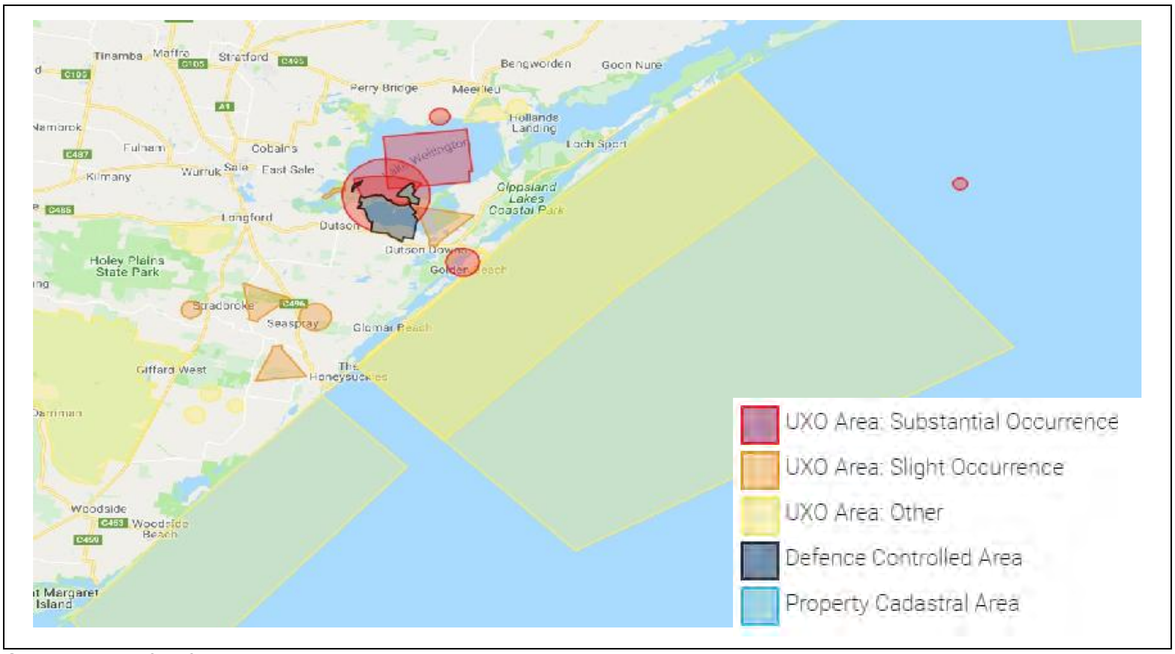
Defence activities that may take place in the region include transit of naval vessels, training exercises, hydrographic surveying, surveillance and enforcement, and search and rescue. There are no defence training areas within the EMBA (DoE, 2015a). The Project area is located beneath Defence Restricted Airspace R359C (Figure 6.50).

The Department of Defence unexploded ordnance database indicates a risk (undefined) of unexploded ordnance in and around the Project area (Figure 6.51).



Source: XcAustralia (2020).

Figure 6.50. Restricted airspace over the Project area



Source: Dept of Defence (2018).

Figure 6.51. Unexploded ordnance risk over the Project area

7. Risk Assessment Methodology

7.1. Overview of methodology

This chapter describes the methodology used for the marine environmental risk assessment. This methodology is consistent with the Australian and New Zealand Standard for Risk Management (*AS/NZS ISO 31000:2018 Risk Management – Principles and Guidelines*).

7.2. Study Area

As noted in Section 6, marine risks have different areas of effect depending on the hazard. For example, the routine discharges of MODUs and vessels have a significantly smaller area of impact (tens to hundreds of metres) than a non-routine hydrocarbon spill resulting from a vessel collision at sea (tens to hundreds of kilometres). Thus, the study area is considered to be the maximum extent of the EMBA by the spill scenarios that were modelled for each phase of the project. The EMBA is outlined in Chapter 6.

7.3. Existing Conditions

As outlined at the start of Chapter 6, multiple data sources were used in preparing this report, including scientific literature, online databases, marine monitoring studies in and around the area conducted by the CSIRO and CarbonNet Project, and a geophysical survey of the Project area conducted by GB Energy. The multitude of different data sources provide information that is collectively sufficient to confidently characterise the environment and conduct the risk assessments presented in Chapters 8, 9 and 10.

7.4. Risk Assessment

The Ministerial guidelines for assessment of the environmental effects under the *Environment Effects Act* 1978 incorporate principles of best practice which include a risk-based approach to ensure that the required assessment, including the extent of investigations, is proportionate to the risk of adverse effects.

The identification of initial risks was undertaken to assess potential risks to the environment arising from the project. Risk levels were categorised as very low, low, medium, high or very high with the initial risk rating assuming standard controls were in place such as legislative requirements.

The results of the initial risk assessment were used as a screening tool to prioritise the key issues for assessment and inform measures to avoid, minimise and manage potential effects. The risk assessment completed for this study is provided as **Appendix 6.**

7.4.1. Risk Assessment Process

The EES risk assessment aimed to:

- Identify the interactions between Project elements and activities and assets, values and uses; and
- Focus the impact assessment and enable differentiation of significant and high risks and impacts from lower risks and impacts.

This section presents an overview of the EES risk assessment process.

7.4.2. Rating Risk

Risk ratings were assessed by considering the consequence and likelihood of an event occurring. In assessing the consequence, the extent, severity and duration of the risks were considered. These are discussed below.

7.4.3. Assigning the Consequence of Risks

'Consequence' refers to the maximum credible outcome of an event affecting an asset, value or use. A consequence framework, as presented in Table 7.1, and consequence criteria, as presented in Table 7.2, were developed for the Project to enable a consistent assessment of consequence across the range of potential environmental effects.

Consequence criteria were assigned based on the maximum credible consequence of the risk pathway occurring. Where there was uncertainty or incomplete information, a conservative assessment was made on the basis of the maximum credible consequence. Consequence criteria have been developed to consider the following characteristics:

- Extent of impact;
- Severity of impact; and
- Duration of threat.

To minimise subjective biases, consequence criteria were developed with reference to:

- Past records;
- Relevant experience;
- Industry practice and experience;
- Relevant published literature;
- Experimental data;
- Quantitative or engineering modelling; and
- Specialist or expert judgement.

Table 7.1 Consequence framework

Level	Qualitative description of biophysical/environmental consequence	Qualitative description of socio-economic consequence
Negligible	No detectable change in a local environmental setting.	No detectable impact on economic, public health and safety, cultural, recreational, aesthetic or social values.
Minor	Short-term, reversible changes, within natural variability range, in a local environmental setting.	Short-term, localised impact on economic, public health and safety, cultural, recreational, aesthetic or social values.
Moderate	Medium-term but limited changes to local environmental setting that are able to be managed.	Medium-term change in quality of economic, public health and safety, cultural, recreational, aesthetic or social values in local setting. Limited impacts at regional level.
Major	Long-term, significant changes resulting in risks to human health and/or the environment beyond the local environmental setting.	Significant, long-term change in quality of economic, public health and safety, cultural, recreational, aesthetic or social values at local, regional and State levels. Limited impacts at national level.
Severe	Irreversible, significant changes resulting in widespread risks to human health and/or the environment at a regional scale or broader.	Significant, permanent impact on regional economy, public health and safety and/or irreversible changes to cultural, recreational, aesthetic or social values at regional, state and national levels.

Table 7.2. Consequence criteria

	Negligible	Minor	Moderate	Major	Severe
Ecosystem function	Ecosystem change not detectable outside natural variation/ occurrence.	Measurable changes to the ecosystem components with a minor change in function (no loss of components or introduction of new species that affects ecosystem function).	Measurable changes to the ecosystem components with a moderate change in function (some loss of components or introduction of new species that affects ecosystem function).	Measurable changes to the ecosystem components with a major change in function.	Long-term and possibly irreversible damage to one or more ecosystem functions.
Threatening processes	No exacerbation of a threatening process.	Exacerbation of threatening process leading to impacts to associated ecological values within the Project study area.	Exacerbation of threatening process leading to impacts to associated ecological values outside the Project area.	Exacerbation of threatening process leading to impacts to associated ecological values within the bioregion.	Exacerbation of threatening process leading to impacts to associated ecological values at the State and/or National level.
Impact on threatened and migratory species	Population change is not detectable outside natural variation.	Detectable population change, but with no impact on population viability.	Detectable population change, with reduction in population viability that is significant at a local level.	Detectable population change, with reduction in population viability that is significant at a bioregional level.	Detectable population change, with reduction in population viability that is significant at a State or Commonwealth level.
Business (commercial fisheries)	On average, impact from the project would result in only the most very marginal businesses becoming unprofitable income in the region.	On average, impact from the project would result in only the most marginal businesses becoming unprofitable in the region.	On average, impact from the project would result in many businesses on the verge of becoming unprofitable in the region.	On average, impact from the project would result in most businesses becoming unprofitable in the region.	On average, impact from the project would result in all businesses becoming unprofitable in the region.

7.4.4. Assigning the Likelihood of Risks

'Likelihood' refers to the chance of an event happening and the maximum credible consequence occurring from that event. The likelihood criteria are presented in Table 7.3.

Table 7.3. Likelihood of an event occurring

Level	Description
Rare	The event may occur only in exceptional circumstances
Unlikely	The event could occur but is not expected
Possible	The event could occur
Likely	The event will probably occur in most circumstances
Almost Certain	The event is expected to occur in most circumstances

7.4.5. Risk Matrix and Risk Rating

Assigning the consequence and risk for each hazard was undertaken by the Principal Environmental Consultant at Aventus Consulting, who has 20 years of experience in undertaking EIA for the upstream petroleum industry. An iterative review of these ratings, along with the EIA itself, was undertaken by a Senior Marine and Freshwater Ecologist, GB Energy's HSE & Regulatory Manager, drilling engineers and pipeline engineer, together with AECOM (as the lead EES Consultant) to ensure that all risks were identified and appropriately addressed.

Risk levels are assessed using the matrix presented in Table 7.4.

The risk is evaluated by 'multiplying' likelihood and consequence. The recommended form of action, escalation and monitoring for each risk level is provided in Table 7.5. Chapter 8 presents the 'initial' rating (pre-treatment) and 'residual' risk rating (with controls adopted) for each risk.

Table 7.4. Risk assessment matrix

		Consequence ratings				
		Negligible	Minor	Moderate	Major	Severe
Likelihood rating	Rare	Very Low	Very Low	Low	Medium	Medium
	Unlikely	Very Low	Low	Low	Medium	High
	Possible	Low	Low	Medium	High	High
	Likely	Low	Medium	Medium	High	Very High
	Almost Certain	Low	Medium	High	Very High	Very High

Table 7.5. Risk treatment action

Risk rating	Treatment action
VERY HIGH The risk is intolerable	• Modify the threat, the frequency or consequence so that the risk is reduced to 'high' or lower. • For an operational activity, the risk shall be reduced as soon as possible, typically within a timescale of not more than a few weeks. • For commercial risks, review the risks and where practicable reduce by additional mitigation measures such as hedging, insurance, etc.
HIGH The risk is tolerable if ALARP	• Repeat threat identification and risk evaluation processes to verify and, where possible, quantify the risk estimation; determine the accuracy and uncertainty of the estimation. • Where the risk ranking is confirmed to be 'high', if practicable, modify the threat, the frequency or consequence to reduce the risk ranking to 'medium' or 'low'. • Where the risk ranking cannot be reduced to 'medium' or 'low', to demonstrate ALARP it is necessary to review if it is reasonably practicable to remove threats, reduce frequencies and/or reduce the severity of consequences, and if it is reasonably practicable, these risk treatment actions shall be applied. If it is not reasonably practicable, no further action is required and ALARP is demonstrated. • For an operational activity, the reduction to 'medium' or 'low' or demonstration of ALARP shall be completed as soon as possible; typically within a timescale of not more than a few months.
MEDIUM The risk is tolerable	• Determine the management plan for the threat to prevent occurrence and to monitor changes that could affect the classification. • Management responsibility must be specified – monitor to determine if risk changes and needs to be reassessed.
LOW The risk is tolerable	• Review at the next review interval. • Manage by routine procedures – reassess at next review.
VERY LOW The risk is tolerable	• Review at the next review interval. • Manage by routine procedures – reassess at next review.

7.4.6. Risk Evaluation

The risk assessment process was used as a screening tool to prioritise potential impact and the subsequent level of assessment undertaken as part of the impact assessment. Where initial risk ratings were found to be 'medium' or higher, options for additional design changes or mitigation and management measures were considered where practicable.

7.4.7. Risk Treatment

Each of the risks identified and evaluated in Chapters 8 to 11 have associated control measures.

Section 3.2 of the EES Scoping Requirements requires that the intended measures for avoiding, minimising, managing and monitoring impacts and risks be addressed (risk treatments). These measures are outlined in:

- Chapter 8 (drilling);
- Chapter 9 (pipelay);
- Chapter 10 (operations); and
- Chapter 11 (decommissioning).

7.4.8. Limitations and Assumptions

The following limitations and assumptions include, but are not limited to:

- Historic database records available for the Project area and surrounds have been included though may not reflect current conditions (though this is largely resolved by using the most recent literature references possible and multiple databases); and
- Conditions in the marine environment, especially nearshore environments, can change quickly (e.g., storms move massive volumes of sediments around, which may expose previously buried reefs), meaning that the conditions described for the EIA may not be the same at the time that the Project proceeds.

Marine investigations such as undertaking seabed habitat assessments (using drop camera, ROV and/or diver survey methods) and collecting water samples to determine the existing conditions within the Project area have not been undertaken. Conducting such studies was not deemed necessary, and is therefore not a limitation, because:

- Geophysical data for the Project area was acquired in March 2020, and provides detailed information on seabed composition and bathymetry, such that the presence or absence of sensitive features is available (i.e., the survey confirms the absence of sensitive features such as rocky reefs and shipwrecks). Seabed grab sampling was also conducted in order to validate the seabed imaging of the Project area.
- The CSIRO provided GB Energy with access to raw seabed data collected at sites in and immediately around the Project area from 2017 to 2020.
- The CarbonNet Project provided GB Energy with access to seabed data collected at sites in and immediately around the Project area in 2017 and 2018.
- OSRA mapping, informed by LiDAR surveys, provides detailed information about seabed conditions within Victorian state waters, including within the Project area.

Even though the habitat mapping by CSIRO and the CarbonNet Project does not cover the entirety of the Project area, the consistency between these datasets, combined with the fact that the OSRA mapping and GB Energy’s geophysical data identifies the dominance of a featureless sandy seabed in the Project area, gives GB Energy confidence that the quantity and quality of data used in this EIA is representative of the Project area and commensurate with the localised and short-term nature of construction activities and the benign nature of the operations phase of the Project.

7.4.9. Stakeholder and Community Engagement

Chapter 5 outlines the issues related to the marine environment raised by the Project stakeholders.

8. Risk Assessment – Drilling and Wellhead Installation

This section describes the risks identified for the drilling and wellhead installation phase of the Project using the methodology described in Chapter 7 of this report.

In accordance with Section 3.1 of the EES Scoping Requirements, this section addresses:

- The potential effects of individual environmental assets as well as having regard to the intended avoidance, mitigation measures;
- The likelihood of adverse effects;
- The likely residual effects, including risks to MNES, that may to occur (assuming the stated avoidance and mitigation measures are implemented);
- The potential for cumulative environmental impacts arising from the impacts of the Project; and
- An analysis of the acceptability of risks to all MNES.

In accordance with of the EES Scoping Requirements, this section presents the risk-based approach outlined in the Ministerial Guidelines and follows the approach outlined in Chapter 4. The section shall (relevant to the drilling and subsea installations phase):

1. Identify **key issues** or risks that the project poses to achieve the draft evaluation objective.
2. Characterise the **existing environment** to underpin impact assessments having regard to the level of risk (addressed primarily in Chapter 6).
3. Assess the **likely effects** of the Project on the existing environment and evaluate their significance.
4. Present design and **mitigation measures** that could substantially reduce and/or mitigate the risk of significant effects. All design and mitigation measures must apply the following mitigation hierarchy with justification of why higher order measures cannot be applied.
    a. Avoidance: measures taken to avoid creating adverse effects on native vegetation and biodiversity values from the outset, such as careful spatial or temporal placement of infrastructure or disturbance.
    b. Minimisation: measures taken to reduce the duration, intensity and extent of impacts that cannot be completely avoided.
    c. Rehabilitation/restoration: measures taken to improve degraded or removed ecosystems following exposure to impacts that cannot be completely avoided or minimised.

    An assessment of residual effects (post-mitigation) and their significance will be required to illustrate the effectiveness of the proposed mitigation measures.
5. Propose **performance objectives** and management measures to evaluate whether the project's effects are maintained within permissible levels and propose contingency approaches if they are not.

In accordance with Chapter 4, this chapter presents the environmental performance objectives (EPO), environmental performance standards (EPS) and measurement criteria required to manage the identified impacts and risks.

The following definitions are used in this section:

- EPO – 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 (i.e., a statement of the environmental objective).
- EPS – a statement of the performance required of a control measure.
- Measurement criteria – defines the measure by which environmental performance will be measured to determine whether the EPO has been met.

This section presents the latest information on the drilling program, noting that more detail will be included in the Drilling EP (for submission to the DJPR ERR Branch under the OPGGS Regulations) and WOMP (for submission to NOPSEMA under the OPGGS Regulations) as more detailed engineering design becomes available.

A summary of the impact and risk ratings for each impact identified and assessed in this chapter is presented in Table 8.1.

Table 8.1. Drilling and wellhead installations environmental risk rating summaries

Risk		Initial risk	Residual risk
1	Seabed disturbance (ecosystem function)	Low	Low
2	Generation of underwater sound – (threatening processes)	Low	Low
	– (threatened and migratory species)	Low	Low
3	Discharge of Drill Cuttings and Muds (threatening processes) – (high exposure)	Medium	Medium
	– (low exposure)	Low	Low
4	Discharge of Cement (threatening processes)	Low	Low
5	Atmospheric emissions (threatening processes)	Low	Low
6	Light emissions – (ecosystem function)	Medium	Low
	– (threatening processes)	Medium	Low
	– (threatened and migratory species)	Medium	Low
7	Discharge of sewage and grey water (ecosystem function)	Low	Low
8	Discharge of cooling and brine water (ecosystem function)	Low	Low
9	Discharge of bilge water and deck drainage (ecosystem function)	Low	Low
10	Accidental overboard release of waste (threatening processes)	Low	Very low

Risk		Initial risk	Residual risk
11	Introduction of IMS – environmental (ecosystem function)	High	Medium
	– business (commercial fisheries)	Medium	Medium
12	Displacement of or interference with third-party vessels – displacement	Low	Very low
	– interference	Low	Low
13	Vessel strike with megafauna – individuals (threatening process)	Low	Low
	– population (threatening process)	Low	Low
14	Accidental bulk discharge of chemicals or hydrocarbons (threatening process)	Low	Very low
15	Diesel spill – Benthic fauna	Low	Low
	– Macroalgal communities	Low	Very low
	– Plankton	Low	Low
	– Pelagic fish	Low	Very low
	– Cetaceans	Low	Low
	– Pinnipeds	Low	Low
	– Marine reptiles	Low	Very low
	– Seabirds	Low	Low
	– Shorebirds	Low	Low
	– Sandy beaches	Low	Low
	– Commercial fisheries	Low	Very low
16	Dry gas release from loss of well containment (ecosystem function)	Very low	Very low
Hydrocarbon spill response activities		Initial risk	Residual risk
17	Relief well drilling (ecosystem function)	Low	Low
	Surveillance and tracking (ecosystem function)	Very low	Very low
	Protection and deflection (ecosystem function) – nearshore habitat	Low	Very low
	– shoreline habitat	Low	Very low
	– fauna disturbance	Low	Very low
	Shoreline assessment and clean-up (ecosystem function) – shoreline habitat	Medium	Low
	Oiled wildlife response (threatened and migratory species) – fauna injury	Low	Very low
	– fauna death	Low	Very low

8.1. Seabed Disturbance

8.1.1. Risk Pathway

The following elements of the activity will result in seabed disturbance:

- MODU positioning – pinning of the jack-up MODU's three legs to the seabed, with the spud cans penetrating the seabed sediments to a depth of up to 3 m (penetration depth is based on jack-up MODU positioning at nearby drill sites in sandy sediments).
- Drilling – the drilling activity will result in the generation of drill cuttings and discharge of cement, which will be deposited either directly at the seabed or settle to the seabed when discharged at the sea surface. Seabed disturbance resulting from the discharge of drilling cuttings and cement is addressed in Section 8.3 and Section 8.4, respectively.
- Subsea production system – the creation of hard substrate through the installation of two subsea wellheads and a trawl guard will provide unique habitat for flora and fauna in an area otherwise dominated by sandy sediments.

Is it not likely that support vessels will anchor on location. Rather, they will use low power while within and around the MODU PSZ, and when undertaking transfers with the MODU, they will use dynamic positioning thrusters to maintain their position.

8.1.2. Known and Potential Environmental Risks

Seabed disturbance has the potential to impact on marine receptors because of:

- Physical removal or disturbance of seabed sediments; and
- Increase in turbidity of the water column near the seabed.
- Physical injury or death of benthic fauna.

The presence of the trawl guard is addressed in Chapter 10 (Operations).

These impacts will result in localised and temporary disturbance, displacement or smothering of benthic habitats and fauna.

The area of benthic habitat that will be disturbed is limited to that of the three spud cans from the MODU and from the area occupied by the wellheads and other subsea installations. The MODU will not move when moving between Golden Beach-2 and Golden Beach-3; rather, the cantilever deck will be 'skidded' out to drill the second well.

At the seabed, the well bore will have a diameter of 36" (920 mm). The spud cans typically have a diameter of 18 m each (an area of 254 m^2). This will result in a total of 762 m^2 of seabed disturbance over three spud can depressions, representing 0.02% of the Project area (which is 3.1 km^2 in size).

There are no listed shipwrecks present within the Project area, so impacts to shipwrecks are not discussed here.

8.1.3. EMBA

The EMBA for seabed disturbance created by MODU positioning is likely to be restricted to the area of each spud can (about 254 m^2). 'Soft pinning' of the MODU is not likely to be required for this Project, as soft pinning is usually only required when a MODU is approaching a platform. As such, furrows in the seabed from soft pinning are unlikely to be created during this phase of the Project.

Receptors that are known to occur or may occur within this EMBA are:

- Benthic species;
- Plankton;
- Demersal species; and
- Pelagic species

8.1.4. Evaluation of Environmental Risks

Physical Removal of Seabed Sediments

Due to the nature of the placement of the MODU and its connection to the seabed through its legs, there will be an unavoidable direct loss of some seabed habitat and sediments. At the drilling location, the geophysical investigations confirm that there are no known sensitive seabed features (such as rocky reef), so MODU positioning will not result in a loss of sensitive or geographically restricted habitats. Disturbance to sponge gardens may occur, though sponges are widely represented in the shallow waters of the surrounding seabed and quick to recolonise, so the temporary loss of any sponges has a negligible consequence.

Surveys of seabed disturbance from anchoring activities indicate that recovery of benthic fauna in soft sediment substrates (such as the sandy seabed that dominates the Project area) occurs between 6 to 12 months after the disturbance was created (URS, 2001). The anchor depression acts as a trap for marine detritus and sand, which will quickly fill and be recolonised by benthic organisms (Currie and Isaac, 2005). The area impacted by spud cans and the well bores is extremely small and will not pose a threat to seabed habitats or fauna communities.

The area that will be disturbed is very small compared with the overall extent of the sandy seabed habitat in the Project area (0.02%) and region in general and consequently, there will be no long-term impacts to the diversity and abundance of benthic fauna, with impacts being extremely localised.

Water Column Turbidity

Some seabed disturbance will occur during jack-up and jack-down of the MODU legs and during the drilling process. This may increase suspended sediment concentrations in the water column, with associated increases in turbidity (and sedimentation). Turbid plumes caused by the MODU legs or the drilling process will be localised to the immediate vicinity of the disturbance area and rapidly dilute as they disperse in tidal and wave driven currents. Localised increased turbidity is likely to be within the limits of natural variability when considering the turbidity created by tides and storm events in the shallow waters of the project area. Temporary increased turbidity would be unlikely to inhibit primary production in marine flora and fauna. Mobile benthic fauna living in sediment (endobenthos) or on sediment (epibenthos) may be temporarily displaced by this turbidity.

Direct Mortality of Benthic Fauna

Mortality of benthic fauna may occur in areas that are directly disturbed by drilling and installation of wellheads, XMT and trawl guard, or disturbed as a result of suspended sediments settling back onto the seabed (i.e., due to smothering). Objects dropped from the MODU or support vessels (e.g., well casing, containers, bins, tools and so forth) may also result in benthic fauna mortality if these objects settle on the seabed.

The sandy habitat that will be disturbed is very small compared with the overall extent of such habitat in the region and consequently, there will be no long-term impacts to the diversity and abundance of benthic fauna populations, with impacts being extremely localised and temporary.

Subsea production equipment

The 36" conductor (and associated wellheads, XMT and trawl guard) that will remain protruding approximately 7 m above the seabed at the completion of drilling provides a hard substrate in a subsea environment otherwise dominated by soft sediments. This hard substrate will provide a hard substrate for the recruitment and settlement of benthic fauna and will provide habitat for marine life which will likely result in a localised increase in biodiversity.

8.1.5. Risks to MNES

Seabed disturbance will not have a significant risk to any MNES, as outlined in Table 8.2.

Table 8.2. Risks to MNES from seabed disturbance

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	There are no benthic species listed as threatened in the Project area.
Listed migratory species (see Section 6.3)	No	Migratory species, if present at the time of MODU jack-up and jack-down, will temporarily transit through the Project area.
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.1.6. Risk Assessment

Table 8.3 presents the risk assessment for seabed disturbance.

Table 8.3. Risk assessment for seabed disturbance

Summary	
Summary of impacts	Removal of and disturbance to seabed sediments. Turbidity of the water column at the seabed.

Extent of impact	Localised – around individual points of disturbance.	
Duration of impact	Temporary – returning to pre-impact condition rapidly.	
Level of certainty of impact	HIGH – the impacts of seabed disturbance are well known.	
Initial mitigation measures		
Performance objective	Performance standard (control)	Measurement criteria
Avoid Avoid physical damage to sensitive habitats (such as rocky reef).	The results of the geophysical and geotechnical (G&G) investigations have been used to inform the MODU location and confirm the drilling locations are free from seabed obstacles.	G&G investigations report verifies the absence of seabed obstacles, with the MODU located in an area free of sensitive habitat.
	Support vessel Masters use bathymetric mapping and Global Positioning System (GPS) to avoid mapped seabed obstacles and monitor vessel clearances to ensure there is clearance at all times between the vessel and the seabed.	Vessel position and water depth is recorded in the navigation data.
	An ROV will be deployed and video used to confirm the MODU positioning and drilling locations are free from seabed obstacles.	ROV operations report verifies that drill locations are free from seabed obstacles.
Avoid objects being dropped overboard.	Large bulky items are securely fastened to or stored on the MODU deck and support vessel decks to prevent loss to sea.	A completed pre-departure inspection checklist verifies that bulky goods are securely sea-fastened.
	A crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects.	Completed handling and transfer procedure checklist, Permit to Work (PTW) and/or risk assessments verify that the procedure is implemented prior to each transfer.
	The crane operators are trained to be competent in the handling and transfer procedure to prevent dropped objects.	Training records verify that crane operators are trained in the loading and unloading procedure.
	Visual inspection of lifting gear is undertaken every quarter by a qualified competent person (e.g., maritime officer) and lifting gear is tested regularly in line with the MODU Planned Maintenance System (PMS).	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.

Restore Large objects dropped overboard will be retrieved wherever possible.	An ROV is deployed to search for (and retrieve, where possible), non-buoyant dropped objects so that there are no obstacles on the seabed at the completion of drilling.	ROV operator logs verify that a survey took place following a non-buoyant dropped object incident.
	Dropped objects left behind at the end of drilling (that cannot be retrieved) will be reported to DJPR (ERR).	Incident report/s verify that the report was issued to DJPR (ERR).
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance objective	Performance standard (control)	Measurement criteria
Minimise		
Seabed disturbance is kept to the minimum area necessary for safe operations.	The MODU will be pinned directly on location and will not undergo soft-pinning, thereby preventing the creation of scour channels in the seabed.	The MODU positioning report confirms direct pinning occurred.
	MODU-specific jack-up procedures are used to ensure compliance with stability criteria and reduce the risk of foundation shift or failure.	The MODU positioning report confirms MODU-specific jack-up procedures were used.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Likely	Low
Environmental Monitoring		
• Post-activity ROV survey for dropped objects.		
Record Keeping		
• G&G investigations report. • MODU-specific jack-up procedures. • MODU positioning report. • Equipment pre-deployment inspections. • Handling and transfer procedure. • Completed handling and transfer checklists. • Crane operator qualification and training records. • PMS records. • PTW records. • Load ratings and load test certificates. • ROV survey footage and operator logs. • Incident reports.		

8.2. Generation of Underwater Sound

8.2.1. Risk Pathway

The following drilling elements will generate underwater sound:

- Drilling – mechanical operation of the drill string, operation of topside equipment such as generators;
- Placement and installation of the MODU;
- Well testing – flaring of gas is estimated as a 12 hour well clean up and then an additional 12 hour flowing period per well;
- Support vessels – engine noise transmitted through the hull and propellers; and
- Helicopter operations – movements within the PSZ (primarily take off and landing).

Drilling

Fixed platforms such as jack-up MODUs have lower radiated sound levels than floating platforms (NCE, 2007). Equipment operating onboard these facilities can contribute to marine environment sound however, airborne and structure-borne (vibration) pathways are considered more significant on floating platforms where equipment can be located below the water line (NCE, 2007).

Underwater noise produced from platforms standing on metal jack-up supports is relatively low given the small surface areas available for sound transmission and also given the location of machinery above the waterline. It is therefore expected that the dominant pathway for sound generation is structure-borne (i.e., vibration from machinery passing through the legs) (NCE, 2007).

There is a paucity of information regarding sound generation from well testing. Jasco Applied Sciences (experts in underwater sound modelling) stated that the sound levels received underwater from well testing depend on many factors, including the height of the flare boom, the angle of the flare boom, the flow rate, its height above sea level and water depth. In general, sound from flaring is considered similar to that from helicopters (McPherson, pers comm., 2020).

Vessel Sound

There will be several support vessel trips per week between the MODU and the supply base, with one support vessel 'on station' close to the MODU at all times for safety purposes. The level of noise generated by the support vessels varies depending on the activity – when idling or moving at low speed, underwater sound generation will be low, whereas while maintaining station beside the MODU when transferring equipment using thrusters, sound will be louder. This is generated from propeller cavitation (the dominant sound source), hydrodynamic flow around the hull and from onboard machinery (Popper *et al*., 2014).

It is unlikely that engine sound levels will be greater than that of any other similarly-sized vessel normally operating in the area (such as vessels supporting the offshore oil and gas operations in the area, recreational vessels, and merchant vessels travelling in the nearby shipping fairway, see Section 6.6.7).

The sound levels and frequency characteristics of underwater sound produced by vessels are related to vessel size and speed. When idle or moving at slow speed within the PSZ, vessels generally emit low-level noise. The typical sound levels generated by vessels are:

- Tugboats, crew boats, supply ships and many research vessels in the 50-100 m size class – 165-180 dB re 1μPa range (Gotz *et al*., 2009);
- Vessels up to 20 m size class – 151-156 dB re 1μPa (Richardson *et al*., 1995);
- Trawlers – peak at around 175 dB re 1μPa (Gotz *et al*., 2009); and
- Large ships – levels exceeding 190 dB re 1μPa (Gotz *et al*., 2009).

Noise from vessels acts to increase the sound in the water column above ambient noise levels. For example, noise emissions from idling vessels are low, however noise from thrusters and strong thrusts from the main engines have been recorded at levels of up to 182 dB re 1μPa at 1 m (McCauley, 1998). Under this mode of operation, McCauley (1998) measured underwater broadband noise of approximately 137 dB re 1μPa at 405 m. Levels of 120 dB re 1 μPa extended for a distance of approximately 3-5 km from the source, depending on water depth, seabed composition and other factors.

Under normal operating conditions when the vessel is idling or moving between sites, vessel noise would be detectable over only a short distance. For example, Woodside (2003) found that vessel noise levels rarely (<1% of the time) exceeded a threshold of 120 dB re 1 μPa (i.e., less than ambient underwater sound intensity in the Project area) from an acoustic monitoring site 5.1 km from the source when a drilling support vessel was holding position using dynamic positioning bow thrusters.

Helicopter Operations

There will be approximately one return helicopter flight each weekday to transport personnel and equipment to the MODU during drilling operations (see Section 3.4.5). Sound emitted from helicopter operations is typically below 500 Hz (Richardson *et al*., 1985).

Sound travelling from a source in the air (e.g., helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface. The received sound level underwater depends on the altitude of the sound source and lateral distance from the receiver, receiver depth, water depth, and other variables. The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles above 13° from the vertical much of the sound is reflected and does not penetrate into the water (Richardson *et al*., 1995; NRC, 2003). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver. This 'zone of ensonification' can be enlarged in rough seas and can also be enlarged in shallow waters (Richardson *et al*., 1995).

Most air traffic supporting offshore installations involves turbine helicopters flying along straight lines. Usually, a helicopter can be heard in air well before and after the brief period it passes overhead and is heard underwater. Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. The peak received level diminishes with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude. Richardson et al (1995) reports figures for a Bell 214 helicopter (considered to be one of the loudest) being audible in air for four minutes before it passed over underwater hydrophones but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth.

8.2.2. Known and Potential Environmental Risks

The impacts and risks resulting from underwater sound are generally well understood with regard to potential mortality and/or physiological injury for cetaceans and fish, with lower levels of certainty for pinnipeds, benthic invertebrates and plankton. There is scientific uncertainty in understanding the spatial and temporal extents of behavioural disturbances and the potential effects on populations. The potential environmental impacts to marine fauna from underwater sound are:

- Physical injury to auditory tissues or other air-filled organs;
- Hearing impairment, categorised as:
  - Temporary threshold shift (TTS) – the temporary loss of hearing sensitivity caused by excessive noise exposure.
  - Permanent threshold shift (PTS) – a permanent loss of hearing sensitivity caused by excessive noise exposure, considered an auditory injury.
- Direct behavioural effects through disturbance or displacement, and consequent disruption of natural behaviours or processes (e.g., migration, resting, calving or spawning); and
- Indirect behavioural effects by impairing/masking the ability to navigate, find food or communicate, or by affecting the distribution or abundance of prey species.

Specifically, underwater sound has the potential to adversely affect the following environmental values and sensitivities within and in the vicinity of the project area, to varying degrees:

- Plankton (including commercially important fish larvae/eggs);
- Marine invertebrate assemblages (such as molluscs and crustaceans);
- Fish:
  - Mobile pelagic and demersal species that are likely to move away from the source as sound levels increase.
  - Site-attached/dependent fish species associated with reef habitats. These species are less likely to move away from the sound source and are expected to seek shelter within reef areas.
- Cetaceans:
  - Migrating and transient whales known to occur in the region (e.g., pygmy blue whales);
  - Dolphin species known to occur in the region (e.g., common dolphin).
- Pinnipeds - foraging habitat for the Australian and New Zealand fur-seals;
- Foraging habitat for seabirds (including penguins) and shorebirds;
- Target species for commercially important fisheries known to operate in and around the Project area (e.g., shark); and
- Environmental values of nearby marine parks.

The potential impacts on individual animals from exposure to elevated sound levels above ambient sound levels in a given area depends on a number of factors, including the extent of sound propagation underwater, its frequency characteristics and duration, its distribution relative to the location of the organisms, the sensitivity and range of spectral hearing among species (Carroll *et al*., 2017). Noise sources from drilling operations are continuous broadband (rather than impulsive sound such as from seismic surveys or piling) and as such, impacts are related mostly to behavioural disturbances rather than injury or mortality.

The marine species most at risk from acoustic disturbance from drilling (and related) operations are generally species that hear and communicate in a similar low frequency range to the range of sounds produced (particularly baleen whale species).

8.2.3. EMBA

The EMBA for underwater sound varies from tens of metres to several hundred metres from the sound sources, dependent on the species and associated thresholds, as outlined in this section.

Receptors that are known to occur or may occur within the underwater sound EMBA, either as residents or migrants, are:

- Benthic species;
- Pelagic species (plankton, fin fish);
- Marine turtles;
- Cetaceans; and
- Pinnipeds.

8.2.4. Evaluation of Environmental Risks

Activities that generate underwater sound can affect marine fauna by interfering with aural communication, eliciting changes in behaviour and, potentially, causing either acute or chronic physiological damage. Various studies have investigated the effects of seismic sound upon a range of marine biota and generally concluded that, although a sound source may pose a potential risk to individuals in very close proximity to the source, the transitory nature of seismic operations and the limited range over which possible effects can occur make it unlikely that seismic noise poses a significant hazard to populations of marine species (McCauley *et al*., 2000a; Wardle *et al*., 2001; Gausland, 2000; Thomson *et al*., 2014). Similarly, the underwater sound generated during this phase of the Project will be transitory in nature and generate a limited range over which possible effects can occur.

The information box below describes how underwater sound is measured and referenced.

The ***decibel (dB)*** *scale is a logarithmic scale that expresses the ratio of two values of a physical quantity. It is used to measure the amplitude or 'loudness' of a sound. As the dB scale is a ratio, it is denoted relative to some reference level, which must be included with dB values if they are to be meaningful. The reference pressure level in underwater acoustics is 1 micropascal (µPa), whereas the reference pressure level used in air is 20 µPa, which was selected to match human hearing sensitivity.*

As a result of these differences in reference standards, sound levels in air are not equal to underwater levels.

There are four main metrics for underwater sound (ISO/DIS 18405.2:2017):

- *Zero-to-peak sound pressure (PK), the greatest magnitude of the sound pressure during a specified time interval, unit: dB re 1 µpa;*
- *Peak-to-peak sound pressure (PK-PK), sum of the peak compressional pressure and the peak rarefactional pressure during a specified time interval, unit: dB re 1 µpa;*
- *Root-mean-square (rms) 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, unit: dB re 1 µpa; and*
- *Sound exposure level (SEL), a measure related to the sound energy in one or more pulses, or the ratio of the time-integrated squared sound pressure to the specified reference value, unit: dB re 1 µpa2·s.*

SEL is specified in terms of either per-impulse (per-pulse) or accumulation period. In this report, the accumulation period applied is 24 hours, and therefore the SEL is referred to as *either per-impulse SEL or SEL_{24h}.*

Source level is a measure of sound at a nominal distance of 1 m from a theoretical point source that radiates the same total sound power as the actual source. It can be expressed as an SPL, SEL or PK. Unit: dB re 1 µPa @ 1 m or dB re 1 $µPa^2·s$.

Given the multiple measures commonly used to express sound levels, it's important to ensure any comparisons between specific sound level values are made using the same measures.

Impact Assessment based on Activity-specific Research

Drilling

Gales (1982), cited in NCE (2007), reports that underwater sound measured from platforms did not exhibit markedly different characteristics from those engaged in production, and that none of the measured sound could be directly related to the mechanical action of the drill bits. It is therefore believed that most sound associated with drilling is created by the operation of the MODU itself (and sound radiated through the MODU structure).

In the same study (Gales, 1982; cited in Richardson *et al*., 1995) it was identified that platform noise was so weak that it was nearly undetectable even when alongside the platform during sea states ≥ 3. At the near-field measurement locations (ranges 9–61 m), the received sound levels were 119-127 dB re 1µPa (Richardson *et al.*, 1995).

Studies performed on the Spartan 151 jack-up MODU in Alaska's Cook Inlet (water depths 18-37 m) verified the underwater acoustic levels as a function of range from the MODU (Marine Acoustics, 2011). Primary sources of MODU-based acoustic energy were identified as originating from the diesel engines, mud pump, ventilation fans and electrical generators. The study identified maximum sound levels were periodic (impulsive <1 second) with received levels at approximately 127 dB re 1µPa to a maximum range of 1.2–1.4km in the frequency range 8.9- 44.7 Hz. Levels in the infrasonic band (i.e., frequencies <20 Hz) between 8.9–11.2 Hz and 11.2–14.1 Hz infrequently exceeded 120 dB re 1µPa at ranges less than 1.7 km and never more than 1 second at a time.

Sound generation and frequency bands from the operation and drilling activities associated with the MODU would be expected to be similar to the sound levels described above (especially given the similar water depths) and to the sound levels emitted from the existing Bass Strait oil and gas production platforms.

On this basis, emissions predominantly below 120 dB re 1µPa with non-continuous (less than 1 second) levels exceeding this to a range of approximately 1.4 km in the frequency band 8.9 Hz to 44.7 Hz (infrasonic and low frequency) as measured in that study is expected to be indicative of the low frequency sound levels emitted by the MODU during drilling activities. This sound level is lower than the recorded ambient sound in the activity area (that varies from a minimum of 148 dB re $1µPa^2$.s SEL to a maximum of 163 dB re $1µPa^2$.s SEL) and is therefore likely to have a negligible impact on marine fauna, regardless of the species, time of year and activity (e.g., foraging, migrating, breeding).

Vessel sound

Noise from vessels acts to increase the sound in the water column above ambient noise levels. For example, noise emissions from idling vessels are low, however noise from thrusters and strong thrusts from the main engines have been recorded at levels of up to 182 dB re 1µPa at 1 m (McCauley, 1998). Under this mode of operation, McCauley (1998) measured underwater broadband noise of approximately 137 dB re 1µPa at

405 m. Levels of 120 dB re 1 µPa extended for a distance of approximately 3-5 km from the source, depending on water depth, seabed composition and other factors.

Under normal operating conditions when the vessel is idling or moving, vessel noise would be detectable over only a short distance. For example, Woodside (2003) found that vessel noise levels rarely (<1% of the time) exceeded a threshold of 120 dB re 1 µPa (i.e., less than ambient underwater sound intensity in the area) from an acoustic monitoring site 5.1 km from the source when a drilling support vessel was holding position using dynamic positioning bow thrusters. Underwater sound generated by the support vessels is therefore considered to be of negligible consequence to ecosystem function and to threatened and migratory marine fauna.

Jasco Applied Sciences undertook modelling an offshore support vessel 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. These results are also seen as being applicable to the MODU as the noise levels from the support vessel are greater than the MODU (support vessel - 137 dB re 1 µPa, at 405 m, MODU 136.3 dB re 1µPa at 100 m).

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

Though the water depths at the modelled locations for both the Woodside and Shell projects are significantly deeper than at the Golden Beach drilling locations (83 m to 105 m), this would lead to an overestimate of the received noise levels based as propagated noise levels are higher in deeper water than shallow water.

The results of the Woodside modelling can be applied to the Golden Beach drilling with confidence as they:

- Are in deeper water and hence are an overestimate in the distance to received levels; and
- Used a source level of 183 dB re 1 µPa @ 1 m, which is at the higher range of source level for a DP vessel based on support vessels being able to 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).

<u>Helicopter operations</u>

Because helicopters have the ability to divert course and directly approach marine fauna, they have the potential to cause distress to marine fauna.

Based on Richardson et al (1995) reporting figures for a Bell 214 helicopter (considered to be one of the loudest) being audible in air for four minutes before it passed over underwater hydrophones but detectable underwater for only 38 seconds (at 3 m depth) and 11 seconds (at 18 m depth), this means that as a conservative case, helicopter sound may be audible underwater for up to two minutes per day based on one return flight per day to and from the MODU. Based on this short time of audibility underwater (0.14% of a day), underwater sound generated from helicopter movements is considered to be of negligible consequence to marine fauna.

Impact Assessment based on Species-specific Research

<u>Cetaceans</u>

Marine mammal species evolved from terrestrial mammals and share basic hearing anatomy and physiology with their terrestrial ancestors. Marine mammals, however, have broader hearing frequency ranges due to the much higher sound speed underwater compared to in air. Odontocetes (toothed whales and dolphins) hear best at higher frequencies, generally in the ultrasonic range (>20,000 Hz), with no responsive hearing below 500 Hz (0.5 kHz). Mysticetes (baleen whales, such as humpbacks and southern right whales) hear better at lower frequencies (Wartzok & Ketten, 1999; Mooney *et al*., 2012), generally at infrasonic frequencies as low as 10-15 Hz (APPEA, 2004). The optimal hearing frequency range for baleen whales is between ~20 and 1,000 Hz (McCauley *et al*., 1994).

Sound is very important to whales and dolphins for effective hunting, navigation and communication. Mysticetes communicate at low frequencies (20 Hz to approximately 5 kHz) using predominantly tonal type calls. Odontocetes communicate using both tonal signals (up to approximately 30 kHz) and echolocation clicks (peak frequencies range from approximately 40 – 130 kHz), which they also use for hunting and navigation (Au *et al*., 2000).

The type and scale of the effect on cetaceans from underwater sound depends on a number of factors including the level of exposure, the physical environment, the location of the animal in relation to the sound source, how long the animal is exposed to the sound, the exposure history, how often the sound repeats (repetition period) and the ambient sound level. The context of the exposure plays a critical and complex role in the way an animal might respond (Gomez *et al*., 2016; Southall *et al*., 2016).

High levels of anthropogenic underwater noise can have potential effects on cetaceans ranging from changes in their acoustic communication, behavioural disturbances and in more severe cases physical injury or mortality (Richardson *et al*., 1995), as described herein.

Physiological risks

Physiological impacts such as physical damage to the auditory apparatus (e.g., loss of hair cells or permanently fatigued hair cell receptors), can occur in marine mammals when they are exposed to intense or moderately intense sound levels and could cause permanent or temporary loss of hearing sensitivity. While the loss of hearing sensitivity is usually strongest in the frequency range of the emitted noise, it is not limited to the frequency bands where the noise occurs but can affect a broader hearing range. This is because animals perceive sound structured by a set of auditory bandwidth filters that proportionately increase in width with frequency.

A TTS is hearing loss from which an animal recovers, usually within a day at most, whereas PTS is hearing loss from which an animal does not recover (permanent hair cell or receptor damage). The severity of TTS is expressed as the duration of hearing impairment and the magnitude of the shift in hearing sensitivity relative to pre-exposure sensitivity, in dB. TTS occurs at lower exposure levels than PTS. The cumulative effects of repeated TTS, especially if the animal receives another sound exposure near or above the TTS threshold before recovering from the previous sensitivity shift, could cause PTS. If the sound is intense enough, an animal could succumb to PTS without first experiencing TTS (Weilgart, 2007). Though the relationship between the onset of TTS and the onset of PTS is not fully understood, a specific amount of TTS can be used to predict sound levels that are likely to result in PTS. For example, in establishing PTS thresholds, Southall et al (2007) assume that PTS occurs with 40 dB of TTS. While there are results from TTS and PTS studies on odontocetes exposed to impulsive sounds (Finneran, 2016), there is no data for mysticetes.

Based on the Woodside (2019), a TTS criteria of 153-179 SEL applied to cetaceans (low-, mid- and high-frequency cetaceans) would be reached at 400 m from a support vessel (an area of 0.5 km^2), noting that this is conservative for the Golden Beach drilling (i.e., an over-estimate) because the Project area's shallower waters means sound is attenuated faster than in deeper waters. Therefore, the risk of TTS for cetaceans resulting from vessel activities is low.

Based on Woodside (2019), a PTS criteria of 173-199 SEL applied to cetaceans (low-, mid- and high-frequency cetaceans) would be reached at 60 m from a support vessel (an area of 0.01 km^2), noting that this is conservative for the Golden Beach drilling (i.e., an over-estimate) because the Project area's shallower waters means sound is attenuated faster than in deeper waters. Therefore, the risk of TTS for cetaceans resulting from vessel activities is very low.

Behavioural risks

A secondary concern arising from sound generation is the potential non-physiological effects on cetaceans including:

- Increased stress levels;
- Disruption to underwater acoustic cues;
- Masking;
- Behavioural changes; and
- Displacement.

These aspects are discussed further in this section.

Behavioural responses to underwater sound are difficult to determine because animals vary widely in their response type and strength, and the same species exposed to the same sound may react differently (Nowacek *et al*., 2004; Gomez *et al*., 2016; Southall *et al*., 2016). An individual's response to a stimulus is influenced by the context in which the animal receives the stimulus and how relevant the individual perceives the stimulus to be. A number of biological and environmental factors can affect an animal's response—behavioural state (e.g., foraging, travelling or socialising), reproductive state (e.g., female with or without calf, or single male), age (juvenile, sub-adult, adult), and motivational state (e.g., hunger, fear of predation, courtship) at the time of exposure as well as perceived proximity, motion and biological meaning of the sound and nature of the sound source.

Animals might temporarily avoid anthropogenic sounds but could display other behaviours such as approaching novel sound sources, increasing vigilance, hiding and/or retreating, that might decrease their foraging time (Purser & Radford, 2011). Some cetaceans might also respond acoustically to seismic survey noise in a range of ways, including by increasing the amplitude of their calls (Lombard effect), changing their spectral (frequency content) or temporal vocalisation properties, and in some cases, cease vocalising (McDonald *et al*., 1995; 2007; Parks *et al*., 2007; Di Ioro & Clark, 2010; Castellote *et al*., 2012; Hotchkin & Parks, 2013; Blackwell *et al*., 2015). Masking can also occur (Erbe *et al*., 2015).

The BRAHSS (Behavioural Response of Australian Humpback whales to Seismic Surveys) project conducted studies at Peregian Beach, Qld, and Dongara, WA, to better understand the behavioural responses of humpback whales to noise from the operation of seismic air gun arrays (Cato *et al*., 2013). Results from the first sets of experiments have been published (Dunlop *et al*., 2015; 2016; Godwin *et al*., 2016), together with concurrent studies of the effects of vessel noise on humpback whale communications (Dunlop, 2016). In most exposure scenarios, a distance increase from the sound source was observed and interpreted as potential avoidance. The study, however, found no difference in the 'avoidance' response to either ‘ramp-up’ or the constant source producing sounds at a higher level than early ramp-up stages. In fact, a small number of groups showed inspection behaviour of the source during both treatment scenarios. ‘Control’ groups also responded, which suggested that the presence of the vessel alone had some effect on the behaviour of the whales. Despite this, the majority of groups appeared to avoid the survey vessel at distances greater than the radius of most injury-based mitigation zones.

Small odontocetes responded to airgun sounds by moving laterally away from the sound, showing the strongest lateral spatial avoidance, compared to mysticetes and killer whales that showed more localised spatial avoidance. Other larger odontocetes studied included long-finned pilot whales (*Globicephala melas*) which only changed their orientation in response to sound exposure, while sperm whales did not significantly avoid the sound (Stone & Tasker, 2006).

Southall et al (2007) extensively reviewed marine mammal behavioural responses to sounds as documented in the literature. Their review found that most marine mammals exhibit varying responses between an SPL of 140 and 180 dB re 1 µPa, but a lack of convergence in the data from multiple studies prevented them from suggesting explicit criteria. The causes for variation between studies included lack of control groups, imprecise measurements, inconsistent metrics, and context dependency of responses including the animal’s activity state.

Pygmy blue whales. There are very few peer-reviewed papers that examine the responses of blue or pygmy blue whales to underwater sound. The only study that specifically examines responses from seismic sound was that from Di Ioro & Clark (2010), who found that blue whales increased their discrete, audible calls during a seismic survey.

Numerous seismic surveys have occurred along the Bonney coast (off southwest Victoria) since the Blue Whale Study was initiated in 1998. The Blue Whale Study uses aerial surveys to assess distribution and migration movements of marine mammals, with particular attention to great whales, in Bass Strait and the Otway Basin. Aerial surveys of blue whale distributions during seismic activities have observed the following:

- In February 2011, during the blue whale peak migration period, aerial surveys (conducted by Origin) observed only a single blue whale within the Astrolabe 3DMSS (Otway Basin), and eight blue whales within a 10 km buffer area around the survey area. The total number of blue whale sightings during the February 2011 aerial surveys was 51, of which 42 were located outside the 10 km buffer around the Astrolabe study area. Blue whales continued feeding behaviour at a distance of approximately 30 km from the seismic vessel, irrespective of the seismic operations.
- Morrice et al (2004) stress that the proximity of whales to seismic vessels must be interpreted in the context of their pressing need to consume tonnes of food per day. Blue whales may need to feed into their zone of acoustic discomfort if the only krill available is in proximity to a seismic vessel. Blue whales have been sighted within approximately 2.4 km of an active seismic source array and cow and calf pairs, which are considered the most sensitive of whale aggregations, were recorded within 7.1 km (Morrice *et al*., 2004).
- In December 2003, Santos carried out a 2D seismic survey (3,150 cui source size) in EPP32 west of Kangaroo Island (SA) where blue whales were observed. Some of the whales approached as close as 2.4 km to the operating seismic source, feeding on dense krill swarms.

- During a seismic survey in VIC/P51 in November 2003, blue whales were sighted near krill swarms approximately 18 km from the seismic vessel and left the area as the vessel approached closer. It is unknown if the approach of the vessel triggered the whales to move from the area.
- During November-December 2002, Santos conducted 2D and 3DMSS in VIC/P51 and VIC/P52 (3,150 cui source size) with no blue whale sightings within 60 km of the operating seismic vessel.
- During the 1999-2000 season, Woodside conducted a 3DMSS in VIC/P43 (2,250 cui sound source). During aerial surveys, no blue whales were sighted within 90 km of the operating seismic vessel, despite abundant krill surface swarms in the area.
- Aspects of the seismic survey that may affect whales (e.g., vessel movements and associated seismic sound) will be transitory at any given location as the vessel traverses the acquisition area at a rate of approximately 6 knots (11 km/hr) and will potentially involve only very temporary and localised exposure. It is considered unlikely that any marine mammals will be exposed to levels likely to cause physiological damage because of their ability to avoid the vessel and seismic source array (McCauley, 1994).

Given these observations and information regarding physiological and behavioural impacts of cetaceans with regards to MODU and support vessel sound, it is highly unlikely that drilling will create anything other than avoidance behavioural in a highly localised area for a very short amount of time.

Southern right whales. The closest known calving/nursery grounds to the Project area occurs at Logan's Beach off the southwest Victorian coast (approximately 433 km west of the Project area). Southern right whales have not been recorded in the VBA search for the Project area and have been recorded 41 times in the EMBA.

If southern right whales are migrating along this part of the Gippsland coast during the drilling campaign, based on the literature summarised above, it is possible that they will experience masking of their communications, and perhaps exhibit avoidance. Any localised avoidance could plausibly add a few kilometres to their migration. Such a marginal increase is not considered likely to significantly affect the metabolic demands of individuals whose migrations occur over thousands of kilometres.

All species of large whales, except Bryde's whale, are known to have populations that migrate from winter breeding grounds in the tropics to summer feeding grounds in the Antarctic (Kasamatsu & Joyce, 1995; Kasamatsu *et al*., 2000). In common with other large whales that feed within Antarctic waters during the Austral summer, the southern right whale has evolved within, and annually enters, an environment with a ubiquitous natural source of low frequency sound.

Humpback whales. While the migration BIA for humpback whales is 350 km northeast of the Project area, there are occasional sightings of humpback whales in Gippsland from the shore, helicopters, vessels and oil and gas production platforms associated with Esso's production facilities. Humpback whales have not been recorded in the VBA search for the Project area and have been recorded 44 times in the EMBA. Esso advises that the period from September to November usually results in the most sightings of humpback whales from their facilities (Bok, pers. comm., March 2017).

Humpback whales have not been observed to be significantly displaced from their migratory pathways as a result of seismic sound, with the most consistent observed response to seismic activity being an alteration of course and swimming speed (McCauley *et al*., 2000a). The BRAHSS experiment previously described found that in most exposure scenarios, a distance increase from the sound source was observed and interpreted as potential avoidance behaviour. As such, the low sound source from drilling is highly unlikely to result in TTS or PTS in humpback whales.

Sei whale. This species is known to prefer deep offshore waters with no known mating or calving areas in Australian waters. As such, underwater sound is highly unlikely to impact on this species.

Fin whale. This species is known to prefer deep offshore waters and are considered rare in Australia. As such, underwater sound is highly unlikely to impact on this species.

Dolphins. The small oceanic dolphins that occur in the area (such as the common dolphin *D. delphis*) have very broad distributions and habitat requirements. Dolphins often ride the bow waves of vessels (Bannister *et al*., 1996, Perrin, 1998; Ross, 2006; Hawkins & Gartside, 2009; Barkaszi *et al*., 2012; Barry *et al*., 2012), indicating a tolerance to sound from vessels.

Burrunan dolphins (*Tursiops australis*), present in the Gippsland Lakes and Port Phillip Bay, are unlikely to be impacted by the activity for the same reasons (in the event that individual dolphins are swimming between the Gippsland Lakes and Port Phillip Bay at the time of the activity). The resident population in the Gippsland Lakes will not be exposed to underwater sound, as the coast provides a barrier to sound transmission between the ocean and the lakes.

<u>Pinnipeds</u>

Pinnipeds (seals and sea lions) produce sounds over a generally lower and more restricted bandwidth (generally from 100 Hz to several tens of kHz) than cetaceans. Their sounds are used primarily in critical social and reproductive interactions (Southall *et al*., 2007). Most pinniped species have peak sensitivities between 1 and 20 kHz (NRC, 2003).

Pinnipeds are divided into two groups:

- Otariid pinnipeds – fur seals and sea lions ('eared' seals, using foreflippers for propulsion). This is the group of seals present in Bass Strait.
- Phocid pinnipeds – true seals ('earless' species).

Pinnipeds may tolerate sound pulses of high intensity and may be able to approach operating equipment to a close range because their hearing is poor in low frequencies (McCauley, 1994). However, it is also suggested that underwater sound from seismic surveys may affect pinniped prey abundance or behaviour, particularly if the seismic survey runs for long periods.

Fur seals are less sensitive to low frequency sounds (<1 kHz) than to higher frequencies (>1 kHz). McCauley (1994) suggests that the sound frequency of seismic air gun pulses is below the greatest hearing sensitivity of Otariid pinnipeds, but data is lacking for Australian species. Aerial sounds produced by the Australian fur-seal (*Arctocephalus pusillis*) have strong tonal components at frequencies that are less than 1 kHz, although they all range up to 6 kHz with most energy between 2-4 kHz. If the low frequency components of calls are used, then seals may also hear at low frequency and may be affected by seismic source pulses. However, Shaughnessy (1999) states that seismic activity will only be a threat to pinnipeds if it takes place close to critical habitats.

Gotz et al (2009) reports that controlled exposure experiments with small airguns (215 – 224 dB re 1 μPa) were carried out over 1 hour to individual harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*), and in seven out of eight trials with harbour seals, the animals exhibited strong avoidance reactions. Two harbour seals equipped with heart rate tags showed immediate, but short-term, startle responses to the initial airgun pulses. The behaviour of all harbour seals seemed to return to normal soon after the end of each trial, even in areas where disturbance occurred on several consecutive days. Only one harbour seal showed no detectable response to the airguns and approached the airgun to within 300 m, and seals remaining in the water returned to pre-trial behaviours within two hours of the end of the experiment (Gotz *et al*., 2009). General avoidance behaviour of other northern hemisphere seal species was exhibited at exposure levels above 170 dB re 1 μPa.

Fish, being the key prey of pinnipeds, are not likely to be impacted in the long-term by drilling. As such, there are not likely to be significant consequences to the foraging habits of fur-seals. Additionally, the Project area is located a significant distance from known breeding areas of the Australian fur-seal and New Zealand fur-seal, meaning that any underwater sound from drilling will have negligible impacts on pinnipeds.

Risks to Benthic Invertebrates

Scallops are present only as isolated individuals (not commercially exploitable beds) in and around the Project area. The nearest isolated rocky reef habitat occurs about 1.5 km to the southwest of the proposed drill site, and this may or may not provide habitat for southern rock lobsters (see Section 6.3.1). These are the marine invertebrates of greatest commercial importance in the region. As such, the potential impacts of drilling-related sound to benthic invertebrates are not considered here.

The impact assessment on benthic invertebrates contained within the accepted Pelican 3D marine seismic survey Environment Plan (which was conducted in February 2018 over the Project area) concluded that, if scallop beds were present (which habitat assessments confirmed do not exist) and if rock lobsters were present, the impacts of the seismic source (an impulsive sound source of far higher intensity than drilling and vessel sound) would be minor. Therefore, it is concluded that the impacts due to the sound sources from drilling will be negligible.

8.2.5. Risks to MNES

Underwater sound will not have a significant risk to any MNES, as outlined in Table 8.4.

Table 8.4. Risks to MNES from underwater sound

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species, particularly whales, will not be significant given the temporary nature of sound generation, that TTS and PTS is not expected other than at extremely close range to the sound source, the seasonality
Listed migratory species (see Section 6.3)	No	

MNES	Impact?	Notes
		of whale presence, their temporary presence in the area and the ability of whales to move away from the sound source.
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

Underwater sound from drilling will not have a 'significant' impact on threatened (endangered or vulnerable) marine fauna species when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), which are:

- Lead to a long-term decrease in the size of a population – NO.
- Reduce the area of occupancy of the species – NO.
- Fragment an existing population into two or more populations – NO.
- Adversely affect habitat critical to the survival of a species – NO.
- Disrupt the breeding cycle of a population – NO.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline – NO.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat – NO.
- Introduce disease that may cause the species to decline – NO.
- Interfere with the recovery of the species – NO.

8.2.6. Risk Assessment

Table 8.5 presents the risk assessment for underwater sound impacts to marine fauna and avifauna.

Table 8.5. Underwater sound risk assessment – biological receptors

Summary		
Summary of impacts	Physiological or pathological impacts to local populations of marine fauna and avifauna.	
Extent of impact	Up to several hundred metres depending on the source of sound.	
Duration of impact	Very short-term (several minutes for helicopters) to the duration of drilling (support vessel movements, drilling sound).	
Level of certainty of impact	Moderate to high.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria

Minimisation		
Cetaceans continue to use the area for migration and foraging without injury.	Support vessel crews will implement EPBC Regulations 2000 (Part 8, Division 8.1), embodied in The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017), which means maintaining watch for cetaceans such that: • Caution zone (300 m either side of observed whales and 150 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone.	Daily Drilling Reports (DDRs) note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision.
	• No approach zone (100 m either side of observed whales and 50 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone and should not enter this zone and should not wait in front of the direction of travel or an animal or pod/group. • Do not encourage bow riding. • If animals are bow riding, do not change course or speed suddenly. • If there is a need to stop, reduce speed gradually.	
	Selected vessel crews have completed an environmental induction covering the above-listed requirements.	Induction records verify that support vessel crews have completed an environmental induction.
	The duration of well testing (flaring) is kept to the shortest time possible, in accordance with the Well Test Plan. Well testing duration is 12 hours for clean-up and 12 hours for flow period.	The DDRs note the total duration of flaring.

Risk assessment (initial)			
Consequence (threatening processes)		Likelihood	Risk rating
Negligible – all fauna groups		Almost certain	Low
Consequence (impact on threatened and migratory species)		Likelihood	Risk rating
Cetaceans	Negligible	Almost certain	Low
Fish	Negligible	Almost certain	Low
Turtles	Negligible	Almost certain	Low
Avifauna	Negligible	Almost certain	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
MODU and vessel power generation and propulsion systems are well maintained.	Engines and thrusters are maintained in accordance with the respective PMS to ensure they are operating efficiently.	PMS records verify that engines and thrusters are maintained to schedule.

<table>
<tr><th colspan="4">Risk assessment (residual)</th></tr>
<tr><td colspan="2">Consequence (threatening processes)</td><td>Likelihood</td><td>Risk rating</td></tr>
<tr><td colspan="2">Negligible – all fauna groups</td><td>Likely</td><td>Low</td></tr>
<tr><td colspan="2">Consequence (impact on threatened and migratory species)</td><td>Likelihood</td><td>Risk rating</td></tr>
<tr><td>Cetaceans</td><td>Negligible</td><td>Likely</td><td>Low</td></tr>
<tr><td>Fish</td><td>Negligible</td><td>Likely</td><td>Low</td></tr>
<tr><td>Turtles</td><td>Negligible</td><td>Likely</td><td>Low</td></tr>
<tr><td>Avifauna</td><td>Negligible</td><td>Likely</td><td>Low</td></tr>
<tr><th colspan="4">Environmental Monitoring</th></tr>
<tr><td colspan="4">• Cetacean observations.</td></tr>
<tr><th colspan="4">Record Keeping</th></tr>
<tr><td colspan="4">• Environmental induction presentation and attendance records.
• Engine and thruster PMS records.
• DDRs.
• Incident reports.</td></tr>
</table>

8.3. Discharge of Drill Cuttings and Muds

8.3.1. Risk Pathway

Cuttings (and adhered fluids) are discharged directly to the seabed during riserless drilling and discharged from the MODU to the sea surface while drilling with the riser connected.

Cuttings and adhered muds disposed from the MODU form a turbid plume, within which the larger particles (90-95%) fall to the seabed close to the discharge point, while the finer particles form an upper plume before dispersing, with a dilution factor of at least 10,000 within 100 m of the discharge point (Hinwood *et al.*, 1994).

Drill cuttings from upper well sections generally accumulate in an approximate 80 x 80 m area around the well, commonly an ellipsoid shape according to tide and current behaviour (Hinwood *et al.*, 1994). When cuttings from the lower sections of the well are discharged, the larger sediment particles settle rapidly to the seabed, generally with 90% of the discharge volume falling within 100 m of the discharge point (Hinwood *et al.*, 1994).

The physical deposition of these cuttings, combined with the properties of the adhered fluids, may have an impact on flora and fauna and benthic habitat, depending on the discharge volumes, exposure levels and the sensitivity of the species themselves.

While drilling the deeper sections of the well, WBM will be circulated and continuously recycled to the surface. The WBM is circulated to surface to separate cuttings from the fluid and in turn allows the mud to be pumped back down into the well. Cuttings are separated from the WBM using shale shakers to remove as much WBM for reuse as possible. The cuttings with residual mud are intermittently discharged from the MODU from a discharge hose above sea level. Periodically, different solids control devices within the mud treatment system may also discharge to sea. The mud treatment system is continuously monitored for operability by the derrickman and drilling fluid properties assessed at least twice daily by the Drilling Supervisors and Drilling Fluids Engineer to optimise separation efficiency.

A bulk discharge of waste WBM will occur at the end of drilling the well.

Drilling Cuttings and Fluids Discharge Modelling

GB Energy commissioned RPS to undertake dispersion modelling of drill cuttings and muds based on the information presented in Table 8.6.

Modelling Methodology

The following information is taken from RPS (2020).

MUDMAP is a three-dimensional plume model used to aid in assessing the potential environmental effects from operational discharges such as drill cuttings, drilling fluids and produced water. The model has been applied to hundreds of assessments in over 35 countries, including Australia.

The model itself is an enhancement of the Offshore Operators Committee (OOC) model and calculates the fates of discharges through three distinct stages, as defined by laboratory and field studies:

- Stage 1, Convective descent – free fall of the combined mass of fluids and cuttings;
- Stage 2, Dynamic collapse stage – the collapse of the combined mass as it meets the seabed (or water surface); and
- Stage 3, Dispersion stage – the transport and dispersion of discharged fluids and particles by the local currents. For cuttings and drilling mud particles that have higher density than seawater, this phase also calculates sinking and settlement to the seabed.

Each stage plays an integral role on different time and distance scales.

Settling under currents is selective for particle size, with the larger particles (rock chips to sand) tending to settle quickly, forming a pile that aligns with the predominant water current axis. Smaller particles (especially silts and clays) will remain suspended for longer periods and will therefore be dispersed more widely by the ambient current conditions. Dispersion of the finer discharged material tend to be enhanced with increased current speeds and water depth and with greater variation in current direction over time and depth.

Along with the advanced analyses tools, MUDMAP can simulate six classes of material (or 36 subcategories), each with unique density and particle-size distribution. During the dispersion stage, the model particles are transported in three dimensions according to the current data and horizontal and vertical mixing coefficients at each time step according to the governing equations.

MUDMAP has been extensively validated and applied for discharge operations in Australian coastal waters.

Based on the drilling program, the drilling program involves approximately 42 days of active drilling and discharges. Table 8.6 summarises the estimated volume of drill cuttings and unrecoverable mud solids for each well interval and the end-of-well mud discharge.

Table 8.6. Summary of the estimated volume of drill cuttings and unrecoverable mud solids for each well interval and the end-of-well mud discharge

Bore diameter (inches)	Well interval	Discharge method	Cuttings discharged (m^3)*	Muds (solids only)**		Discharge duration (days)
				Type	Volume discharged (m^3)	
Golden Beach-2						
36	Surface	Directly to seabed	66	WBM	12.5	0.5
26	Intermediate		135	WBM	35.0	3.0
17.5	Intermediate	Brought to surface, mud recovered, cuttings discharged overboard	140	WBM	90.0	6.0
9.5	Production Hole		30	WBM	102.0	4.5
8.681	Completion and Test	Discharged overboard	Nil	Brine	32.0	6.0
Well total			***371***		***271.5***	***20.0***
Golden Beach-3						
36	Surface	Directly to seabed	66	WBM	12.5	0.5
26	Intermediate		135	WBM	35.0	3.0
12.25	Pilot	Brought to surface, mud recovered, cuttings discharged overboard	40	WBM	11.3	2.0
17.5	Intermediate		140	WBM	90.0	6.0
9.5	Production Hole		30	WBM	102.0	4.5
8.681	Completion and Test	Discharged overboard	Nil	Brine	32.0	6.0
Well total			***411***		***282.8***	***22.0***

** 15% greater than anticipated to allow for over-gauge.*

*** Solids determined as 10% of total mud system (assumed losses from the separation system that adhere to discharged cuttings).*
The volumes of mud discharged overboard in this table do not reflect exactly 10% of the volumes noted in Table 3.8 and Table 3.9. This is because the modelling was undertaken using the drilling plan that was current at the time (March 2020), but has since been refined. The volumes noted in this table represent 19.4% (Golden Beach-2) and 12.3% (Golden Beach-3) of the mud volumes stated in Table 3.8 and Table 3.9, and are therefore considered conservative (an over-estimation of mud to be discharged).

The input data used to setup the dispersion model included:

- Volume and discharge duration of the cuttings and unrecovered muds;
- Particle size distributions and associated settling velocities of discharged cuttings and unrecoverable muds;
- Bulk density of the discharged cuttings and unrecoverable muds;
- Temperature and salinity profile of the receiving waters;

- The size and orientation of the discharge pipe;
- The height/depth of the discharge point relative to mean sea level; and
- Depth-varying current data to represent local physical forcing.

Table 8.7 provides a summary of the discharge configuration and the estimated volume of cuttings and muds used as input into the discharge model. Each simulation represented the sequential completion of each section, with rates of discharge and the discharge depth varying to represent the plan. Discharge was represented over 42 days and the model was run for an additional six days to allow finer sediments to settle out of suspension or to disperse.

A cuttings density of 2,600 kg/m^3 and a mud density of 4,200 kg/m^3 were applied following Nedwed (2004). As the well will be drilled using a conventional drilling approach, the particle sizes for cuttings and drilling muds were represented by literature data for conventional drilling (Table 8.8). It is important to note that grain size has a greater influence on the rate of settling than density, and grain sizes are expected to vary between 0.016 mm and 6 mm in diameter. The fall velocities for the various size classes were derived from empirical data provided by Dyer (1986).

A stochastic modelling approach was following with one hundred simulations modelled per well (or 25 per quarter per well). Each discharge simulation for the respective well had the same information but different commencement times, and thus, prevailing current conditions were different. This approach ensured that the cuttings and muds experienced a wide range of current conditions (speeds and directions). The results from all 100 simulations per well, were integrated to identify the overall area of exposure on the seabed and in water. The outputs are presented as contours relative to the maximum predicted bottom thickness of deposited material on the seabed or total suspended solids (TSS) concentrations.

Table 8.7. Input data used for the drill cuttings and dispersion modelling for both wells

Parameter/description	Values/configuration
Volume of cuttings discharged near the seabed	402 m^3
Volume of muds discharged near the seabed	95 m^3
Volume of cuttings discharged near the sea surface	380 m^3
Volume of muds discharged near the sea surface	459.3 m^3
Total volume of cuttings discharged	782 m^3
Total volume of muds discharged	554.3 m^3
Density of drill cuttings	2,600 kg/m^3
Density of drilling muds	4,200 kg/m^3
Duration of discharge [simulation discharge]	42 days [48 days]
Depth of discharge sea-seabed	2 m above seabed
Depth of discharge at sea surface	Sea level (18 m water depth)
Orientation of discharge for sea surface discharges	Vertically downwards
Sea surface discharge pipe diameter	60”
Stochastic modelling approach and conditions	Randomly selected start simulation dates between January–December (2009–2019)

Parameter/description	Values/configuration
	25 simulations per quarter (Q1: January–March, Q2: April–June, Q3: July–September and Q4: November–December)

Note: considering the stochastic modelling methodology applied, the contour figures of predicted TSS concentration do not represent the location of the plume at any point in time, but rather are a summary of concentrations predicted to occur across all replicate simulations and all model time steps. Similarly, predicted bottom thickness results are presented as a summary of the range of final outcomes of maximum bottom thickness across all replicate simulations for each quarter assessed.

Table 8.8. Discharged grain size distribution and settling velocities assumed for well intervals consisting of cuttings and drilling fluids

Class	Grain size (mm)	Settling velocity (m/s)	Well section consisting of cuttings & drilling fluids (composition %)
Large cuttings	6	53.62	8.6
	5	49.46	8.6
	2	28.55	8.6
	1	12.73	5.8
	0.5	7.5	5.8
	0.45	6.6	2.9
Medium cuttings	0.4	6	2.9
	0.35	5	2.8
	0.3	4	2.8
	0.25	3.1	2.8
	0.2	2.3	2.8
	0.15	1.6	2.8
Light cuttings	0.1	0.8	2.8
	0.05	0.22	2.8
	0.04	0.15	2.9
	0.03	0.08	2.9
	0.02	0.04	2.9
Drilling muds solids	0.063	0.34	0.4
	0.05	0.22	1.6
	0.035	0.11	3.7
	0.026	0.06	6
	0.02	0.038	7.4
	0.016	0.026	9.4

Reporting Thresholds

The following information is taken from RPS (2020).

The MUDMAP model can track and predict sediment concentrations and thickness to very low levels that may not be practical or ecologically significant; therefore, thresholds were carefully selected for reporting the model-predicted outcomes.

A study by Rogers (1990) reported that a sedimentation rate of 1 mg/cm^2/day resulted in no effect or minimal effect to benthic communities. Based on the combined cuttings and muds density of approximately 3,500 kg/m^3 and an assumed void ratio of 1.5, this sedimentation rate is equivalent to 3.38 mm/year. Therefore, as a conservative measure, a thickness of 0.05 mm was employed as a minimum reporting threshold for the 6-day active discharge period (Table 8.9).

Table 8.9. Reporting thresholds for sediment thickness and TSS concentrations for the drill cuttings and muds discharge modelling

Reporting criteria	Total sediment thickness (mm)	TSS concentration (mg/L)
Minimum reporting threshold	0.05	5
Low exposure	1 – 10	10 – 1,830
High exposure	> 10	> 1,830

Note that while the active drilling time is 6 days, the full operation is much longer. Therefore using 6 days to calculate the deposition threshold is another level of conservatism built into the study.

- Sediment thickness – based on available literature, thresholds of 1-10 mm and above 10 mm were used to define low and high exposure levels for this study, respectively. In addition, Trannum et al (2009) reports a significant decrease in species count, abundance of individuals, Shannon-Wiener diversity, and biomass of marine animals with increasing depth of deposited cuttings (3-24 mm). Furthermore, a study by Kjeilen-Eilertsen et al (2004) reports that depositional thicknesses greater than 9.6 mm are likely to cause smothering impacts on benthic ecosystems, including corals. A study by Smit et al (2008) established that a thickness threshold of greater than 6.5 mm would be needed before potential harm to benthic macrofauna occur. Assuming newly settled cuttings and drilling muds will be less compact due to incorporation of water between grains of sediment deposits, a bulking factor of 2.5 was applied to predicted bottom thicknesses to account for porosity.

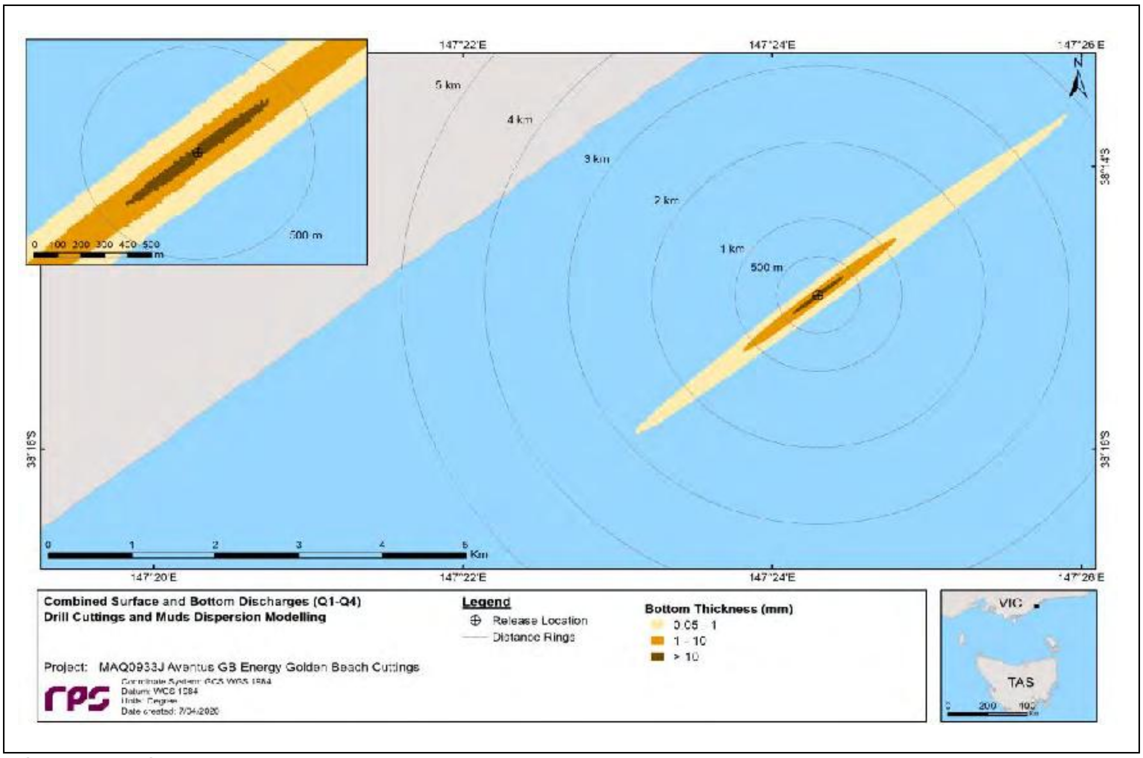
- TSS – the minimum reporting threshold for TSS concentrations used for this study is 5 mg/L. Nelson et al (2016) reports <10 mg/L as a minimal or no effect, whilst concentrations above 10 mg/L have a sublethal effect to pelagic biota. Furthermore, IOGP (2016) cite that very high concentrations (>1,830 mg/L) of TSS has been shown to result in mortality of pelagic biota. Hence, a threshold range of 10-1,830 mg/L and greater than 1,830 mg/L were used to define low and high exposure, respectively (see Table 8.9).

Stochastic Modelling Results – Sediment Thickness

Figure 8.1 illustrates the predicted coverage and sediment thickness from the combined near-seabed and sea surface drill cuttings and unrecoverable muds discharges from all

200 simulations (i.e., 100 simulations near-seabed and 100 simulations from sea surface discharges). Table 8.10 presents the same results.

The total area of coverage on the seafloor above the minimum reporting threshold is 1.17 km^2, which is predicted to occur up to a maximum distance of 3.95 km from the drill rig. In comparison, the area of coverage based on the low (1-10 mm) and high (>10 mm) exposure thresholds is 240 m^2 and 30 m^2, respectively. The maximum distance from the well to the low and high exposure thresholds is 1.56 km and 390 m, respectively. The modelling results demonstrate that the settlement of the cuttings and drilling muds occur predominantly along a northeast–southwest axis, coinciding with the dominant current directions in the Project area.



Source: RPS (2020).

Figure 8.1. Predicted maximum thickness at each grid cell from all 200 simulations used to define the area of greatest extent from the discharge of drill cuttings and unrecoverable muds for all quarters

Table 8.10. Predicted area of coverage and maximum distance as a function of sediment thickness

Sediment reporting thickness (mm)	Reporting criteria	Collective assessment of all combined simulations		
		Area of coverage of cuttings and muds ≥0.05 mm thickness (km^2)	Percentage of modelled area covered by sediment	Maximum distance from the well (km)
0.05 – 0.1	Minimum reporting threshold	1.41	83	3.95
1 – 10	Low exposure	0.24	15	1.04
> 10	High exposure	0.03	2	0.35

Results are based on the collective assessment of all 200 individual simulations (i.e., 100 combined near-seabed and surface discharges per well) representative of January to December, 2009-2018 conditions.

Table 8.11 provides a summary of the stochastic dispersion modelling assessment for each of the year's four quarters, presenting the predicted maximum bottom thickness, total area of coverage and the maximum distance (and direction from the platform) to the minimum threshold. The maximum distance from the platform above the minimum threshold ranged from 3.63 km (Q1) to 3.91 km (Q2). The maximum distance from the well to the low (1–10 mm) and high (>10 mm) exposure thresholds ranged between 1.02 km (Q2) to 1.04 km (Q1) and 0.34 km (Q4) to 0.35 km (Q1), respectively.

Maximum sediment thicknesses (or height of sediment mounds) ranged between 2.20 m (Q4) and 2.29 m (Q1) at the immediate vicinity of each well location. The maximum distance of deposited material from the drill rig above the minimum threshold ranged from 3.63 km (Q1) to 3.91 km (Q2), whist the total area of coverage ranged between 1.33 km^2 (Q2 and Q4) and 1.36 km^2 (Q1).

Table 8.11. Predicted maximum bottom thickness, area of coverage and maximum distance to the minimum reporting threshold from combined near-seabed and sea surface drilling on a quarterly basis

Drilling start period	Maximum stochastic bottom thickness (m) per well	Total stochastic area of coverage (km^2) at or above 0.05 mm	Maximum distance (km) from the well to 0.05 mm thickness	Maximum distance (km) from the well to >1 mm thickness
Q1	2.29	1.36	3.63	1.04
Q2	2.28	1.33	3.91	1.02
Q3	2.24	1.34	3.77	1.03
Q4	2.20	1.33	3.81	1.03

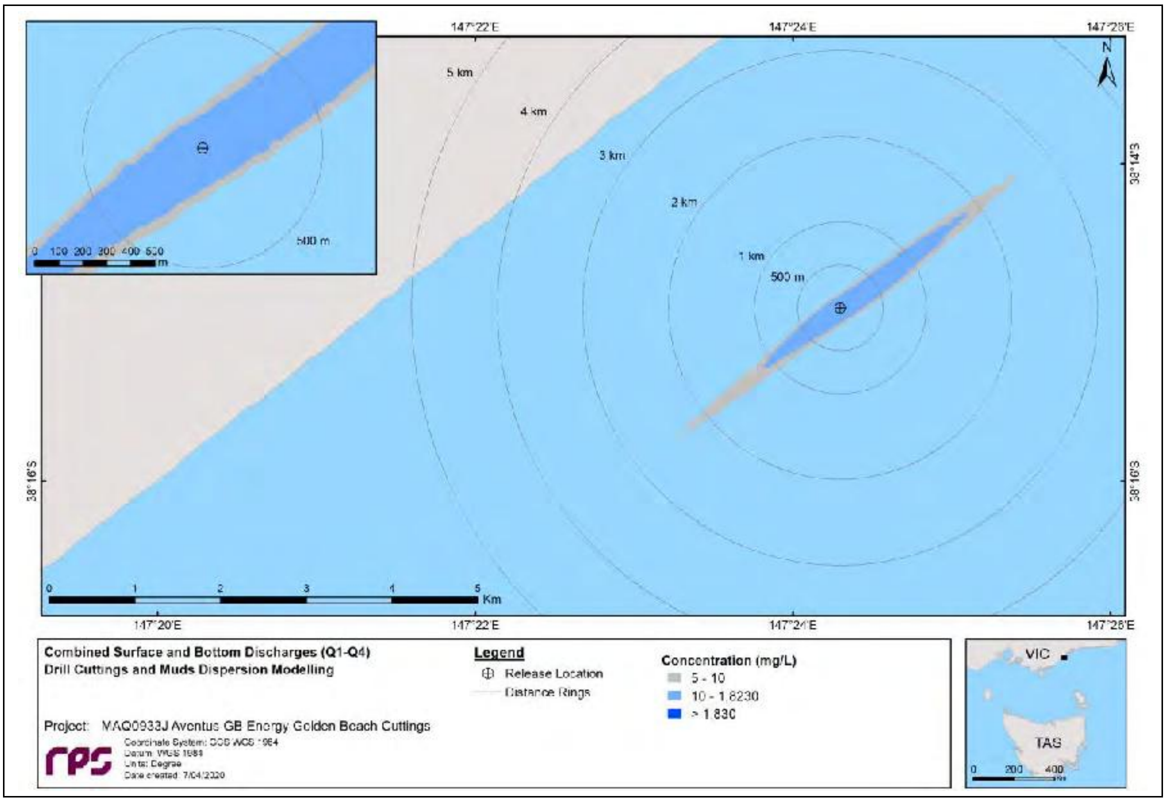
Results are based on the collective assessment of all 200 individual simulations (i.e., 100 combined near-seabed and surface discharges) representative of January to December, 2009-2018 conditions.

Lie et al (1994) reports the criterion for resuspension of deposited sediment on the seafloor is based around the sinking velocity of the sediment. If the sinking velocity of the sediment is lower than 1 cm/s, there is potential for it to be brought into resuspension. Based on Table 8.8, a settling velocity of less than 1 cm/s corresponds to sediment sizes less than 0.1 mm in diameter. The percentage contribution of material smaller than this is 42.8%, so there is potential for up to 570 m^3 of the total volume of discharged cuttings and muds (1,335 m^3) to be resuspended over time. During resuspension events, native sediments will also be resuspended. Therefore, the overall effect of resuspension is somewhat dilutive as it spreads the discharged sediments out over larger areas.

Stochastic Modelling Results – TSS Concentrations

Figure 8.2 illustrates the maximum instantaneous TSS concentrations at each grid cell from all 100 individual simulations (i.e., 100 sea surface drilling muds discharges at the end of drilling) used to define the area of greatest extent from the discharge of drilling muds (at the completion of drilling) on an annualised basis.

The total area of coverage above the minimum reporting threshold was 0.88 km^2, which was predicted to occur up to a maximum distance of 3.86 km from the drill rig. In comparison, the area of coverage based on the low (10-1,830 mg/L) exposure thresholds was 0.47 km^2. The maximum distance from the well to the low exposure thresholds was 1.62 km (Table 8.12). The area of coverage based on the high (>1,830 mg/L) exposure threshold was <0.01 km^2. The maximum distance from the well to the high exposure threshold was 0.01 km.



Source: RPS (2020).

Figure 8.2. Predicted maximum instantaneous TSS concentrations in each grid cell through the water column from all 100 simulations (i.e., 100 sea surface discharge operations of waste muds at the completion of drilling) used to define the area of greatest extent from the discharge of muds on an annualised basis

Table 8.12. Predicted area of coverage and maximum distance as a function of instantaneous TSS concentration

Maximum instantaneous TSS concentration (mg/L)	Reporting criteria	Collective assessment of all combined simulations	
		Area of coverage of Maximum instantaneous TSS concentrations (km^2)	Maximum distance from well (km)
5 – 10	Minimum reporting threshold	0.88	2.23
10 – 1,830	Low exposure	0.47	1.62
> 1,830	High exposure	<0.01	0.01

Results are based on the collective assessment of all 200 individual simulations (i.e., 100 combined near-seabed and surface discharges) representative of January to December, 2009-2018 conditions.

Table 8.13 provides a summary of the maximum instantaneous TSS concentration, total area of coverage, maximum distance and direction from the well to the 5 mg/L minimum threshold. The results are based on 4-hour sea surface discharges at the well.

The distance from the well for TSS concentrations, equal to or above 5 mg/L (minimum threshold), range from 2.23 km (Q4) to 2.12 (Q2). The distance from the well for TSS concentrations, equal to or above 10 mg/L (low exposure), range from 1.48 km (Q1) to 1.62 (Q3). The maximum distance from the well for TSS concentrations, equal to or above 1,830 mg/L (high threshold), was 0.01 km in all quarters. The TSS concentrations occurred predominantly along a northeast–southwest axis, coinciding with the dominant current directions adjacent to the release site.

Table 8.13. Predicted maximum instantaneous TSS concentrations, area of coverage and maximum distance to the minimum reporting threshold for sea surface waste drilling muds discharges at the end of drilling on a quarterly basis

Drilling start period	Maximum instantaneous TSS concentration (mg/L)		Total stochastic area of coverage (km^2), 5 mg/L TSS concentration	Maximum distance (km) from the well to 5 mg/L concentration	Maximum distance (km) from the well to 10 mg/L concentration
	Near-bottom discharge	Sea surface discharge			
Q1	4,639	1,816	0.79	2.15	1.48
Q2	4,646	1,860	0.80	2.12	1.48
Q3	4,696	1,927	0.81	2.17	1.62
Q4	4,637	1,852	0.81	2.23	1.60

HDD Punch Through

Drilling muds and cuttings will also be released to the marine environment from the shore-crossing punch through on the seabed. The shore crossing drilling muds and cuttings will be recovered, handled, re-used and/or disposed of onshore at the shore crossing pad/site, with a minor release of muds to the marine environment upon punch through. The volume of muds and cuttings released at the punch through to the marine environment is minimal and of a very short duration in comparison to drilling, and as such, this discharge has not been modelled.

8.3.2. Known and Potential Environmental Risks

The known and potential environmental impacts of the discharge of drill cuttings and fluids discharges are:

- Increased turbidity of the water column;
- Smothering of benthic habitat and fauna;
- Alteration of benthic substrate from sedimentation; and
- Potential toxicity impacts to fauna.

8.3.3. EMBA

The EMBA for drill cuttings and unrecovered muds discharges is up to up to 3.63 km from the well for sediment deposition and 2.23 km in a northeast direction from the well for TSS, as outlined in Section 8.3.1.

Receptors that are known to occur or may occur within this EMBA are:

- Benthic species;
- Plankton;

- Demersal and pelagic fish species;
- Pinnipeds; and
- Cetaceans.

8.3.4. Evaluation of Environmental Risks

Smothering of Benthic Habitat and Fauna

The modelling results indicate that the volume of drill cuttings discharged over the course of the campaign is 782 m^3 over 42-day discharge period.

In high energy environments (such as the shallow water, nearshore environment of the Project area), drill cuttings and muds do not tend to accumulate on the seabed because they are redistributed by bottom currents soon after deposition (Neff, 2010).

Once particulate material has settled onto the seabed it requires energy to re-suspend similar to existing sediments present on the seabed. Re-suspension volumes are a function of the surface area available to re-distributing currents, tides and storm events (i.e., induced wave stress). Redistribution is expected in areas of shallow water (<50 m) and strong seabed currents (Breuer *et al*., 2003). Accordingly, the surface layer of deposited sediment is expected to re-suspend during strong currents (e.g., during storms), however the magnitude of re-suspension is expected to be of a similar order to re-suspension of existing seabed sediments and should not result in a material impact to benthic habitats/fauna.

Sediment sampling undertaken at the Fortescue Platform (79 km east-southeast of the proposed drill location) in 1994-95 after seven months of drilling with WBM supports this observation, as the sampling did not identify any accumulation of barium (an indicator of WBM) in the vicinity of the platform (Terrens *et al*., 1998). Similar observations would be expected at the Golden Beach drilling location after this time given the current data available for the Project area (see Section 6.1.3).

The main disturbance to the seabed is smothering and burial of sessile benthic and epibenthic fauna (Hinwood *et al*., 1994). Studies undertaken on faunal counts/diversity have shown no significant effects of drill cuttings as a function of thickness with respect to settling communities (i.e., recolonization) (Setvik, 2010). This is consistent with the findings of Daan & Muldur (1996) that identified no adverse impacts on benthic communities from WBM cuttings one year after deposition, even as close as 25 m from a former discharge site. Field and laboratory studies support that benthic fauna are not significantly harmed from WBM if the exposure is of short duration and the cuttings are rapidly diluted. Impacts of WBM are generally limited to within 100m of the discharge point and recovery is well within one year (Setvik, 2010). Studies indicate that benthic infauna and epifauna recover relatively quickly, with substantial recovery within 3-10 years (Jones *et al*., 2012).

The modelling results for the Golden Beach drilling program indicate that there are no areas of seabed sensitivity likely to be impacted by cuttings deposition, with areas of low and high exposure limited to sandy seabed. The modelling results indicate that drill cuttings will not reach the Ninety Mile Beach MNP (located 25 km to the west-southwest). Impacts to the following seabed habitats from sediment deposition are predicted:

- Sandy seabed (Figure 8.3) – is sparsely populated by benthic assemblages (see Section 6.3.1). Impacts to sandy seabed will be temporary, with rapid re-colonisation of benthic infauna within the deposited cuttings soon after the cessation of drilling. Small and isolated sponge gardens and associated marine flora that potentially occur in and around the Project area will not be buried by sedimentation due to the very small area of exposure (0.03 km^2) to high sedimentation (>10 mm).

- Commercial scallops – the absence of beds of commercial scallops in and around the Project area (see Section 6.3.1) and the fact that no areas of known scallops are exposed to sediment thickness above the minimum reporting threshold means no impacts to scallops are predicted.
- Isolated low-profile rocky reef – occurs about 1.3 km to the southwest of the proposed drilling location and may support southern rock lobsters (see Section 6.3.1). The modelling indicates that sediments will not be deposited in this area. The areas of high and low exposure of sediment thickness extend a maximum of 350 m and 1.04 km respectively from the drill site.

On the basis of the information presented here, it is possible that smothering of benthic habitat (1-10 mm) may occur in an area of 0.27 km^2 extending a maximum distance of 1.04 km from the drill site. For sediment thickness >10 mm (that may cause harm to benthic macrofauna), the area of impact is limited to 30 m^2 around the drill site.

Based on available literature for cuttings redistribution in Bass Strait, the impacts are expected to be short term (months up to a year). Species re-settlement within one year of the drilling campaign would be expected as per quoted studies. This impact area is miniscule compared with the available sandy seabed habitat available throughout eastern Bass Strait. As such, the impact consequence of smothering of benthic habitat is negligible.

<u>Increased Turbidity of the Water Column</u>

During riserless drilling, the larger particles of the drill cuttings will settle in the immediate vicinity of the well, with smaller particles spreading further from the source aided by ocean currents. Once the riser is installed, drill cuttings are discharged just below the sea surface resulting in dissipation of the cuttings over a larger area. Hinwood et al (1994) and Neff (2005) note that within 100 m of the discharge point, a drilling cuttings and fluid plume will have diluted by a factor of at least 10,000, while Neff (2005) states that in well-mixed oceans waters (as is the case within the Project area), drilling mud is diluted by more than 100-fold within 10 m of the discharge.

When WBM and WBM-coated cuttings are discharged to the ocean, the larger particles, representing about 90% of the mass of the mud solids, form a plume that settles quickly to the bottom (or until the plume entrains enough seawater to reach neutral buoyancy).

About 10% of the mass of the mud solids form another plume in the upper water column that drifts with prevailing currents away from the platform and is diluted rapidly in the receiving waters (Neff, 2005; 2010). Neff (2005) states that although the total volumes of WBM and cuttings discharged to the ocean during drilling a well are large, the impacts in the water column environment are minimal, because discharges of small amounts of materials are intermittent. Drilling mud solids do not increase to high concentrations in the water column and affect only small parcels of water.

Periodic, minor increases in the turbidity and suspended particulate material concentrations in the upper water column during cuttings and mud discharges are unlikely to have an environmentally significant effect on phytoplankton, zooplankton and pelagic animal communities in the vicinity of the drill site (Neff, 2005).

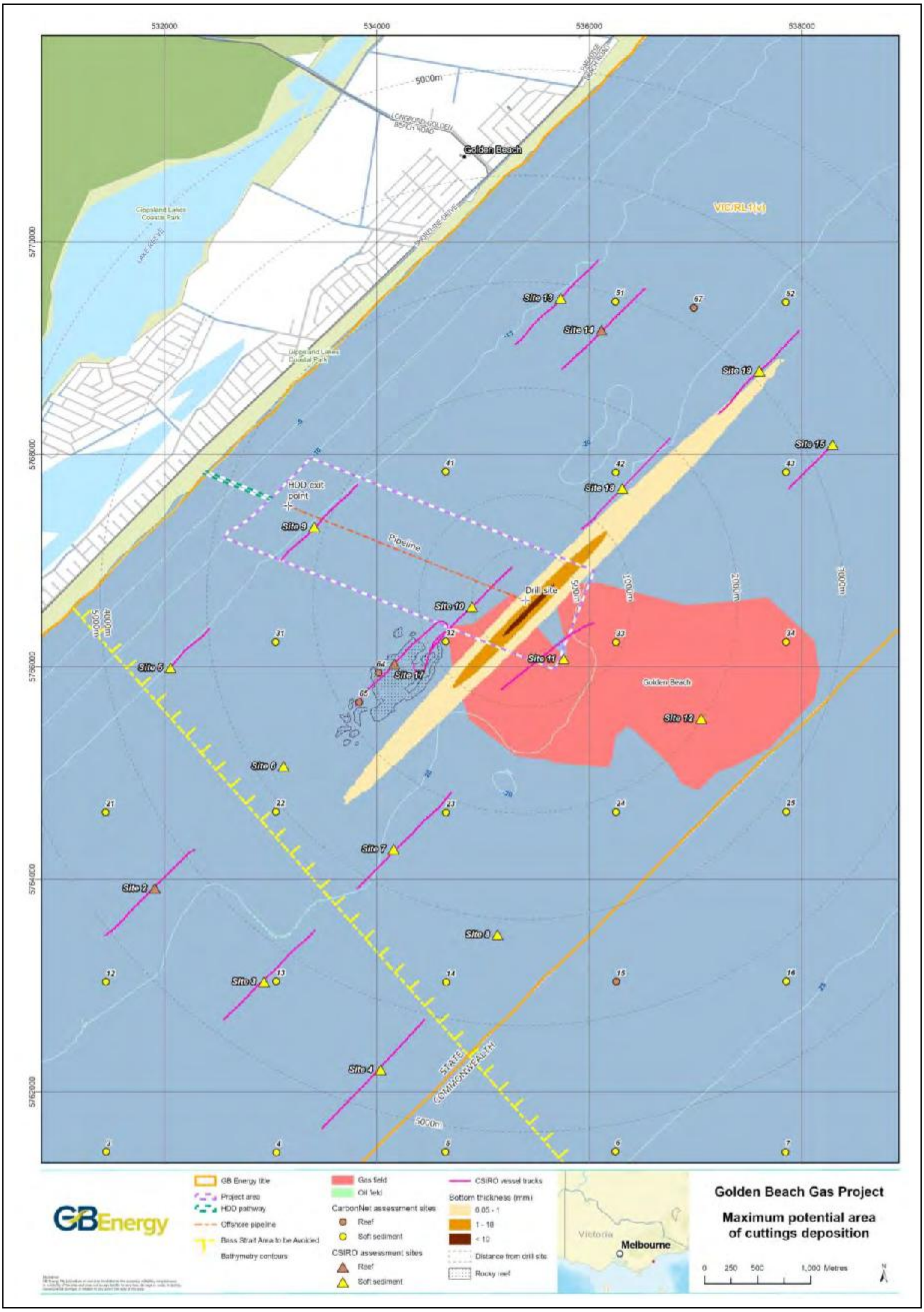


Figure 8.3. The impact of cuttings deposition with regard to seabed types

Water column turbidity increases as a result from the suspended solids, with a subsequent minor decrease in available light in the water column, which may temporarily reduce primary production. Impacts to fauna may include obstructions to respiratory processes and other physiological processes as well as behavioural changes due to a reduction in visibility and available oxygen (due to reduction in primary production).

The impacts from cuttings discharge are expected to be restricted to a small area around the drill site. The quantity of material discharged is extremely small compared with the water volume in which the material is dispersing, thus water quality is expected to quickly return to background levels close to the source of the discharge once the discharge ceases.

The results of the TSS concentration modelling are presented in Section 8.3.1. This information has been overlaid over the results of the CSIRO and CarbonNet marine habitat sampling sites, such that Figure 8.4 shows the impact of TSS concentrations with regard to seabed types.

The mapping of TSS concentrations against seabed types, and thus scallop and rock lobster habitat sites, are included here for completeness only, noting that TSS concentrations are relevant for the water column and not at the seabed. In this instance, the results only have applicability for species residing in the water column (e.g., fish and plankton) and indicate that TSS plumes that may have sublethal effects on pelagic fauna cover an area of just 0.56 km^2, with TSS concentrations that may result in mortality (high exposure) limited to less than <0.01 km^2. These results suggest that the impacts to pelagic fauna are likely to be negligible.

The distribution of TSS predicted by the modelling indicates that there are no areas of pelagic sensitivity likely to be impacted by TSS. The modelling results also predict that TSS concentrations above the minimum reporting threshold will not reach the Ninety Mile Beach MNP. As such, the consequence of this impact is considered negligible.

Impacts to Fisheries

The discharge of drill cuttings and muds will have no impacts on commercial fisheries. The modelling indicates cuttings and mud plumes will not impact rocky reefs (relevant to the single rock lobster fisher operating in the area), and there are no commercial scallop beds in or around the drill site.

The only pelagic fisheries that may operate in or immediately around the Project area is the Commonwealth-managed Southern & Eastern Scalefish & Shark Fishery and the Victorian-managed Ocean Access and Ocean Purse Seine fisheries. The temporary nature of the drilling mud plumes, the rapid settling of cuttings and exclusion of fishing activities within the 500-m PSZ around the MODU means that there will be minimal impacts to these pelagic fisheries from cuttings and muds discharges.

Alteration of Benthic Substrate

Modelling indicates that the maximum height of a sediment mound forming around the wells is predicted to range between 2.20 and 2.29 m. These sediment mounds are predicted to be limited to within the immediate vicinity of each well location. This will alter the nature of the seabed in this localised area for up to a year.

A cuttings mound will result in complete smothering of benthic fauna, though the mounds themselves (if they don't become redistributed with ocean currents) will provide new habitat for benthic fauna to colonise.

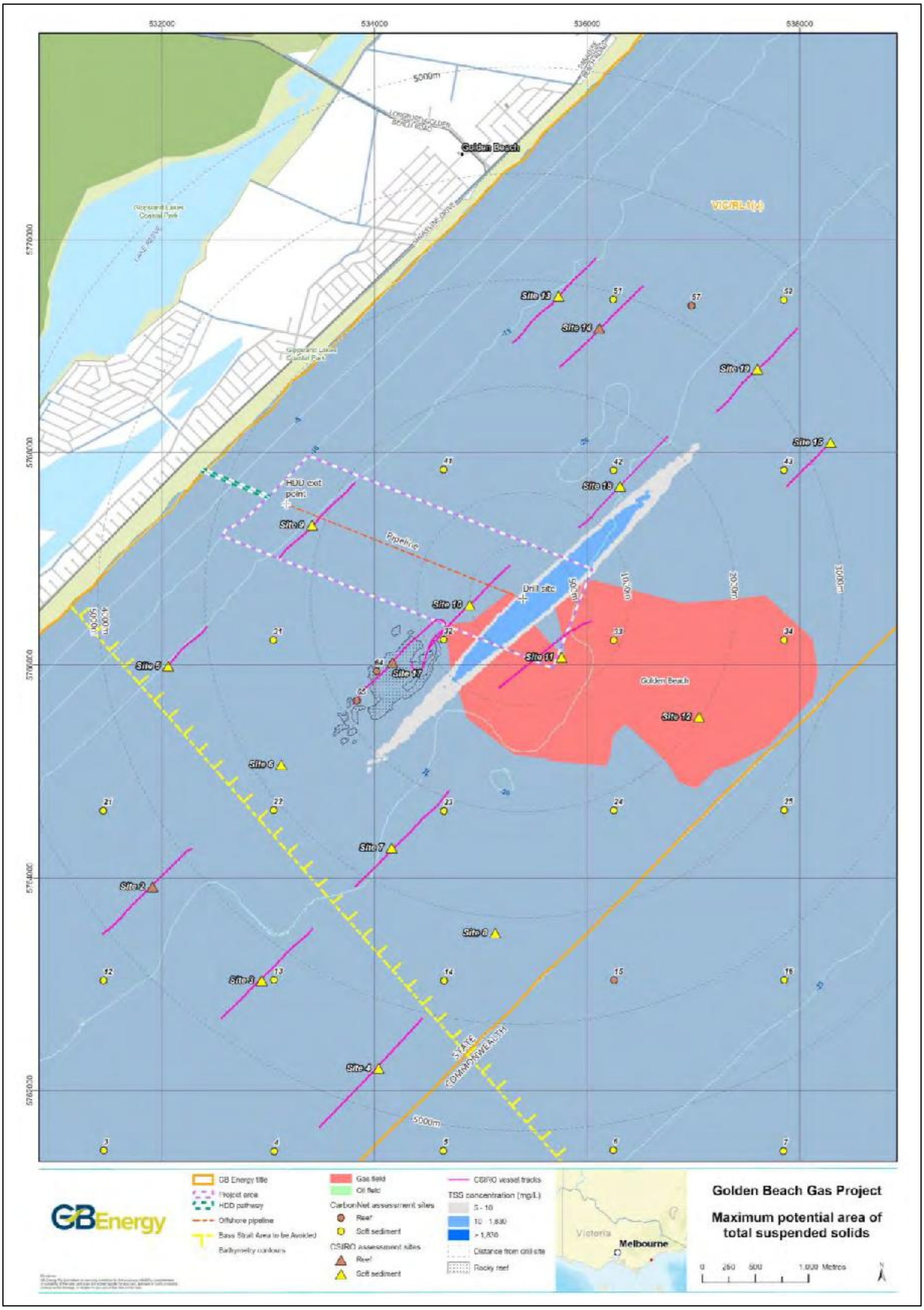


Figure 8.4. Predicted maximum instantaneous TSS concentrations in each grid cell through the water column from all 100 individual simulations with regard to seabed types

This area may be readily and rapidly reworked into existing seabed sediments by natural process including movement through bottom currents and infauna burrowing.

Potential Toxicity Impacts to Marine Fauna

The chemical composition of the drilling muds adhered to the deposited cuttings has the potential to result in toxicity impacts to marine fauna.

The non-toxic nature of the WBM means that acute or chronic toxicity impacts to fauna, especially immobile benthic fauna smothered by the cuttings, are highly unlikely. The lack of toxicity and low bioaccumulation potential of the drilling muds means that the effects of the discharges are highly localised and are not expected to spread through the food web (Neff, 2010).

There are few reports that deal specifically with the mineralogical toxicity or heavy metal content of cuttings, which is thought to be because of the inherent chemical stability of the rock substrate encountered during drilling.

Neff (2010) identifies that field and laboratory studies performed in temperate and cold water environments have shown that any metals present in drill cuttings are not bio-accumulated by marine organisms, primarily because they exist as extremely insoluble inclusions in cuttings minerals. Many field surveys investigating the concentrations of metals and hydrocarbons in tissues of marine animals in the vicinity of offshore WBM and cuttings discharges have shown that metals and hydrocarbon concentrations in tissues of marine animals near drilling platforms are similar to concentrations in tissues of the same or similar species well away from and out of the influence of the drilling platforms (Neff, 2010).

Based on this information, the bioavailability of metals within cuttings generated from drilling activities is low and thus the impacts to marine biota are insignificant.

8.3.5. Risks to MNES

The discharge of drill cuttings and muds will not have a significant risk to MNES, as outlined in Table 8.14.

Table 8.14. Risk to MNES from the discharge of drill cuttings and muds

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species will not be significant given the temporary nature and small coverage area of discharge plumes, the seasonality of presence of most threatened and migratory species, their temporary presence in the area and their ability to move away from disturbances.
Listed migratory species (see Section 6.3)	No	

MNES	Impact?	Notes
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 98 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.3.6. Risk Assessment

Table 8.15 presents the risk assessment for the discharge of drill cuttings and muds during drilling of the offshore wells. Controls will be adopted for the shore crossing HDD as appropriate.

Table 8.15. Risk assessment for the discharge of drill cuttings and muds

Summary		
Summary of impacts	Increased water column turbidity, smothering of benthic habitat and potential toxicity impacts to fauna.	
Extent of impact	Localised (up to four kilometres), in the direction of the dominant water currents (predominantly NE/SW orientation).	
Duration of impact	Temporary (days for TSS plumes, months for deposited cuttings).	
Level of certainty of impact	HIGH – the impacts of drill cuttings and fluids discharges are well studied and understood.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid Only low toxicity, readily biodegradable and non-bioaccumulating WBM and additives will be used during offshore drilling and HDD to minimise ecotoxicity impacts to marine fauna.	The mud contractor uses only ‘Poses Little or No Risk’ (PLONOR), ‘D’/’E’ (non-CHARM) or ‘Gold’/’Silver’ (CHARM) OCNS-rated base fluids and additives in the drilling fluid system.	The Mud Chemical Inventory verifies that all chemicals are PLONOR, ‘D’/’E’ (non-CHARM) or ‘Gold’/’Silver’ (CHARM) OCNS-rated.

	Where for technical reasons an additive is required that has not been registered with CEFAS (and therefore does not have a rating), the mud contractor will apply the CHARM, or in the case of non-CHARMable products, the OCNS process (https://www.cefas.co.uk/cefas-data-hub/offshore-chemicalnotification-scheme/hazardassessment-process/) to calculate the CHARM rating or OCNS grouping. Only additives with a hazard quotient of <30 (silver/gold ranking) or an OCNS grouping of D/E will be used.	MoC documentation verifies that, for products not registered with CEFAS, the CHARM and/or OCNS process has been applied and that only additives with a hazard quotient of <30 or an OCNS grouping of D/E are used.
Minimise Mud operations during offshore drilling are managed to ensure cuttings discharges are optimised to minimise adhered muds.	In accordance with the Fluid Program, the shaker screens and centrifuges are used during drilling the 12.25 x 14.75" and 9.5" well sections to maximise fluid separation from cuttings prior to overboard disposal.	Daily Mud Report (DMR) indicates screen and cuttings dryer usage during reporting period.
	Operation of the separation treatment system is monitored on a full-time basis by the Derrickman/Shaker-Hand to ensure optimal system performance.	Performance of the system is logged by the Mud Engineer in DMRs.
	Drilling fluid testing is performed by the Mud Engineer working under the supervision of the Drilling Supervisor at least twice per day.	Mud Engineer verifies through DMRs that fluids properties have been tested and system optimisation activities actioned.

Risk assessment (initial)			
Risk factor (threatening processes)	Consequence	Likelihood	Risk rating
Deposition – low exposure	Negligible	Almost certain	Low
Deposition – high exposure	Minor	Almost certain	Medium
TTS – low exposure	Negligible	Almost certain	Low
TTS – high exposure	Minor	Almost certain	Medium

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Mud discharges will be managed to minimise adverse effects to pelagic and benthic fauna.	At the end of the drilling program, mud will be discharged over a minimum duration of 6 hours.	The relevant DMR indicates that the minimum discharge duration was enforced.

Risk assessment (residual)			
Risk factor (threatening processes)	Consequence	Likelihood	Risk rating

Deposition – low exposure	Negligible	Likely	Low
Deposition – high exposure	Minor	Likely	Medium
TTS – low exposure	Negligible	Likely	Low
TTS – high exposure	Minor	Likely	Medium
Environmental Monitoring			
• Mud volumes discharged overboard. • Mud chemical inventory. • Separation treatment system monitoring.			
Record Keeping			
• DDRs. • Daily mud report (including chemical inventory). • End-of-well fluids report. • MoC documents. • Incident reports.			

8.4. Discharge of Cement

8.4.1. Risk Pathway

Cement is used during the drilling phase on board the MODU to cement the drill casing in place (sealing the annulus).

Cement is usually mixed as required (‘on-the-fly’) and hence waste is minimal. The following activities will result in the discharge of wet or dry cement overboard:

- Dry cement from the bulk tanks may be blown overboard during windy conditions in preparation for the cement job (estimated to be in the order of 2 m^3);
- Washing the cement unit and flushing hoses to prevent curing (estimated to be in the order of 6 m^3 of cement contaminated water for each well section, totalling 72 m^3 for both wells). This is usually done with seawater or compressed air after every cementing operation; and
- Cement overspill at the seabed during cementing of well structural casing jobs, which will only occur during the top hole (36”) and surface hole (22”) cement job. Once good cement returns are observed at the seabed, the mixing of cement will cease and displacement will commence.

Bulk dry cement remaining onboard the MODU at the completion of drilling will be left on the MODU for use by the next operator. Failing that, the cement will be mixed with seawater and discharged overboard as a slurry.

It is estimated that up to 40 m^3 of cement will be discharged to the ocean/seabed over the course of drilling each well.

8.4.2. Known and Potential Environmental Risks

Cement discharges, like drill cuttings, can impact the marine environment through:

- Localised and temporary increased turbidity of the water column;

- Smothering of benthic habitat and fauna;
- Alteration of benthic substrate; and
- Potential toxicity impacts to fauna.

8.4.3. EMBA

The EMBA for cement discharges is likely to be within the immediate vicinity of the discharge points (e.g., tens of metres to several hundred metres).

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Benthic habitat and fauna;
- Demersal fish;
- Pelagic fish;
- Marine mammals (cetaceans and pinnipeds); and
- Marine reptiles

8.4.4. Evaluation of Environmental Risks

Water column turbidity

Similar to drill cuttings dispersion and settling (see Section 8.3.4), cement discharges from the surface of the MODU (i.e., cement hose and equipment flushing) will form a turbid surface plume, where the larger, coarser components of the cement will precipitate. This would be expected to settle on the seabed within a radius of 100-200 m from the MODU. The remaining finer components are rapidly dispersed by ocean currents, aiding dispersion and dilution, and minimising water column turbidity. Although turbidity can decrease the available oxygen and light at the water surface (thereby reducing planktonic photosynthetic activity), the brief discharge periods and small volumes discharges result in only localised and temporary impacts.

Modelling of larger cement discharges (approximately 78 m^3 over a one-hour period) was undertaken for BP (2013), noting this modelling was undertaken in much deeper waters than for this project. Results of this modelling showed that within two hours, TSS concentrations ranged between 5-50 mg/L within the extent of the plume (approximately 150 m horizontal and 10 m vertical). Four hours post-discharge, concentrations fell to <5 mg/L. Given the estimated volume of cement discharges for the drilling of the Golden Beach wells is much less than the volume estimated by BP (in terms of any one single discharge), it is expected that the concentration of suspended sediments would be lower than predicted in the BP (2013) modelling, even with the shallower waters for this project.

For the Port Phillip Bay Channel Deepening Project EES, Jenkins and McKinnon (2006) reported that levels of suspended sediments greater than 500 mg/L (in the 'low exposure' threshold band for TSS in the cuttings and muds modelling in the previous section) are likely to produce a measurable impact upon larvae of most fish species, and that levels of 100 mg/L will affect the larvae of some species if exposed for periods greater than 96 hours. Jenkins and McKinnon (2006) also indicated that levels of 100 mg/L may affect the larvae of several marine invertebrate species and that fish eggs and larvae are more vulnerable to suspended sediments than older life stages. Neither the modelling by de Campos et al (2017) or BP (2013) suggest that TSS concentrations from a discharge of the cement washing will be at or near levels required to cause an effect on fish or invertebrate larvae (i.e., predicted levels were well below a 96-hr exposure at 100 mg/L, or instantaneous 500 mg/L exposure). This, the fact that there is no habitat (such as rocky reef) for site-attached species within the EMBA for cement discharges (such as rocky reef) and that fish (and other) species are transient in the area of impact, means that impacts from plumes of suspended solids will be negligible.

Smothering of benthic habitat and fauna/alteration of seabed substrate

The minor volumes of cement that may be discharged at the seabed during cementing of the upper well hole sections are likely to result in localised smothering of benthic habitat and fauna.

Cement discharges will not result in smothering of isolated low-profile rocky reefs that occur to the west-southwest of the proposed drill site (avoiding potential impacts to rock lobster), and because there are no known commercial scallop beds in the EMBA for cement discharges, there will be no impacts to scallops or scallop fishing.

Given the mobile nature of the sandy seabed sediments (see Section 6.1.2), cement that settles on the seabed will rapidly shift and disperse. Should colonising benthic species be present, impacts to them and their habitats will therefore be negligible.

It is estimated that approximately 40 m^3 of cement will be discharged to seabed per well. BP (2013) modelled a 200 t (~83 m^3) cement discharge, with the extent of potential impact from this discharge volume expected to be limited to within 10 m of the discharge point. Based on the BP (2013) modelling, it would therefore be expected that 40 m^3 of cement discharged for each Golden Beach well result in impacts proportionately lower than 10 m from the discharge point.

Toxicity impacts to marine fauna

Cement is considered inert and while the cementing program has not yet been finalised, cement additives will be of low toxicity (according to OSPAR rankings, in line with drill fluids). As such, these constituents of the cement will have negligible chronic or acute toxicity impacts to benthic fauna and other fauna exposed to the cement.

In summary, cement discharges are small in volume, inert, unlikely to result in permanent smothering of benthic impact and are generally restricted to a highly localised area around the drill site (other than cement fines that rapidly disperse through the water column).

8.4.5. Risks to MNES

The discharge of cement will not have a significant risk to MNES, as outlined in Table 8.16.

Table 8.16. Risks to MNES from cement discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species will not be significant given the temporary nature

MNES	Impact?	Notes
Listed migratory species (see Section 6.3)	No	and small area of impact from cement discharge plumes, the seasonality of presence of most threatened and migratory species, their temporary presence in the area and their ability to move away from disturbances.
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.4.6. Risk Assessment

Table 8.17 presents the risk assessment for cement discharges.

Table 8.17. Risk assessment for cement discharges

Summary		
Summary of impacts	Localised and temporary turbidity of the water column, smothering and alteration of benthic habitat and potential toxicity impacts to benthic fauna	
Extent of impact	Localised – tens to hundreds of metres from the discharge point, in the direction of dominant water currents (likely NE/SW orientation).	
Duration of impact	Temporary – intermittently during drilling.	
Level of certainty of impact	HIGH – the impacts of inert discharges such as cement are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Only low toxicity cement additives will be used to minimise ecotoxicity impacts to marine fauna.	The cement contractor ensures that only PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated cement additives are used.	The Cement Chemical Inventory verifies that all additives are PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated.

	Where for technical reasons an additive is required that has not been registered with CEFAS (and therefore does not have a rating), GB Energy will apply the CHARM, or in the case of non-CHARMable products, the OCNS process (https://www.cefas.co.uk/cefas-data-hub/offshore-chemicalnotification-scheme/hazardassessment-process/) to calculate the CHARM rating or OCNS grouping. Only additives with a hazard quotient of <30 (silver/gold ranking) or an OCNS grouping of D/E will be used.	MoC documentation verifies that, for products not registered with CEFAS, the CHARM and/or OCNS process has been applied and that only additives with a hazard quotient of <30 or an OCNS grouping of D/E are used.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Cement losses to the seabed during top hole cementing operations are minimised.	Once good cement returns are noted at the seabed by the ROV Technician (with the aid of fluorescein dye) and/or pH probe, the mixing and pumping of cement will cease, and displacement of the string with drilling fluid will begin.	The Cement Report for the top hole section notes visual returns of cement were confirmed and details the pumping schedule.
Cement remaining at the completion of drilling is managed so as to avoid or minimise its discharge overboard.	Manage the cement program such that nearly all cement is used in the cement jobs. At the completion of drilling the second well, if dry cement remains, then: • Minimise the inventory of cement on board. If that is not possible, then; • Transfer cement to the next operator. If that is not possible, then; • Any leftover slurry is mixed with seawater and discharged overboard over a minimum of 4 hours.	The Cement Report for the last section of the second well notes that the cement disposal options were considered and followed.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Likely	Low
Environmental Monitoring		
• Real-time ROV observations during conductor cementing operations. • Tracking of chemical additive use.		
Record Keeping		

- Cement chemical inventory.
- Cement job reports (and DDRs).
- MoC documents.
- End-of-well cement report.
- ROV footage/reports.

8.5. Atmospheric Emissions

8.5.1. Risk Pathway

The following activities will generate atmospheric emissions from the MODU and support vessels:

- Combustion of MDO from engines, generators and deck equipment;
- Flaring of gas during well testing;
- Fuel combustion (aviation gas) from the helicopter;
- Painting and paint storage, resulting in the release of fugitive Volatile Organic Carbons (VOCs) as vapours; and
- Release of ODS from refrigerants used in the centralised air-conditioning system during maintenance activities.

Based on a drilling program (using a jack-up MODU) undertaken in early 2020 located 7 km to the east-southeast of the proposed Golden Beach drill site, the following fuel volumes were used, and are an indication of the volumes that could be expected to be used for this drilling program:

- MODU – averaged 14.5 m^3 of MDO consumption per day. Assuming 40 days for this drilling campaign, that equates to 584 m^3. Vessels – the two vessels combined averaged 12.7 m^3 of MDO consumption per day. Assuming 40 days for this drilling campaign, that equates to 508 m^3. This would result in the generation of about 1,370 tonnes of CO^2-e, which is equivalent to the emissions from 315 average Australian vehicles driven an average number of kilometres for a year.

The use of MDO to power engines, generators and mobile and fixed plant (e.g., ROV, crane), will result in gaseous emissions of GHG such as CO^2, methane (CH^4) and nitrous oxide (N^2O), along with non-GHG such as sulphur oxides (SOx) and nitrous oxides (NOx). From the MODU, combustion emissions will be expelled from exhaust stacks about 22-25 m above deck level to ensure adequate aerial dispersion.

Note that the GHG risks associated with drilling are addressed in Technical Report H and EES chapter 14.

Onboard the MODU, maintenance activities including painting may be undertaken, resulting in small and unquantifiable releases of VOCs contained in fumes from the paint.

The heating, venting and air conditioning (HVAC) onboard the MODU may utilise refrigerants R134a, R407C and R410A (with high Global Warming Potential) in a closed operating system.

8.5.2. Known and Potential Environmental Risks

The known and potential environmental risks of atmospheric emissions are:

- Localised and temporary decrease in air quality due to gaseous emissions and particulates from diesel combustion; and
- Incremental build-up of GHG in the atmosphere (influencing climate change).

8.5.3. EMBA

The EMBA for atmospheric emissions associated with MODU and vessel activities is the local air shed – likely to be within hundreds of metres of the sources, both horizontally and vertically. Receptors that may occur within this EMBA, either as residents or migrants, are seabirds.

8.5.4. Evaluation of Environmental Risks

Localised and temporary decrease in air quality from diesel combustion

The combustion of MDO fuel can create continuous or discontinuous plumes of particulate matter (soot or black smoke) and the emission of non-GHG, such as SOx and NOx. Inhaling this particulate matter can cause or exacerbate health impacts to humans exposed to the particulate matter, such as offshore personnel or residents of nearby towns (e.g., respiratory illnesses such as asthma) depending on the volume of particles inhaled. Similarly, the inhalation of particulate matter may affect the respiratory systems of fauna. In the Project area, this is limited to seabirds overflying the MODU and support vessels.

It is rare that fuel combustion on the MODU or support vessels will generate black smoke. Particulate matter released to the atmosphere is not likely to impact on the health of local fauna, as winds will rapidly disperse and dilute particulate matter. This rapid dispersion and dilution will also ensure that seabirds are not exposed to concentrated plumes of particulate matter from vessel exhaust points.

Contribution to the GHG effect

The use of fuel to power engines, generators and any mobile/fixed plant will result in gaseous emissions of GHG such as CO_2, CH^4 and N^2O. While these emissions add to the GHG load in the atmosphere, which adds to global warming potential, they are relatively small on a global, national or state scale, representing a negligible contribution to overall GHG emissions. The activity is similar to other industrial activities contributing to the accumulation of GHG in the atmosphere.

Flaring of hydrocarbons during flow-back and well testing operations are considered a direct (Scope I) GHG emission. Based upon DoEE guidance, the level of CO_2-e and the short duration of flaring, GHG emissions from well testing are not considered a 'substantial cause' of impact to climate change.

Refer to EES Technical Report H (GHG emissions) and EES Chapter 14, which quantitatively assess GHG emissions.

In the context of oil and gas exploration and production activities that have been occurring in this part of Bass Strait for over 60 years, the atmospheric emissions from this drilling program will be negligible.

8.5.5. Risks to MNES

Atmospheric emissions will not have a significant risk to MNES, as outlined in Table 8.18.

Table 8.18. Risks to MNES from atmospheric emissions

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species flying overhead will not be significant given the temporary nature of emissions, the seasonality of presence of most threatened and migratory bird species, their temporary presence flying through the area and their ability to fly away from plumes. There is no habitat critical to any threatened or migratory bird species restricted to the air space around the drilling location.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.5.6. Risk Assessment

Table 8.19 presents the risk assessment for atmospheric emissions.

Table 8.19. Risk assessment for atmospheric emissions

Summary		
Summary of impacts	Decrease in air quality due to gaseous emissions and particulates from MDO combustion and flaring and contribution to the incremental build-up of GHG in the atmosphere (influencing climate change).	
Extent of impact	Localised (local air shed for air quality), widespread (for GHG).	
Duration of impact	Temporary – duration of drilling (emissions are rapidly dispersed and diluted).	
Level of certainty of impact	HIGH – the impacts of atmospheric emissions are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria

Avoid Solid combustible waste is not incinerated.	All solid combustible waste is returned to shore for appropriate disposal.	The Garbage Record Book verifies that waste is transferred to shore for disposal.
Minimise Combustion systems on the MODU and support vessels operate in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) requirements.	Only low-sulphur (<0.5% m/m) MDO will be used in order to minimise SOx emissions.	Bunker receipts verify the use of low-sulphur MDO.
	All combustion equipment is maintained in accordance with the PMS (or equivalent).	PMS records verify that combustion equipment is maintained to schedule.
	Vessels with gross tonnage >400 tonnes possess equipment, systems, fittings, arrangements and materials that comply with the applicable requirements of MARPOL Annex VI.	IAPP certificate is current.
	Vessels >400 gross tonnes and involved in an international voyage implement their SEEMP to monitor and reduce air emissions.	SEEMP records verify energy efficiency records have been adopted.
	Vessels >400 gross tonnes must ensure that firefighting and refrigeration systems are managed to minimise ODS.	ODS record book is available and current.
There is no black smoke generated during flaring.	Flaring equipment is maintained in good operational order to ensure optimal efficiency.	PMS records verify that flaring equipment is maintained according to schedule.
	A high efficiency burner head (e.g., EverGreen) is used to maximise hydrocarbon combustion and eliminate smoke generation and liquids drop out.	The DDRs and/or supplier records verify that a high efficiency burner is fitted.
	The duration of flaring is kept to the shortest time possible, in accordance with the Well Test Plan. Well testing is estimated as 12-hour clean up and then an additional 12- hour flow period.	The DDRs note the total duration of flaring.

Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Almost certain	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Cold venting is initiated during suitable weather conditions to maximise gas dispersion.	Cold venting, if undertaken, is undertaken in accordance with vendor procedures, including undertaking pre-start checks to ensure vented gas rapidly disperses and that the volume of gas is recorded.	Completed pre-start checklist is available, verifying that checks were completed.
		Well test report includes measured gas volume.

The MODU HVAC system will be maintained to minimise refrigerant gas leaks.	The HVAC system is maintained in accordance with the PMS (or equivalent).	PMS records verify that the HVAC system is maintained to schedule.
Fuel use will be measured, recorded and reported.	Fuel use will be measured, recorded and reported for abnormal consumption, and in the event of abnormal fuel use, corrective action will be taken to minimise air pollution.	Fuel use is recorded in the DDRs.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Likely	Low
Environmental Monitoring		
• Fuel consumption.		
Record Keeping		
• Fuel bunkering receipts. • PMS records. • IAPP certificates. • SEEMPs. • ODS record book/s. • Fuel use records. • Waste manifest/s. • Garbage record book/s.		

8.6. Light Emissions

8.6.1. Risk Pathway

The following activities will result in artificial lighting:

- MODU operations – drill derrick, helideck and vessel deck lighting will be kept on 24 hours a day for maritime safety and crew safety purposes (Photo 8.1);
- Well testing – the flame resulting from gas flaring will be large and highly visible from coastal towns (Photo 8.2);
- Support vessel operations – navigational and vessel deck lighting will be kept on 24 hours a day for maritime safety and crew safety purposes; and
- ROV operations – underwater light will be emitted when the ROV is submerged in order to illuminate an area of interest.

Photo 8.1. Example of night-time lighting on a MODU

Photo 8.2. Examples of MODU flaring

8.6.2. Known and Potential Environmental Risks

The known and potential environmental and social risks of artificial lighting are:

- Localised light glow may act as an attractant or deterrent for marine fauna (e.g.,fish, squid and zooplankton), in turn affecting predator-prey dynamics and can also affect schooling, spatial distribution, migration, reproduction and changes in population dynamics;
- Attraction of migratory birds which can lead to injury or mortality from collisions, disorientation and unnecessary energy expenditure;

- Attraction of non-migratory seabirds, which can become trapped within the sphere of light where they mill around until they become exhausted or get injured from collisions;
- Attraction of seabirds that may use offshore structures as habitual roosting sites; and
- Attraction or disorientation of sea turtles to night-time lighting.

8.6.3. EMBA

The EMBA for light glow associated with MODU activities is likely to be less than a 500 m radius, less than a 100 m radius around the support vessels and less than 20 m radius around the ROV (underwater). During well testing, flaring will be visible from many kilometres away, with the exact distance not able to be determined as this relates to the location of the observer, the weather conditions (i.e., visibility) at the time and the well test flow rate. The intensity of artificial lighting diminishes with the square of the distance (i.e., light is reduced to 1% of the initial intensity after 10 m) (Apache Energy, 2008), so the received intensity of lighting will be very low. The degree of the potential reduction in visual amenity is subjective and thus a definitive EMBA cannot be provided.

Light-sensitive receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Squids;
- Marine reptiles
- Fish; and
- Seabirds and migratory birds.

Residents of and visitors to Golden Beach and Paradise Beach will see lights in the distance towards the horizon from vantage points higher than the sand dunes (e.g., balconies on double-storey houses along Shoreline Drive), from the beach viewing platforms and from the beach itself. Lights on the MODU will be more visible than those of the support vessels due to its higher position above the sea surface and the greater number and density of lights. Flaring will be a highly visible activity, though it will be a short-term impact to visual amenity (expected to be less than 24 hours for each well).

8.6.4. Evaluation of Environmental Risks

Light glow at the surface

Seabirds

Seabirds may be attracted to light glow at night time. Bright lighting can disorientate birds, thereby increasing the likelihood of seabird injury or mortality through collision with infrastructure, or mortality from starvation due to disrupted foraging at sea (Wiese et al., 2001 in DSEWPC, 2011a). This disorientation may also result in entrapment, stranding, grounding and interference with navigation (DoEE, 2020).

Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie *et al*., 2008) and that lighting can attract birds from large catchment areas (Wiese *et al*., 2001). The light may provide enhanced capability for seabirds to forage at night.

Migrating seabirds may be attracted by the lights of the MODU and/or vessels, which may result in drawing them off course from their usual migration path (DoEE, 2020).

Given the close proximity of the proposed drill site to the coast, this is unlikely to be of any significance. The DoEE (2020) reports that petrel species in the Southern Ocean may be unable to take off from a deck. To date, personnel based on the Yolla-A platform (225 km southwest of the proposed drill site in the middle of Bass Strait) have not encountered any unusual bird behaviour, injuries or deaths around light sources.

Should such light attraction occur during drilling, it will be temporary (up to 90 days) and highly localised and therefore will not have impacts at the species population level or ecosystem level.

There are no actions within the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-16 (DSEWPC, 2011a) or the National Light Pollution Guidelines for Wildlife (DoEE, 2020) that are compromised by light emissions from this activity.

Fish and plankton

Depending on the species, fish and zooplankton are likely to be be directly or indirectly affected by artificial lighting. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan *et al*., 2001), with traps drawing catches from up to 90 m (Milicich *et al*., 1992). Lindquist et al (2005) concluded from a study of larval fish populations around an oil and gas platform in the Gulf of Mexico that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, was caused by the platforms' light fields. The concentration of organisms attracted to light results in an increase in food source for predatory species and marine predators are known to aggregate at the edges of artificial light halos. Shaw et al (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms. This could potentially lead to increased predation rates compared to unlit areas.

Should such light attraction occur during the activity, it will be temporary and highly localised and therefore will not have impacts at the species population level or ecosystem level.

Cetaceans

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to monitor their environment rather than visual sources (Simmonds *et al*., 2004), so light is not considered to be a significant factor in cetacean behaviour or survival.

Light glow in the water column

Underwater light from the ROV is unlikely to cause environmental impacts. While the ROV dives, fauna in different strata of the water column will be exposed to light for only very brief moments, and usually for a few minutes at a time near the seabed where the ROV conducts most of its work. Observations of ROV inspections at the seabed (Pinzone, pers. obs., 2013) indicate that fauna is not negatively impacted by the bright light source, and other than some fauna exhibiting inquisitiveness, fish and other fauna appear unaffected by the light source.

8.6.5. Risks to MNES

Light emissions will not have significant risks to MNES, as outlined in Table 8.20.

Table 8.20. Risks to MNES from light emissions

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species flying overhead will not be significant given the temporary nature of emissions, the seasonality of presence of most threatened and migratory bird species and their temporary presence flying through the area. There is no habitat critical to any threatened or migratory bird species restricted to the air space around the drilling location.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas:		
- AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.6.6. Risk Assessment

Table 8.21 presents the risk assessment for light emissions.

Table 8.21. Risk assessment for light emissions

Summary		
Summary of impacts	Light glow may act as an attractant to light-sensitive species (e.g., seabirds, fish, migratory and non-migratory birds, sea turtles and zooplankton), in turn affecting predator-prey and population dynamics (due to attraction to or disorientation from light).	
Extent of impact	Localised – small radius of light glow around the MODU and vessels.	
Duration of impact	Temporary – duration of drilling.	
Level of certainty of impact	HIGH – the impacts of light glow on marine fauna are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		

External MODU and support vessel lighting conforms to that required by maritime safety standards.	Light glow is minimised by managing external vessel lighting in accordance with: • AMSA Marine Orders Part 30 (Prevention of Collisions). • AMSA Marine Orders Part 59 (Offshore Support Vessel Operations).	Vessel class certifications are current.

Risk assessment (initial)			
Consequence criteria	Consequence	Likelihood	Risk rating
Ecosystem function	Minor	Likely	Medium
Threatening processes	Minor	Likely	Medium
Threatened and migratory species	Minor	Likely	Medium

Additional mitigation measures

Performance outcome	Performance standard (control)	Measurement criteria
Light levels from MODU and support vessel activities is kept as low as reasonably practicable to minimise light glow impacts to marine fauna and avifauna.	Lighting is directed to working areas (rather than overboard) to minimise light spill to the ocean.	Completed MODU and vessel inspection checklists and photos verify that lights are directed inboard, and where this is not possible, lights are switched off when not in use.
	Lighting directed overboard can be manually over-ridden (with a local switch were possible) such that it is only switched on as required (e.g., man overboard).	
	Flaring equipment is maintained in good operational order to ensure optimal efficiency.	PMS records verify that flaring equipment is maintained according to schedule.
	The duration of well testing (flaring) is kept to the shortest time possible, in accordance with the Well Test Plan. Well testing duration is 12 hours for clean-up and 12 hours for flow period.	The DDRs note the total duration of flaring.

Risk assessment (residual)			
Consequence criteria	Consequence	Likelihood	Risk rating
Ecosystem function	Negligible	Likely	Low
Threatening processes	Negligible	Likely	Low
Threatened and migratory species	Negligible	Likely	Low

Environmental Monitoring

- None required.

Record Keeping

- Vessel class certification.
- PMS records.
- Completed inspection checklists.
- Photos.
- DDRs.
- Well Test records.
- Injured fauna incident records.

8.7. Discharge of Sewage and Grey Water

8.7.1. Risk Pathway

The composition of sewage and grey water (when untreated) may include:

- Particulate matter – such as solids composed of floating, settleable, colloidal and dissolved matter, substances that affect aspects of aesthetics such as ambient water colour, the presence of surface slicks/sheens and odour.
- Chemical contaminants – including:
    - Nutrients (e.g., ammonia, nitrite, nitrate and orthophosphate);
    - Organics (e.g., volatile and semi-volatile organic compounds, oil and grease, phenols, endocrine disrupting compounds); and
    - Inorganics (e.g., hydrogen sulphide, metals and metalloids, surfactants, phthalates, residual chlorine);
- Biological pathogens – including bacteria, viruses, protozoa and parasites.

The use of ablution, laundry and galley facilities by the MODU and support vessel crews will result in the discharge of treated sewage and grey water. When treated to a tertiary level, the contaminants listed above are reduced to negligible levels.

Total volumes of sewage and grey water typically generated at offshore facilities range between 0.04 and 0.45 m^3 per person per day (NERA, 2017). Assuming 100 people working on the MODU each day and 12 people on each of the two support vessels (a total of 124 people), this equates to between 4.96 and 55.8 m^3 of sewage and grey water generated daily.

8.7.2. Known and Potential Environmental Risks

The known and potential environmental impact of treated sewage and grey water discharges is:

- Temporary and localised increase in the nutrient content of surface waters around the MODU and support vessels.

8.7.3. EMBA

Given the buoyant nature of sewage and grey water discharges, the EMBA is likely to be the top 10 m of the water column and a 50 m radius from the discharge point. This is based on modelling of continuous wastewater discharges (including treated sewage and greywater) undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex), which found:

- Rapid horizontal dispersion of discharges occurs due to wind-driven surface water currents;
- Vertical discharge is limited to about the top 10 m of the water column due to the neutrally buoyant nature of the discharge; and
- A concentration of a component within the discharge stream is reduced to 1% of its original concentration at no less than 50 m from the discharge point under any condition (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Vagrant sea turtles;
- Pinnipeds; and
- Seabirds.

8.7.4. Evaluation of Environmental Risks

Water Quality

Sewage will be treated through STPs to a tertiary level, so there are no potential impacts relating to the release of particulate matter, chemicals and pathogens in untreated sewage. Solids that are retained in the treatment process are retained onboard prior to disposal at a licensed facility located onshore.

Nutrients in sewage, such as phosphorus and nitrogen, may contribute to eutrophication of receiving waters (although usually only still, calm, inland waters and not offshore waters), causing algal blooms. These algal blooms can degrade aquatic habitats by reducing light levels, producing certain toxins that are harmful to marine life and by reducing dissolved oxygen levels in water potentially resulting in fish kills.. Given the tidal movements and currents in open oceanic waters and the assimilative capacity of the open sea, eutrophication of receiving waters will not occur.

Grey water (used water from the galley, showers, hand basins and laundry) can contain a wide variety of pollutant substances at different strengths, including oil and some organic compounds, hydrocarbons, detergents and grease, metals, suspended solids, chemical nutrients, food waste, coliform bacteria and some medical waste. Grey water is treated through the STP, so pollutants will be largely removed from the discharge stream.

The effects of treated sewage and sullage discharges on the water quality at Scott Reef were monitored for a MODU operating near the edge of the deep-water lagoon area at South Reef. Monitoring at stations 50 m, 100 m and 200 m downstream of the MODU and at five different water depths confirmed that the discharges were rapidly diluted in the upper 10 m water layer and no elevations in water quality monitoring parameters (e.g., total nitrogen, total phosphorous and selected metals) were recorded above background levels at any station (Woodside, 2011).

Treated sewage and grey water discharges will be rapidly diluted in the surface layers of the water column and dispersed by currents. The biological oxygen demand (BOD) of the treated effluent will be low as sewage and greywater will be treated to remove organic matter prior to release. On release, surface water currents will assist with oxygenation of the discharge. Depletion of oxygen in receiving waters is therefore unlikely to occur.

Biological Receptors

Plankton forms the basis of all marine ecosystems, and plankton communities have a naturally patchy distribution in both space and time (ITOPF, 2011a). They are known to have naturally high mortality rates (primarily through predation), however in favourable conditions (e.g., supply of nutrients), plankton populations can rapidly increase. Once the favourable conditions cease, plankton populations will collapse and/or return to previous conditions. Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF, 2011a). Any potential change in plankton diversity, abundance and composition as a result of treated sewage and grey water discharges is expected to be very low (given the waste stream is treated) and localised (as outlined in the EMBA), and is likely to return to background conditions within tens to a few hundred metres of the discharge location (NERA, 2017). Accordingly, impacts further up the food chain (e.g., fish, reptiles, birds and cetaceans) are expected to be negligible.

Social Impacts

Sewage and grey water discharges will not have any impacts to social activities (e.g., swimming, fishing) in or around the Project area because of the distance between the MODU and recreational beaches (3.2 km) and because there are no recognised dive sites (e.g., shipwrecks, reefs) in the Project area or discharge EMBA. There will also be a 500 m radius PSZ around the MODU, which will prevent third-party access to the area impacted by the discharge.

The impacts of treated sewage and grey water discharges to the physical, biological and social environment are expected to have negligible consequences because of the:

- Low discharge volumes;
- Intermittent nature of the discharge;
- Treatment of the waste stream prior to discharge;
- High dilution and dispersal factor in open waters;
- Distance from shore;
- High biodegradability and low persistence of the waste; and
- Absence of sensitive habitats in the EMBA area.

8.7.5. Risks to MNES

Treated sewage and grey water discharges will not have significant risks to MNES, as outlined in Table 8.22.

Table 8.22. Risks to MNES from treated sewage and grey water discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.

MNES	Impact?	Notes
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges over a short-term drilling program, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the EMBA for sewage and grey water discharges.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.7.6. Risk Assessment

Table 8.23 presents the risk assessment for the discharge of treated sewage and grey water.

Table 8.23. Risk assessment for the discharge of treated sewage and grey water

Summary		
Summary of impacts	Reduction in surface water quality around the discharge point.	
Extent of impact	Localised – up to 50 m horizontally and 10 m vertically from the discharge point.	
Duration of impact	Temporary – duration of activity.	
Level of certainty of impact	HIGH – the impacts of treated and untreated sewage and grey water discharges to water quality are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Sewage and grey water discharges comply with Section 23G of POWBONS.	Sewage and grey water are treated in a MARPOL-compliant STP prior to overboard discharge.	ISPP certificate is valid.
	The STP is maintained in accordance with the PMS.	PMS records confirm that the STP is maintained to schedule.

	In the event of a STP malfunction, untreated sewage will be managed accordingly: • MODU – stored in holding tanks until issue is rectified, or transferred to support vessels for discharge >12 nm from shore. • Support vessels - discharged when the vessel is >12 nm from shore.	Discharge records confirm discharge of untreated sewage in waters >12 nm from shore.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
None identified.		
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Environmental Monitoring		
• None required.		
Record Keeping		
• ISPP certificates. • STP PMS records. • Discharge records.		

8.8. Discharge of Cooling and Brine Water

8.8.1. Risk Pathway

Seawater is used as a heat exchange medium for cooling machinery engines on MODUs and support vessels. Brine is created through the desalination processes for potable water generation.

Seawater is used as a heat exchange medium for cooling engines and other equipment. Seawater is drawn up from the ocean, where it is de-oxygenated and sterilised by electrolysis (by release of chlorine from the salt solution) and then circulated as coolant for various equipment through the heat exchangers (in the process transferring heat from the machinery). It is then discharged to the ocean either at surface or at depth. Upon discharge, it will be warmer than the ambient water temperature and may contain low concentrations of residual biocide and scale inhibitors if they are used to control biofouling and scale formation.

The maximum cooling water discharge rate for the MODU and support vessels is unknown. Also unknown is the temperature at which the heat exchangers are designed to discharge the cooling water at (generally several degrees Celsius above ambient sea temperature). Other MODUs that have worked in Australian waters in recent years have cooling water discharge rates and temperatures as follows:

- *West Telesto* jack-up MODU – 300 m^3/day that is 2°C higher than ambient water temperature; and

- *Stena Clyde* semi-submersible MODU - 130 m^3/day that is 2°C higher than ambient water temperature.

Brine water (hypersaline water) is created through the desalination process that creates freshwater for drinking, showers, cooking etc. This is achieved through reverse osmosis (RO) or distillation resulting in the discharge of seawater with a slightly elevated salinity (~10-15% higher than seawater). The freshwater produced is then stored in tanks on board. Upon discharge, the concentration of the brine is (based on modern vessels) likely to range from 44-61 ppm, which is 9-26 ppm higher than seawater salt concentration (35 ppm). Brine concentration is dependent on throughput and plant efficiency.

8.8.2. Known and Potential Environmental Risks

The known and potential environmental impacts of cooling water and brine discharges are:

- Temporary and localised increase in sea water temperature, causing thermal stress to marine biota;
- Temporary and localised increase in sea surface salinity, potentially causing harm to fauna unable to tolerate higher salinity; and
- Potential toxicity impacts to marine fauna from the ingestion of residual biocide and scale inhibitors.

8.8.3. EMBA

The EMBA for cooling water and brine discharges associated with vessel activities is likely to be the top 10 m of the water column and a 100 m radius from the discharge point. This is based on modelling of continuous wastewater discharges undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex), which found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being less than 1°C above background levels within 100 m (horizontally) of the discharge point, and will be within background levels within 10 m vertically (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds; and
- Avifauna.

8.8.4. Evaluation of Environmental Risks

Temporary and Localised Increase in Seawater Temperature

Once in the water column, cooling water will remain in the surface layer, where turbulent mixing and heat transfer with surrounding waters will occur. Prior to reaching background temperatures, the impact of increased seawater temperatures down current of the discharge may result in changes to the physiological processes of marine organisms, such as attraction or avoidance behaviour, stress or potential mortality.

Modelling of continuous waste water discharges (including cooling water) undertaken by Woodside for its Torosa South-1 drilling program in the Scott Reef complex found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being less than 1°C above background levels within 100 m (horizontally) of the discharge point, and will be within background levels within 10 m vertically (Woodside, 2008). As such, impacts to most receptors are expected to be negligible even within this mixing zone.

Temporary and Localised Increase in Sea Surface Salinity

Brine water will sink through the water column where it will be rapidly mixed with receiving waters, and dispersed by ocean currents. Walker and McComb (1990) found that most marine species are able to tolerate short-term fluctuations in water salinity in the order of 20-30%, and it is expected that most pelagic species passing through a denser saline plume would not suffer adverse impacts. Other than plankton (which move with the currents), pelagic species are mobile and would be subject to slightly elevated salinity levels for a very short time as they swim through the 'plume.' As such, impacts to pelagic species are expected to be negligible.

Potential Toxicity Impacts

Scale inhibitors and biocide may be used in the heat exchange and desalination process to avoid fouling of pipework. Scale inhibitors are low molecular weight phosphorous compounds that are water-soluble, and only have acute toxicity to marine organisms about two orders of magnitude higher than typically used in the water phase (Black *et al*., 1994). The biocides typically used are highly reactive and degrade rapidly and are very soluble in water (Black *et al*., 1994).

These chemicals are inherently safe at the low dosages used, as they are usually 'consumed' in the inhibition process, ensuring there is little or no residual chemical concentration remaining upon discharge.

The impacts of cooling and brine water discharges to the physical and biological environment are expected to have negligible consequences because of the:

- Low discharge volumes;
- Intermittent nature of the discharges;
- Temporary nature of the discharges;
- 'Consumption' of the chemicals prior to discharge;
- High dilution and dispersal factor in open waters; and
- Absence of sensitive habitats in the Project area.

8.8.5. Risks to MNES

Cooling and brine water discharges will not have significant risks to MNES, as outlined in Table 8.24 below.

Table 8.24. Risks to MNES from cooling and brine water discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international	No	The nearest Ramsar-listed wetland (Gippsland

MNES	Impact?	Notes
importance (see Section 6.4.4)		Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges over a short-term drilling program, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the EMBA for cooling and brine water discharges.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.8.6. Risk Assessment

Table 8.25 presents the risk assessment for the discharge of cooling and brine water.

Table 8.25. Risk assessment for the discharge of cooling and brine water

Summary		
Summary of impacts	Increased sea surface temperature and salinity around the discharge point. Potential toxicity impacts to marine fauna from residual biocide and scale inhibitors.	
Extent of impact	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of impact	Temporary – duration of activity.	
Level of certainty of impact	HIGH – the impacts of sea surface temperature and salinity increases on marine fauna are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Equipment that requires cooling by water, and the RO plant, is well maintained.	Engines and associated equipment that require cooling by water will be maintained in accordance with the PMS so that they are operating within accepted parameters.	PMS records verify that the equipment is maintained to schedule.

Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Only low-toxicity chemicals are used in the cooling and brine water systems.	Only ONCS 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM)-rated chemicals are used in the cooling and brine water systems.	Chemical inventory records verify that biocides and scale inhibitors are of low toxicity.
If an Electrolytic Marine Growth Protection System (EMGPS) is used, it is maintained in accordance with the PMS so it is operating within specified operating parameters.	The EMGPS is maintained in accordance with the PMS to ensure it is operating efficiently (without the use of chemicals).	PMS records verify that the EMGPS is maintained to schedule.

Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Likely	Low

Environmental Monitoring
• None required.

Record Keeping
• PMS records. • Chemical inventory.

8.9. Discharge of Bilge Water and Deck Drainage

8.9.1. Risk Pathway

Bilge tanks will receive fluids from closed deck drainage and machinery spaces which may contain contaminants such as oil, detergents, solvents, chemicals and solid waste. An oily water separator (OWS) will treat this water prior to discharge overboard in order to meet the MARPOL requirement that no greater than 15 ppm oil-in-water (OIW) is discharged overboard. The volume of these discharges is small and intermittent (on an as-required basis, based on bilge tank storage levels).

Decks that are not bunded and drain directly to the sea may lead to the discharge of contaminated water, caused by ocean spray and rain ('green water') or deck washing activities capturing trace quantities of contaminants such as oil, grease and detergents, or a chemical or hydrocarbon spill or leak washed overboard.

MODUs typically discharge (intermittently) and treat about 20-35 m^3 of bilge water per month during operations. This results in an average hydrocarbon discharge of 2 to 3.5 litres/month (assuming an OIW content of 10 ppm).

8.9.2. Known and Potential Environmental Risks

The known and potential environmental impacts of the discharge of bilge water and deck drainage are:

- Temporary and localised reduction of surface water quality (organics and toxins) around the discharge point; and
- Acute toxicity to marine fauna through ingestion of, or contact with, contaminated water in a localised mixing zone (only in the event of malfunction of the OWS or an uncontrolled spill emanating from an open drainage area).

8.9.3. EMBA

The EMBA for bilge and deck water discharges is likely to be the top 10 m of the water column and a 100 m radius from the discharge point.

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds; and
- Avifauna.

8.9.4. Evaluation of Environmental Risks

Temporary and Localised Reduction of Surface Water Quality

Small volumes and low concentrations of oily water (<15 ppm) from bilge discharges and traces of chemicals or hydrocarbons discharged to the ocean through open deck drainage may temporarily reduce water quality.

Given the absence of sensitive habitat types in the water column of the EMBA for these discharges, the greatest risk will be to plankton and pelagic fish. These discharges will be rapidly diluted, dispersed and biodegraded to undetectable levels within a very small mixing zone.

Toxicity to Marine Fauna

While small volumes and low concentrations of oily water from bilge discharges may temporarily reduce water quality, such discharges are not expected to induce acute or chronic toxicity impacts to marine fauna or plankton through ingestion or absorption through the skin. In the event the OWS malfunctions and discharges off-specification water, these impacts may occur, though this is only likely in a highly localised mixing zone (meaning that few individuals would be exposed).

The impacts of bilge water and deck drainage discharges to the physical and biological environment will have negligible consequences because of the:

- Low discharge volumes;
- Intermittent nature of the discharge;
- High dilution and dispersal factor in open waters; and
- Absence of sensitive habitats in the Project area.

8.9.5. Risks to MNES

The discharge of bilge water and deck drainage will not have significant risks to MNES, as outlined in Table 8.26.

Table 8.26. Risks to MNES from bilge water and deck drainage discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges over a short-term drilling program, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to this discharge EMBA.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.9.6. Risk Assessment

Table 8.27 presents the risk assessment for the discharge of bilge water and deck drainage.

Table 8.27. Risk assessment for the discharge of bilge water and deck drainage

Summary	
Summary of impacts	Reduction of surface water quality around the discharge point. Acute toxicity to marine fauna through ingestion of, or contact with, heavily contaminated water (in the event of malfunction of the OWS or an uncontrolled spill on an un-bunded deck).
Extent of impact	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.
Duration of impact	Temporary – intermittently for the duration of drilling.

Level of certainty of impact	HIGH – the impacts of oily water discharges on the marine environment are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Bilge water discharges comply with Section 8(4)(e) of POWBONS.	All bilge water passes through a MARPOL-compliant OWS set to limit OIW to <15 ppm prior to overboard discharge.	IOPP certificates are current.
	The OWS is maintained in accordance with the vessel PMS.	PMS records verify that the OWS is maintained to schedule.
	The OWS is calibrated in accordance with the PMS to ensure the 15 ppm OIW limit is met.	PMS records verify that the OWS is calibrated to schedule.
	The residual oil from the OWS is pumped to tanks and disposed of onshore (no whole residual bilge oil is discharged overboard).	The Oil Record Book verifies that waste oil is transferred to shore.
	In the event of OWS malfunction, all oily water is retained onboard for transfer to shore or discharged in waters >12 nm from the shore.	The Oil Record Book verifies that bilge water is transferred to shore or discharged in waters >12 nm from shore.
Hydrocarbon or chemical spills on deck are not discharged overboard.	Hydrocarbon and chemical storage areas (process areas) are bunded and drain to the bilge tank (or equivalent).	Vessel piping and instrumentation diagrams (P&IDs) verify that hydrocarbon and chemical storage areas are bunded and drain to the bilge tank.
	Portable bunds and/or drip trays are used to collect spills or leaks from equipment that is not contained within a permanently bunded area (non-process areas).	Site inspections (and associated completed checklists) verify that portable bunds and/or drip trays are used in non-process areas as required.
The marine crews are competent in spill response and have appropriate resources to respond to a spill.	The MODU and vessel crews are competent in spill response and have appropriate response resources in order to prevent or minimise hydrocarbon or chemical spills discharging overboard.	Training records verify that crews receive spill response training.
	Fully stocked SMPEP response kits and scupper plugs or equivalent drainage control measures are readily available to the crew and used in the event of a spill to deck to prevent or minimise discharge overboard.	Site inspections (and associated completed checklists) verify that fully stocked spill response kits and scupper plugs (or equivalent) are available on deck in high-risk locations.

		Review of incident reports indicate that the spills of hydrocarbons or chemicals to deck are cleaned up.
Level 1 spills (<10 m^3) of oil or oily water overboard are rapidly stopped.	The vessel-specific Shipboard Marine Pollution Emergency Plan (SMPEP) is implemented in the event of a large spill of hydrocarbons or chemicals overboard.	Incident report verifies that the SMPEP was implemented.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Planned open deck discharges are non-toxic.	Deck cleaning detergents are biodegradable.	Safety Data Sheet (SDS) records verify that deck cleaning agents are biodegradable.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Likely	Low
Environmental Monitoring		
• Volume of bilge water discharge.		
Record Keeping		
• IOPP certificates. • PMS records. • Oil Record Books. • Crew training records. • Inspection and checklist records. • P&IDs. • SDS (for all hazardous materials, including deck cleaning agents). • SMPEPs. • Incident reports.		

8.10. Accidental Overboard Release of Waste

8.10.1. Risk Pathway

The handling and storage of materials and waste on board the MODU and support vessels has the potential for accidental overboard disposal of hazardous and non-hazardous materials and waste.

Small quantities of hazardous and non-hazardous materials will be used and waste created, and then handled and stored. In the normal course of operations, solid and liquid hazardous and non-hazardous materials and wastes will be stored onboard until it is transferred to shore via port facilities for disposal at licensed onshore facilities.

However, accidental releases to sea are a possibility, especially in rough weather conditions (e.g., high winds, large waves, storms) when items may roll off or be blown off the deck.

The following non-hazardous materials and wastes will be disposed of to shore, but have the potential to be accidentally dropped or disposed overboard due to overfull bins or crane operator error:

- Putrescible waste transferred from the MODU to the support vessels;
- Paper and cardboard;
- Wooden pallets;
- Scrap steel, metal and aluminium;
- Glass;
- Foam (e.g., ear plugs); and
- Plastics (e.g., hard hats).

The following hazardous materials may be used and waste generated through the use of consumable products and will be disposed to shore, but may be accidentally dropped or disposed overboard:

- Hydrocarbons, hydraulic oils and lubricants;
- Hydrocarbon-contaminated materials (e.g., oily rags, pipe dope, oil filters);
- Batteries, empty paint cans, aerosol cans and fluorescent tubes;
- Contaminated personal protective equipment (PPE);
- Laboratory wastes (such as acids and solvents); and
- Larger dropped objects (that may be hazardous or non-hazardous) may be lost to the sea through accidents (e.g., crane operations) include:
    - Sea containers;
    - Towed equipment;
    - ROV; and
    - Entire skip bins/crates.

8.10.2. Potential Environmental Risks

The risks of the release or accidental disposal of hazardous and non-hazardous materials and waste to the ocean, creating marine debris, are:

- Marine pollution (litter);
- Artificial increase in nutrient content in the case of putrescible waste;
- Degradation of marine water quality;
- Injury and entanglement of individual animals (such as seabirds and seals); and
- Localised (and normally temporary) smothering or pollution of benthic habitats.

8.10.3. EMBA

The EMBA for the accidental disposal of hazardous and non-hazardous materials and waste is likely to extend from tens of metres to kilometres from the release site depending on the exact nature (mainly buoyancy) of the accidentally released item.

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Benthic fauna;
- Benthic habitat (sand and reef substrates);
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles; and
- Avifauna.

In particular, the EPBC Act-listed species documented as being negatively impacted by the ingestion of, or entanglement in, harmful marine debris (and known to occur in the EMBA) are (according to DAWE, 2020a):

- The five marine turtle species;
- Eight albatross species and three petrel species;
- Other birds (flesh-footed shearwater, southern fairy prion);
- Australian fur-seal;
- Indian Ocean bottlenose dolphin; and
- The southern right, pygmy blue, humpback, sei, pygmy right and killer whales.

8.10.4. Evaluation of Environmental Risks

Hazardous Materials and Waste

Hazardous materials and wastes are defined as a substance or object that exhibits hazardous characteristics, is no longer fit for its intended use and requires disposal. Some of these hazardous characteristics (as outlined in Annex III to the Basel Convention) include being toxic, flammable, explosive and poisonous.

Marine debris (or marine litter) is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.

Hazardous materials and wastes released to the sea cause pollution and contamination, with either direct or indirect effects on marine organisms. For example, chemical or hydrocarbon spills can (depending on the volume released) impact on marine life from plankton to pelagic fish communities, causing physiological damage through ingestion or absorption through the skin. Impacts from an accidental release would be limited to the immediate area surrounding the release, prior to the dilution of the chemical with the surrounding seawater. In an open ocean environment such as Bass Strait, it is expected that any minor release would be rapidly diluted and dispersed, and thus temporary and localised. The absence of particularly sensitive seabed habitats and the widespread nature of the sandy seabed present in the Project area further limits the extent of potential impacts.

Solid hazardous materials, such as paint cans containing paint residue, batteries and so forth, would settle on the seabed if dropped overboard. Over time, this may result in the leaching of hazardous materials to the seabed, which could result in the adjacent substrate becoming toxic and unsuitable for colonisation by benthic fauna. The benthic habitats of the area are broadly similar to those elsewhere in the region (e.g., extensive sandy plains), so impacts to very localised areas of seabed will not result in the long-term loss of benthic habitat or species diversity or abundance.

All hazardous waste will be disposed of at appropriately licensed facilities, by licenced contractors.

Non-hazardous Materials and Waste

Discharged overboard, non-hazardous wastes can cause smothering of benthic habitats as well as injury or death to marine fauna or seabirds through ingestion or entanglement (e.g., plastics caught around the necks of seals or ingested by seabirds and fish). For example, the TSSC (2015b) reports that there have been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion since 1998 (humpback whales being the main species).

Marine fauna including cetaceans, turtles and seabirds can be severely injured or die from entanglement in marine debris, causing restricted mobility, starvation, infection, amputation, drowning and smothering (DoEE, 2018). Seabirds entangled in plastic packing straps or other marine debris may lose their ability to move quickly through the water, reducing their ability to catch prey and avoid predators, or they may suffer constricted circulation, leading to asphyxiation and death. In marine mammals and turtles, this debris may lead to infection or the amputation of flippers, tails or flukes (DoEE, 2018).

If dropped objects such as skip bins are not retrievable (e.g., by crane), these items may permanently smother very small areas of seabed, resulting in the loss of benthic habitat. However, as with most subsea infrastructure, the items themselves are likely to become colonised by benthic fauna over time (e.g., sponges) and become a focal area for sea life, so the net environmental impact is likely to be neutral. The sandy seabed substrates that dominate the Project area and surrounds can rapidly recover from temporary and localised impacts. The benthic habitats in the Project area are broadly similar to those elsewhere in the region (e.g., extensive sandy plains), so impacts to very localised areas of seabed will result in negligible loss of benthic habitat or species diversity or abundance.

The accidental overboard release of macerated food wastes creates a localised and temporary increase in the nutrient load of surface and near-surface waters and increases biological demand in the receiving waters. Organic materials from the discharge are a food source for scavenging marine fauna and/or seabirds, whose numbers may temporarily increase as a result. The rapid consumption of putrescible waste by scavenging fauna, and its physical and microbial breakdown and dispersion, ensures that the consequences of such a release are negligible.

8.10.5. Risks to MNES

The accidental release of hazardous and non-hazardous materials and waste will not have significant risk to MNES, as outlined in Table 8.28.

Table 8.28. Risks to MNES from the accidental release of hazardous and non-hazardous materials and waste

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.

MNES	Impact?	Notes
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the low risk of this release, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.10.6. Risk Assessment

Table 8.29 presents the risk assessment for the accidental disposal of hazardous and non-hazardous materials and waste.

Table 8.29. Risk assessment for the accidental disposal of hazardous and non-hazardous materials and waste

Summary		
Summary of risks	Marine pollution (litter and a temporary and localised reduction in water quality), injury and entanglement of individual animals (such as seabirds and seals) and smothering or pollution of benthic habitats.	
Extent of risk	Non-buoyant waste will sink to the seabed close to where it was lost. Buoyant waste may float long distances with ocean currents and winds.	
Duration of risk	Short-term to long-term, depending on the type of waste and location.	
Level of certainty of risk	HIGH – the effects of inappropriate waste discharges are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
The EPO, EPS and measurement criteria listed below are in addition to those for 'seabed disturbance'.		
Comply with POWBONS (Part 2, Divisions 2, 2A & 2B) by ensuring there is no unplanned release of hazardous or non-hazardous solid wastes or	A MARPOL Annex V-compliant Garbage Management Plan (GMP) is in place for the MODU (and for support vessels >100 gross tonnes or certified to carry 15 persons or more) that sets out the procedures for minimising, collecting, storing, processing and discharging garbage.	A GMP is in place, readily available on board and kept current.

materials.	Waste is stored, handled and disposed of in accordance with the GMP. This will include measures such as: • No discharge of general operational or maintenance wastes or plastics or plastic products of any kind. • Waste containers are covered with secure lids to prevent solid wastes from blowing overboard. • All solid wastes are stored in designated areas before being sent ashore for recycling, disposal or treatment. • Any liquid waste storage on deck must have at least one barrier to minimise the risk of spills to deck entering the ocean. This can include containment lips on deck (primary bunding) and/or secondary containment measures (bunding, containment pallet, transport packs, absorbent pad barriers) in place. • Correct segregation of solid and hazardous wastes.	Garbage Record Book (along with the waste manifest) verifies that the GMP is implemented. Visual inspections (and associated completed checklists) verify that waste is stored and handled according to its waste classification. Visual inspections (and associated completed checklists) verify that waste receptacles are properly located, sized, labelled, covered and secured for the waste they hold. A licensed shore-based waste contract is in use for the management of onshore waste transport.
	MODU and vessel crews are inducted into waste management procedures at the start of the drilling program to ensure they understand how to implement the GMP.	Induction records verify that all crew members have been inducted.
	Crane transfers are undertaken in accordance with the MODU-specific lifting procedures.	PTW (and associated JSA) is available for each shift.
	The MODU cranes and lifting equipment are maintained fit for use at all times to minimise the risk of dropped objects.	PMS records and/or the sling register verifies that checks and maintenance are undertaken to schedule.
	Solid waste that is accidentally discharged overboard is recovered if reasonably practicable.	Incident records are available to verify that credible and realistic attempts to retrieve the materials lost overboard were made.
Putrescible waste discharges comply with Section 23B of POWBONS.	No putrescible waste is discharged in the Project area (or state waters in general). All putrescible waste is transferred to shore for suitable disposal.	The Garbage Record Book verifies that putrescible waste was offloaded to support vessels for transfer to shore.

Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor (threatening processes)	Unlikely	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Grease and chemicals are stored in chemical storage lockers.	A chemical locker is available, bunded and used for the storage of all greases and non-bulk chemicals (i.e., those not in tote tanks) in order to prevent discharge overboard.	Site inspection verifies that greases and chemicals are stored in a chemical locker.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor (threatening processes)	Rare	Very low
Environmental Monitoring		
• Waste tracking in the activity-specific waste manifest.		
Record Keeping		
• GMP. • Garbage Record Book. • Crew induction records. • Inspection records/checklists. • PMS records. • PTW and JSA records. • Shore-based waste contract. • Waste manifest. • Incident reports.		

8.11. Introduction and Establishment of Invasive Marine Species

8.11.1. Risk Pathway

The DAWR (2018) defines marine pests (referred to in this report as Invasive Marine Species [IMS]) as:

> *Non-native marine plants or animals that harm Australia's marine environment, social amenity or industries that use the marine environment, or have the potential to do so if they were to be introduced, established (that is, forming self-sustaining populations) or spread in Australia's marine environment.*

The following activities have the potential to result in the introduction of IMS in the Project area:

- Discharge of ballast water from the MODU spud cans and support vessels, which may contain foreign species; and
- Translocation of foreign species through biofouling of the MODU legs and support vessel hull and niches (e.g., sea chests, bilges, strainers) or in-water equipment (e.g., ROV).

The MODU legs may pose a risk of introducing IMS. This risk is reduced compared to semi-submersible MODUs and vessels because the legs are raised out of the water when towed between drilling locations, meaning that any biofouling generally dehydrates and dies (and may dislodge) between locations (Photo 8.3) and is therefore less likely to survive in a new location once the MODU is jacked down.

There is little risk of ballast water from the MODU introducing IMS. This is because of the way in which ballast water is managed for a jack up MODU during the mobilisation phase. The MODU will arrive at the offload point (most likely Port Phillip Bay or Western Port) via Heavy Lift Vessel (HLV) on 'dry tow' with the legs and hull raised above the water. Once deployed from the HLV, some ballast will be taken on at the offload point and spud cans flooded. The MODU will then be 'wet towed' to site via support vessels whereby the hull remains in contact with the sea surface and the legs are raised above the hull. These are typically for short mobilisations within the same region. Once the MODU arrives at the drill site, additional ballast will be taken on to preload the rig and confirm adequate seabed foundation. Once the foundations have been confirmed, ballast will be discharged.

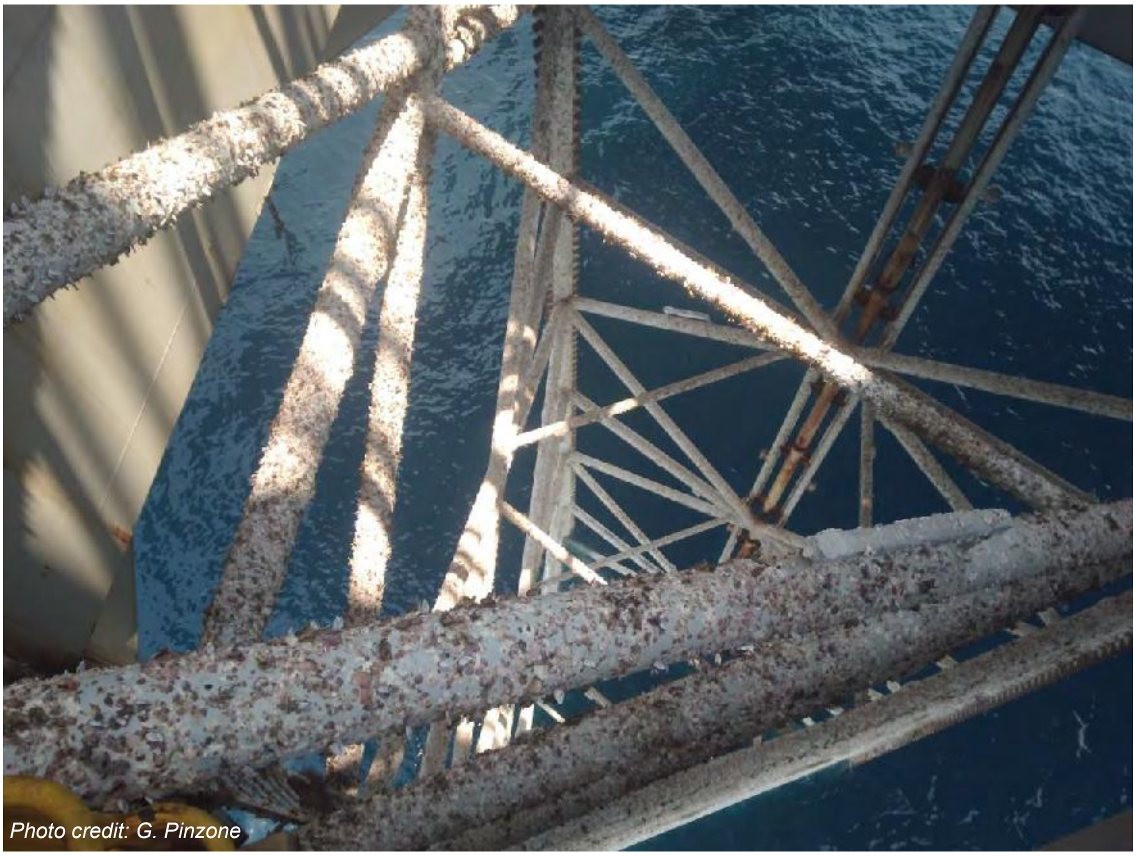


Photo 8.3. An example of desiccated biofouling on a jack-up MODU leg

The support vessels may ballast and de-ballast to improve stability, even out vessel stresses and adjust vessel draft, list and trim, with regard to the weight of equipment on board at any one time.

The DAWE Biosecurity Department indicates that ballast water is responsible for 20-30% of all marine pest incursions into Australian waters (DAWR, 2015). The DAWE declares that all saltwater from ports or coastal waters outside Australia's territorial seas presents a high risk of introducing foreign marine pests into Australia (AQIS, 2011), while DAWR (now DAWE) (2018) notes that the movement of vessels and marine infrastructure is the primary pathway for the introduction of IMS.

Biofouling is the accumulation of aquatic microorganisms, algae, plants and animals on vessel hulls and submerged surfaces. More than 250 non-indigenous marine species have established in Australian waters, with research indicating that biofouling has been responsible for more foreign marine introductions than ballast water (DAWR, 2015).

8.11.2. Potential Environmental Risks

The risks of IMS introduction (assuming their survival, colonisation and spread) include:

- Reduction in native marine species diversity and abundance;
- Displacement of native marine species;
- Socio-economic impacts on commercial fisheries; and
- Changes to conservation values of protected areas.

8.11.3. EMBA

Receptors most at risk within the Project area, either as residents or migrants, are:

- Benthic fauna (because of their limited ability to move to other suitable areas);
- Benthic habitat; and
- Pelagic and demersal fish.

8.11.4. Evaluation of Environmental Risks

Successful IMS invasion requires the following three steps:

1. Presence of the marine pest on a vector (e.g., vessel hull), in a vector (e.g., ballast water) in a donor region (e.g., home port).
2. Survival of the marine species on/in the vector during the voyage from the donor region (e.g., vessel mobilisation port) to the recipient region (e.g., Project area).
3. Colonisation (e.g., dislodgement or reproduction) of the marine species in the recipient region, followed by successful establishment of a viable new local population.

If successful invasion takes place, the IMS is likely to have little or no natural competition or predation, thus potentially outcompeting native species for food or space, preying on native species or changing the nature of the environment. It is estimated that approximately one in six introduced marine species becomes pests (AMSA, n.d).

Marine pest species can also deplete fishing grounds and aquaculture stock, with between 10% and 40% of Australia’s fishing industry being potentially vulnerable to marine pest incursion (AMSA, n.d). For example, the introduction of the Northern Pacific seastar (*Asterias amurensis*) in Victorian and Tasmanian waters was linked to a decline in scallop fisheries. Similarly, the ability of the New Zealand screw shell (*Maoricolpus roseus*) to reach densities of thousands of shells per square metre has presented problems for commercial scallop fishers in the Gippsland region (MESA, 2017). The ABC (2000) reported that the New Zealand screw shell is likely to displace similar related species of screw shells, several of which occupy the same depth range and sediment profile. Even native species can become over-abundant outside their usual habitat. For example, DELWP (no date) reports that the purple urchin (*Heliocidaris erythogramma*) has caused significant loss of broadleaf seagrass habitat in the Ramsar-listed Nooramunga Marine and Coastal Park in Corner Inlet.

Marine pests can also damage marine and industrial infrastructure, such as encrusting jetties and marinas or blocking industrial water intake pipes. By building up on vessel hulls, they can slow the vessels down and increase fuel consumption.

The CoA (2009) states that the operational and maintenance needs of immersible seismic survey equipment means that they do not typically pose a threat for biofouling accumulation and translocation. This is likely to apply equally to non-seismic immersible equipment (such as ROVs), which will be cleaned prior to initial use either in port or otherwise outside the project area.

Risks to marine life and habitat in and around the Project area include the potential for IMS to displace sponges and nearby reef-dependent species such as butterfly perch (*Caesioperca lepidoptera*), morwong (*Cheilodactylus* sp.), cowfish (*Arcana* sp.), boarfish (*Pentaceropsis recurvirostris*), wrasse (*Labridae* sp), rock cod (*Pseudophycis* sp.) and rock lobster, ultimately outcompeting them for food and habitat resources.

It is possible, though highly unlikely, that IMS may spread from the Project area to the Ninety Mile Beach MNP (located 25 km to the southwest). This marine park is noted for its diverse benthic assemblages, so the colonisation of IMS in this marine park may have a negative impact on benthic species diversity in the long-term.

8.11.5. Risks to MNES

The introduction of IMS is unlikely to have significant risks to MNES, as outlined in Table 8.30.

Table 8.30. Risks to MNES from the introduction of IMS

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	There are no threatened benthic marine species (which are more susceptible to the effects of IMS) recorded in the Project area and surrounds. Impacts to threatened and migratory marine species will not be significant given their ability to find resources in other parts of the marine environment. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas:		
- AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest. The long distance between the Beagle AMP (and its deeper, colder waters) and the Project area (with shallower, warmer waters) makes it unlikely that IMS introduced in the Project area would spread to and survive in the AMP.

MNES	Impact?	Notes
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.11.6. Risk Assessment

Table 8.31 presents the risk assessment for the introduction of IMS.

Table 8.31. Risk assessment for the introduction of IMS

Summary		
Summary of risks	Reduction in native marine species diversity and abundance, displacement of native marine species, socio-economic impacts on commercial fisheries and changes to conservation values of protected areas.	
Extent of risk	Localised (isolated locations if there is no spread) to widespread (if colonisation and spread occurs).	
Duration of risk	Short-term (IMS is detected and eradicated, or IMS does not survive long enough to colonise and spread) to long-term (IMS colonises and spreads).	
Level of certainty of risk	HIGH – the impacts associated with IMS introduction are well known and the vectors of introduction are known. Regulatory guidelines controlling these vectors have been established.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		
Biofouling		
The MODU and support vessels present a low biofouling risk.	The MODU and support vessels are managed in accordance with the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (AQIS, 2009). This means: • Conducting in-water inspection by divers or inspection in drydock if deemed necessary. • Biofouling risk will be assessed, with cleaning of hull and internal seawater systems undertaken if deemed necessary. • Anti-fouling coating status taken into account, with antifouling renewal undertaken if deemed necessary.	Biofouling assessment report prior to mobilising to site confirms acceptability of MODU and support vessel entry into Commonwealth waters.

	The MODU and any support vessels >400 gross tonnes carry a current International Anti-fouling System (IAFS) Certificates that is complaint with and Marine Order Part 98 (Anti-fouling Systems).	The IAFS Certificates are valid.
Ballast water		
The support vessels discharge only low risk ballast water.	Support vessels will fulfil the requirements of the Australian Ballast Water Management Requirements (DAWR, 2017, v7). This includes requirements to: • Carry a valid Ballast Water Management Plan (BWMP). • Submit a Ballast Water Report (BWR) through the Maritime Arrivals Reporting System (MARS). o If intending to discharge internationally-sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival. o If intending to discharge Australian-sourced ballast water, seek a low-risk exemption through MARS. • Hold a Ballast Water Management Certificate (BWMC). • Ensure all ballast water exchange operations are recorded in a Ballast Water Record System (BWRS).	BWMP is available and current. BWR (or exemption) is submitted prior to entry to the Project area. A valid BWMC is in place. An up-to-date BWRS is in place. An ePAR is available and signed off by DAWE.
Reporting		
Known or suspected non-compliance with biosecurity measures are reported to regulatory agencies.	Non-compliant discharges of domestic ballast water are to be reported to EPA and DAWE immediately.	Incident report notes that contact was made with DELWP and DAWR regarding non-compliant ballast water discharges.

Risk assessment (initial)			
Risk focus	Consequence	Likelihood	Risk rating
Environmental (ecosystem function)	Major	Possible	High
Social (commercial fisheries)	Major	Unlikely	Medium

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Submersible equipment (e.g., ROV) carries a negligible risk of IMS introduction.	Submersible equipment will be cleaned (e.g., biofouling is removed) prior to mobilising to site and prior to initial use for the project.	Records are available to verify that towed equipment was cleaned prior to use in the Project area.

The MODU and support vessels carry a low risk of IMS introduction.	A vessel contractor pre-qualification is undertaken to ensure biofouling and ballast water controls meet Project requirements.	Vessel contractor pre-qualification report verifies the MODU and support vessel meet the requirements outlined in this table.
The MODU and support vessels present a low biofouling risk.	For the MODU and support vessels (and Heavy Lift Vessel or tow vessels, if it/they enter the Project area), an IMS evaluation takes place prior to the MODU mobilising to site based on the following: • Inspecting the IAFS certificates to ensure they are current. • Reviewing recent MODU/vessel inspection/audit reports to ensure that the risk of IMS introduction is low. • Determining recent ports of call to determine the IMS risk of those ports. • Determining the need for in-water cleaning and/or re-application of anti-fouling paint if neither has been done recently in line with Anti-fouling and in-water cleaning guidelines. Implementing the biofouling guidance provided in part 5 of the Offshore Installations Biosecurity Guideline (v1.3, DAWR, Feb 2019).	An IMS evaluation report (or memo or similar) verifies that the evaluation took place and that the IMS risk is low.

Risk assessment (residual)

Risk focus	Consequence	Likelihood	Risk rating
Environmental (ecosystem function)	Major	Unlikely	Medium
Social (commercial fisheries)	Major	Rare	Medium

Environmental Monitoring

- Ballast water discharges.

Record Keeping

- Contractor pre-qualification reports.
- Biofouling risk assessment reports.
- BWMP.
- BWR.
- BWMC.
- BWRS.
- IAFS Certificates.
- DAWE-signed ePARs.
- DAWE-signed ballast water exchange logs.
- Incident reports.

8.12. Displacement of or Interference with Third-party Vessels and Activities

8.12.1. Risk Pathway

The physical presence of the MODU and support vessels will necessitate the enforcement of a small-radius (i.e., 500-m) temporary PSZ around the MODU to exclude third-party vessels (e.g., commercial and recreational fishing vessels and merchant vessels) and maximise the safety of the MODU and associated crew.

At the completion of drilling, the two subsea production wellheads and XMTs will remain protruding above the seabed, protected by a trawl guard (6 m above seabed). These will have a permanent PSZ in place (see the *operations phase* impact assessment).

Note that this section deals with displacement or interference in a socio-economic sense; collision hazard (and consequent MDO spill impacts) is addressed in Section 8.15.

8.12.2. Potential Environmental Risks

The risks of displacement of or interference with third-party vessels and activities are:

- Collisions between the MODU and third-party vessels (resulting in MODU and/or vessel damage). Note that impact causing an MDO spill as a result of a collision are addressed in Section 8.15;
- Diversion from navigation paths (leading to increased travel times and fuel usage/costs);
- Vessel damage (resulting in financial loss); and
- Damage to or loss of fishing equipment and/or loss of commercial fish catches (resulting in financial loss).

8.12.3. EMBA

The EMBA for the displacement of or interference with third-party vessels and activities is the PSZ around the MODU (a 500-m radius) and wherever support vessel movements occur in the Project area (more specifically the immediate area around two intersecting vessels).

Receptors most at risk within this EMBA are:

- Commercial and recreational fishing vessels;
- Commercial fishing equipment (e.g., trawl nets, lobster pots); and
- Merchant vessels.

8.12.4. Evaluation of Environmental Risks

Displacement of Third-party Vessels

The presence of the MODU (and to a lesser extent, the support vessels) will temporarily exclude other users of the marine environment in order to protect the MODU. Displacement of third-party vessels by the MODU is unlikely to occur because:

- The MODU is stationary and highly visible (due to its height above the water line and lighting), meaning vessels have sufficient time to detect the MODU (visually and by radar) and instigate an early detour around the PSZ;
- The Project area is contained entirely within the Bass Strait ATBA; and

- The Project area is distant from the Bass Strait shipping fairway (see Section 6.6.7 ‘Commercial Shipping’).

If displacement was to occur, it would result in a negligible increase in travel time and fuel cost at most, but in the context of an entire journey, this is not considered significant.

The consequence of displacing other users, such as commercial and/or recreational fishers, is considered negligible given the very sparse use of the area by fishers (see Section 6.6.3 ‘Commercial fishing’).

Interference with Third-party Vessels

In the event of a MODU-to-vessel or vessel-to-vessel collision, health and safety impacts are more likely than environmental impacts. Should the force of a collision be enough to breach a vessel hull (which is unlikely due to the high visibility of the vessels, sophisticated navigation aids used by large vessels and project consultation), an MDO spill may eventuate (this is addressed in Section 8.15).

Damage to or Loss of Fishing Equipment and Loss of Catch

Commercial (and recreational) fishing vessels will be excluded from operating within the PSZ for the duration of the activity. Interactions between the MODU, support vessels and third-party fishing vessels is likely to be minimal, because:

- There is a very low level of fishing in the Project area (only one commercial fisher operates in and immediately around the Project area);
- The MODU is highly visible;
- The support vessels are highly visible and slow-moving;
- The support vessels will escort errant third-party vessels away from the MODU; and
- Large vessels use sophisticated navigation aids.

If the previous points were not enough for a trawl fisher to avoid the area, there is the remote possibility that fishing gear (e.g., trawl nets) may get entangled by the MODU legs. This would likely result in the gear becoming detached from the fishing vessel and the loss of any associated catch. In addition to the cost of repairing or replacing this equipment, it could also result in the loss of income from fish caught during that fishing expedition.

Given the short duration of the activity, the low fishing intensity in the Project area and the single fisher currently working in the area, the risk of interference with third-party vessels is negligible.

Installed Subsea Production Equipment

The FFS, protruding 6 m above the seabed, will be installed to protect against damage to the wellhead and XMT and to minimise snagging of commercial fishing nets. If the FFS does result in trawl gear becoming detached from the fishing vessel and the loss of any associated catch, this could result in the loss of income from caught fish during that fishing expedition and costs associated with repairing or replacing this damaged equipment. This risk will be negated through:

- Installing a FFS over the wellhead and XMT;
- Conducting a post-drilling ROV survey to ensure there is no other debris remaining on the seabed at the completion of drilling;
- Communicating the location of the well with fisheries stakeholders; and

- Liaising with the Australian Hydrographic Office (AHO) to ensure that the wells and their PSZ are marked on navigation charts.

8.12.5. Risks to MNES

The displacement of and interference with third-party vessels and activities will not have significant risks to MNES, as outlined in Table 8.32.

Table 8.32. Risks to MNES from the displacement of and interference with third-party vessels and activities

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species are not relevant to this risk.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.12.6. Risk Assessment

Table 8.33 presents the risk assessment for the displacement of or interference with third-party vessels and activities.

Table 8.33. Risk assessment for the displacement of or interference with third-party vessels and activities

Summary	
Summary of risks	Presence of vessel/s (and towed equipment), damage to or loss of fishing equipment and loss of commercial fish catches.
Extent of risk	Highly localised – immediately around vessels.
Duration of risk	Short-term (minutes for a third-party vessel detour) to long-term (vessel collision).

Level of certainty of risk	HIGH – the impacts associated with vessel collisions are well known. The Bass Strait ATBA was established in acknowledgement of the risk posed by merchant vessels and petroleum infrastructure and smaller vessels.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid Collisions with the MODU and support vessels are avoided by ensuring they are readily identifiable to, and their location communicated to third-party vessels.	GB Energy has undertaken thorough pre-activity consultation with fishing stakeholders to ensure that commercial fishers are aware of the drilling and support vessel operations, timing and PSZ.	Consultation records verify that safety exclusion requirements were communicated to commercial fishing stakeholders.
	The AHO will be notified of the activity no less than four weeks prior to the activity commencing to enable the promulgation of Notice to Mariners and AusCoast navigational warnings.	Notice to Mariners is available, including MODU and support vessel details, location and timing.
	The MODU and support vessels are readily identifiable to third-party vessels.	Visual inspection (and associated completed checklists) verify that the anti-collision monitoring equipment (e.g., 24-hour radar watch, Global Maritime Distress Safety System [GMDSS] and AIS) is functional and in use.
The risk of collision with the MODU is avoided by gazetting and enforcing a 500-m radius PSZ.	The temporary PSZ is gazetted in the Victorian Government Gazette, effective from the MODU's arrival on location.	The PSZ gazettal is issued to GB Energy and available on the Victorian Government website.
	Visual and radar watch is maintained on the bridge of the support vessels at all times. The Vessel Masters and deck officers have valid SCTW certificates in accordance with AMSA Marine Order 70 (seafarer certification) (or equivalent) to operate radio equipment to warn of potential third-party spatial conflicts (e.g. International Convention on Standards of Training, Certification and Watch-keeping for Sea-farers [STCW95], GDMSS proficiency).	Appropriate qualifications are available to verify the competence of the Vessel Masters and deck officers.
	Constant communications between the MODU and support vessels are maintained to ensure the vessels are patrolling the PSZ at all times.	Visual confirmation and interview with the MODU Watch Keeper and Control Room Operator verifies that the support vessels are patrolling the MODU PSZ at all times.

	The Vessel Masters issue warnings (e.g., radio warning, flares, lights/horns) to third-party vessels approaching the PSZ in order to prevent a collision with the MODU.	Radio communications/ bridge log verifies that warnings to third-party vessels approaching the PSZ have been issued as necessary.
	One of the support vessels will remain with the MODU at all times and will intercept approaching vessels that have not heeded radio advice about the presence of the MODU.	Bridge log verifies that a support vessel has intercepted a third-party vessel approaching the PSZ as necessary.
Minimise The MODU and support vessels are authorised to operate within the Bass Strait Area to be Avoided.	GB Energy will apply to NOPSEMA and obtain permission for the MODU and support vessels to operate within the Bass Strait ATBA.	An 'Area to be Avoided' authorisation from NOPSEMA is granted to GB Energy.
Vessel-to-vessel collisions are managed in accordance with vessel-specific emergency procedures.	The Vessel Master will sound the general alarm, manoeuvre the vessel to minimise the effects of the collision and implement all other measures as outlined in the vessel or structure collision procedure (or equivalent).	Incident report verifies that the relevant safety procedure was implemented.
	Vessel collisions will be reported to Transport Safety Victoria and AMSA if that collision has or is likely to affect the safety, operation or seaworthiness of the vessel or involves serious injury to personnel.	Incident report verifies that AMSA was notified of a vessel collision.

Risk assessment (initial)			
Risk focus	Consequence	Likelihood	Risk rating
Displacement (commercial fishing)	Negligible	Almost certain	Low
Interference (commercial fishing)	Moderate	Unlikely	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Prevent damage to commercial fishing equipment and the wellheads.	Once drilling is complete, a trawl guard will be installed over the wellheads and XMTs to minimise the potential for snagging with fishing trawl gear.	The post-drilling ROV survey report and photos confirm that the trawl guard is in place.
	Within one week of drilling completion, the location of the wellhead trawl guard will be provided to commercial fisheries stakeholders via direct communications from GB Energy.	Stakeholder consultation records confirm that notification to commercial fisheries associations and the AHO was provided within a week of completing drilling.
	Within one week of drilling completion, the location of the wellhead trawl guard will be provided to the AHO so that navigation charts can be updated.	

Collisions with the MODU are avoided by ensuring it is readily identifiable to, and its location communicated to third-party vessels.	GB Energy will use South East Trawl Fishing Industry Association's (SETFIA) short message service (SMS) service to notify fishers of the drilling activity, timing and PSZ at least 2 weeks prior to drilling.		Consultation records verify the SMS service was used.
Risk assessment (residual)			
Risk focus	Consequence	Likelihood	Risk rating
Displacement (commercial fishing)	Negligible	Rare	Very low
Interference (commercial fishing)	Moderate	Rare	Low
Environmental Monitoring			
• Continuous bridge monitoring.			
Record Keeping			
• Stakeholder consultation communication records. • Notice to Mariners. • AusCoast warnings. • PSZ gazettal. • ATBA authorisation. • Bridge communication logs. • Crew qualifications. • Incident reports.			

8.13. Vessel Strike with Megafauna

8.13.1. Risk Pathway

The movement of the support vessels within the PSZ has the potential to result in collision or entanglement with megafauna, this being cetaceans, pinnipeds and vagrant sea turtles.

The MODU legs will not present a strike hazard to megafauna as they are stationary and readily detected and avoided by megafauna (similar to the oil and gas platform jackets in Bass Strait). In Bass Strait, fur-seals frolic around MODU legs and platform jackets without any apparent risk of injury.

8.13.2. Potential Environmental Risks

The risks of vessel strike with megafauna are:

- Injury; and
- Death.

8.13.3. EMBA

The EMBA for vessel strike with megafauna is the immediate area around the support vessels.

Receptors most at risk within this EMBA are:

- Cetaceans (whales and dolphins);

- Pinnipeds (fur-seals and true seals); and
- Marine turtles.

8.13.4. Evaluation of Environmental Risks

Cetaceans and pinnipeds are naturally inquisitive marine mammals that are often attracted to offshore vessels, and dolphins commonly 'bow ride' with offshore vessels. The reaction of whales to the approach of a vessel is quite variable. Some species remain motionless when in the vicinity of a vessel (e.g., narwhals) while others are known to be curious and often approach ships that have stopped or are slow moving, although they generally do not approach, and sometimes avoid, faster moving ships (Richardson et al., 1995). The DoEE (2017) notes that whale and dolphin watching from vessels has a relatively low impact on target animals when appropriate management measures are implemented (noting of course that support vessels are not operating in a cetacean watching capacity).

Peel et al (2016) reviewed vessel strike data (2000-2015) for marine species in Australian waters and identified the following:

- Whales – including the humpback, pygmy blue, Antarctic blue, southern right, dwarf minke, Antarctic minke, fin, bryde's, pygmy right, sperm, pygmy sperm and pilot species were identified as having interacted with vessels. The humpback whale exhibited the highest incidence of interaction followed by the southern right whale, and these species may migrate through the waters of the Project area (see Section 6.3.5).
- Dolphins – including the Australian humpback, common bottlenose, Indo-pacific bottlenose and Risso's dolphin species were also identified as interacting with vessels. The common bottlenose dolphin exhibited the highest incidence of interaction. A number of these species may reside in or pass through the waters of the Project area (see Section 6.3.5).
- Australian or New Zealand fur-seal – there were no vessel interaction reports during the period for either these seals. There have been incidents of seals being injured by boat propellers, however all indications are rather than 'boat strike' these can be attributed to be the seal interacting/playing with a boat, with a number of experts indicating the incidence of boat strike for seals is very low.
- Turtles – all turtle species present in Australian waters are identified as interacting with vessels. The green and loggerhead species exhibited the highest incident of interaction. The likelihood of turtles been present in the Project area is considered remote.

Collisions between vessels and cetaceans occur more frequently where high vessel traffic and cetacean habitat coincide (WDCS, 2006). There have been recorded instances of cetacean deaths in Australian waters (e.g., a Bryde's whale in Bass Strait in 1992) (WDCS, 2006), though the data indicates this is more likely to be associated with container ships and fast ferries. Some cetacean species, such as humpback whales, can detect and change course to avoid a vessel (WDCS, 2006). The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with an animal (species not defined) (NMSC, 2010).

The DoE (2015b) reports that there were two blue whale strandings in Victoria in the Bonney Upwelling with suspected ship strike injuries visible. When the vessels are stationary or slow moving, the risk of collision with cetaceans is extremely low, as the vessel sizes and underwater noise 'footprint' will alert cetaceans to its presence and thus illicit avoidance. Laist et al (2001) identifies that larger vessels moving in excess of 10 knots may cause fatal or severe injuries to cetaceans with the most severe injuries caused by vessels travelling faster than 14 knots.

When moving through the PSZ, the support vessels will either be stationary (holding station) or be travelling very slowly, generally no greater than 4 knots (7 km/hr) (less than the speed identified as being able to cause fatal or severe injuries to cetaceans). This stationary or slow travel speed greatly minimises the risk of injury to megafauna.

Outside of the respective migration periods, there is a low likelihood of presence of southern right, pygmy blue and humpback whales in the Project area. Even during migration season, the shallow water of the Project area is not preferred habitat for humpback whales and there is no defined migration route for pygmy blue whales through the region, meaning there is a lower probability of these two species being present. This makes it even less likely that vessel strike with whale species will occur. Southern right whales do have a defined nearshore migration route and may be present in the Project area during their migration season (May to October), though the risk of collision with this species is low due to the low speeds of the support vessels and their likely avoidance of the underwater sound associated with the vessels.

Dolphins and fur-seals are highly agile species and fast swimmers, which makes them more likely to avoid an oncoming vessel, particularly at such slow speed.

8.13.5. Risks to MNES

Vessel strike with megafauna will not have significant risk to MNES, as outlined in Table 8.34.

Table 8.34. Risks to MNES from vessel strike with megafauna

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	The low likelihood of presence of southern right, pygmy blue and humpback whales outside of the migration period in the Project area, combined with the lack of a defined migration route for pygmy blue whales and preference for deeper water by humpbacks and pygmy blues in the Gippsland region, makes it unlikely that vessel strike with threatened whale species will occur. Vessel collisions are listed as a threat to cetaceans in the: • Conservation Management Plan for the Southern Right Whale (DSEWPC, 2012c); • Conservation Management Plan for the Blue Whale (DoE, 2015b); • Conservation advice for the sei whale (TSSC, 2015a); • Conservation advice for the fin whale (TSSC,
Listed migratory species (see Section 6.3)	No	

MNES	Impact?	Notes
		2015d); and • Conservation advice for the humpback whale (TSSC, 2015b). The EPS listed in this Table 8.35 aim to minimise the risk of vessel strike with megafauna, and do not breach the management actions of the above-listed whale conservation plans.
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.13.6. Risk Assessment

Table 8.35 presents the risk assessment for megafauna vessel strike and entanglement.

Table 8.35. Risk assessment for megafauna vessel strike

Summary		
Summary of risks	Injury or death of cetaceans, pinnipeds and turtles.	
Extent of risk	Localised – limited to individuals coming into contact with the support vessels.	
Duration of risk	Temporary (if individual animal dies or has a minor injury) to long-term (if there is a serious injury).	
Level of certainty of risk	HIGH – injury may result in the reduced ability to swim and forage. Serious injury may result in death.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid		
No injury or death of megafauna as a result of vessel strike.	Support vessel crews will implement The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017b) for sea-faring activities, which means: • Caution zone (300 m either side of observed whales and 150 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone.	DDRs note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision.

	• No approach zone (100 m either side of observed whales and 50 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone and should not enter this zone and should not wait in front of the direction of travel or an animal or pod/group. • Do not encourage bow riding. • If animals are bow riding, do not change course or speed suddenly. • If there is a need to stop, reduce speed gradually.	
	Support vessel crews have completed an environmental induction covering the above-listed requirements.	Induction and attendance records verify that support vessel crews have completed an environmental induction.
	Vessel crews, but most notably the vessel Masters and Mates, will keep watch for whales and dolphins at all times so that the guidelines can be implemented.	Whale and dolphin sighting records verify that watch was maintained at all times and that the guidelines were followed as required.
Rehabilitate Vessel strike is reported to regulatory authorities.	Injury to megafauna serious enough to require intervention/rescue is reported to the Whale and Dolphin Emergency Hotline on 1300 136 017 as soon as possible. No attempts to assist/rescue megafauna should be made by vessel crew.	Incident report verifies contact was made with the Whale and Dolphin Emergency Hotline.
	Vessel strike causing injury to or death of a cetacean is reported to the DoEE via the online National Ship Strike Database (https://data.marinemammals.gov.au/report/shipstrike) within 72 hours of the incident.	Electronic record of report submittal is available.

Risk assessment (initial)			
Risk	Consequence	Likelihood	Risk rating
Individual animal (threatening processes)	Minor	Possible	Low
Population level (threatening processes)	Minor	Unlikely	Low
Additional mitigation measures			
None additional mitigation identified.			
Risk assessment (residual)			
Risk	Consequence	Likelihood	Risk rating
Individual animal (threatening processes)	Minor	Possible	Low
Population level (threatening processes)	Minor	Unlikely	Low
Environmental Monitoring			

• Vessel crew induction presentation and attendance records. • Megafauna sightings by vessel crew.
Record Keeping
• DDRs. • Induction and attendance records. • Megafauna sighting records. • Incident reports.

8.14. Accidental Bulk Discharge of Drilling Fluids, Chemical or Hydrocarbons

8.14.1. Risk Pathway

The following activities have the potential to result in spills of drilling fluids, chemicals and hydrocarbons:

- MODU operations – crane transfers and bunkering operations; and
- Support vessel operations – crane transfers and bunkering operations.

Crane transfers or bunkering operations between support vessels and the MODU may result in accidental discharges of various products overboard or to deck, such as:

- Drilling muds (WBM);
- Bulk drilling chemicals (e.g., barite, bentonite);
- Bulk chemicals (e.g., pipe dope, BOP hydraulic fluids);
- Hydraulic oil from the cranes' electric prime movers;
- Helicopter aviation fuel (avgas [aviation gasoline] or diesel [Jet-A]) (helicopter refuelling is unlikely to be required at the drilling location because of its close proximity to heliports, but there will be a small volume [generally several cubic metres] stored on the MODU in case of emergency); and
- Assorted pumps, winches, power packs and generators.

Spills overboard may be caused by:

- Hose or connection failure (due to equipment condition or failure of a support vessel to keep station);
- Failure to align valves correctly during transfer to tanks;
- Overfilling of tanks on MODU;
- Dropped objects from crane transfers; and
- Accidental or emergency disconnection of the riser.

Fluids stored in tanks (or pits) are pumped between tanks or to mixing equipment using transport pumps. The pipes through which they are pumped are under pressure. Possible causes of spills during these transfers include:

- Leaks due to the condition of pipes, connections, flanges and valves;
- Leaks from pump packers;
- Leaks from blocked mixing hoppers;
- Loss of storage tank integrity; and
- Failure to align valves correctly during transfer to tanks.

8.14.2. Potential Environmental Risks

The known and potential environmental risks of the bulk discharge of drilling muds, chemicals and fuel are:

- Temporary and localised reduction of water quality; and
- Acute toxicity to marine fauna through ingestion or absorption.

8.14.3. EMBA

The EMBA for the risk of bulk discharge of drilling muds, chemicals and fuel is likely to range from tens to hundreds of metres depending on the product and volume spilled, so a precise EMBA cannot be determined.

Receptors most at risk within this EMBA are:

- Fish;
- Marine mammals; and
- Turtles.

8.14.4. Evaluation of Environmental Risks

The impact of the discharge of drilling muds is addressed in Section 8.3. The impacts of an accidental bulk discharge of drilling muds will be similar to the routine discharge of mud, dependent on the volume released. There is the potential for an unplanned release to be of higher volume and shorter duration than routine discharges, meaning there is potential for a larger turbidity plume and larger extent of seabed deposition. It is likely that such a release will take longer to dilute and disperse through the water column and that there may be higher levels of deposition on the seabed.

The risks associated with the discharge of chemicals is addressed in Section 8.10. The risks of a bulk discharge of chemicals will be no different, though the increased release volume means it will take longer to dilute and disperse through the water column.

The risks associated with the discharge of MDO is addressed in Section 8.15. The risks of a discharge of aviation fuel will be less than that resulting from a vessel collision due to the much smaller volumes involved, so the extent of spread will be less, and the high volatility of aviation fuel means a greater proportion of fuel will evaporate much faster than MDO.

8.14.5. Risks to MNES

Accidental bulk discharge of drilling fluids, chemicals or hydrocarbons will not have a significant risk to MNES, as outlined in Table 8.36.

Table 8.36. Risks to MNES from the accidental bulk discharges of drilling fluids, chemicals or hydrocarbons

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international	No	The nearest Ramsar-listed wetland (Gippsland

MNES	Impact?	Notes
importance (see Section 6.4.4)		Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

8.14.6. Risk Assessment

Table 8.37 presents the risk assessment for the bulk discharge of drilling muds, chemicals and fuel.

Table 8.37. Risk assessment for the bulk discharge of drilling muds, chemicals and fuels

Summary		
Summary of risks	Pollution of the water column. Toxicity to marine fauna.	
Extent of risk	Localised – a small mixing zone around the MODU.	
Duration of risk	Temporary – duration of the activity.	
Level of certainty of risk	HIGH – the impacts associated with drilling fluid, chemical and hydrocarbon spills at sea are well known and documented.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		
Hydrocarbons and chemicals stored on the MODU are stored in a manner that prevents bulk release.	All hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.	Visual inspection verifies that hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.

	Where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.	Visual inspection verifies that where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.
The MODU management and crew are well prepared to respond to deck spills.	The MODU OIM ensures that crew undertake spill response training every three months in accordance with the SMPEP and training matrix.	Training records show that relevant crew receive quarterly spill response training.
	In accordance with the SMPEP, oil spill response kits are available in relevant locations around the MODU, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for MDO spills to deck record that the spill is cleaned up using SMPEP resources.
Reporting		
A bulk spill of chemicals or hydrocarbons at surface will be promptly reported internally and managed.	The MODU OIM will report a bulk spill to the GB Energy Drilling Supervisor and lead the onboard response in line with the SMPEP.	Incident reports and logs confirm that internal notifications were made in a timely fashion.
A bulk spill of chemicals or hydrocarbons at surface will be promptly reported to external regulatory agencies.	GB Energy will report to the DJPR (EMB) within 2 hours of becoming aware of the spill.	Incident reports and logs confirm that regulatory authorities were notified within 2 hours of GB Energy becoming aware of the spill.

Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor (ecosystem function)	Unlikely	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
MODU storage systems (bunds, hoppers), hose fittings and so forth are well maintained.	Planned maintenance is undertaken to the PMS schedule.	PMS records verify that maintenance work (and repairs where necessary) is undertaken.
The operation of the dump valve/s for the mud tanks will be managed under a PTW system.	The mud dump valve/s are locked, with the keys remaining secure in a key locker. A PTW will be required to unlock the dump valve/s, which involves an assessment by the OIM regarding the need for a specific operation.	Visual inspection of key locker and dump valve/s verify its integrity.
		PTW records verify that a PTW was prepared prior to unlocking the dump valve/s.

A pre-acceptance inspection of the MODU takes place.	GB Energy's pre-acceptance inspection of the MODU confirms that storage tanks, equipment, bunding and machinery spaces are free of defects.	MODU pre-acceptance inspection records verify good condition of all equipment.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor (ecosystem function)	Rare	Very low
Environmental Monitoring		
• Not applicable.		
Record Keeping		
• Pre-acceptance MODU inspection records. • Inspection records. • Training records. • Daily fluids reports. • PMS records. • PTWs and Job Safety Analysis (JSAs). • Incident reports.		

8.15. Diesel Spill

8.15.1. Risk Pathway

The MODU and support vessels carry large inventories of MDO. The fuel inventory is split between numerous tanks and may be spilled in the event of an emergency. The following events may result in the loss of part of the inventory of one or more fuel tanks:

- A vessel-to-vessel collision (e.g., third-party vessel with the support vessel); or
- Vessel grounding (e.g., in shallow waters on a rocky reef or sand bar).

DNV (2011) indicates that for the period 1982-2010, there were no spills over 1 tonne (1 m^3) for offshore vessels caused by collisions or fuel transfers.

Properties of MDO

The following points summarise the nature and behaviour of MDO, based on APASA (2012):

- MDO is dominated by n-alkane hydrocarbons that give diesel its unique compression ignition characteristics and usually consist of carbon chain C11-C28 but may vary depending upon specifications (e.g., winter vs. summer grades).
- While MDOs are generally considered to be non-persistent oils, many can contain a small percentage (approximately 3-7%) by volume of hydrocarbons that are classified as 'persistent' under International Oil Pollution Compensation Fund definition (i.e., greater than 5% boiling above 370°C).
- Diesel fuels are light, refined petroleum products with a relatively narrow boiling range, meaning that when spilled on water, most of the oil evaporates or naturally disperses quickly (hours to days).
- Diesel fuels are much lighter than water, so it is not possible for diesel oil to sink and accumulate on the seabed as pooled or free oil.

- 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. While the majority of the MDO evaporates quickly (for this study, the evaporation rate after 2 days is between 38% in 15 knot winds and 45% in 5 knot winds, as shown in Figure 8.5), it is common for the residues of MDO spills after weathering to contain n-alkanes, iso-alkanes and naphthenic hydrocarbons.
- Minor quantities of polyaromatic hydrocarbons (PAHs) will be present.
- When spilled on water, MDO spreads very quickly to a thin film and have low viscosities that can result in hydrocarbons becoming physically dispersed as fine droplets into the water column when winds exceed 10 knots.
- Droplets of MDO that are naturally or chemically dispersed sub-surface behave quite differently to oil on the sea surface. Diesel droplets will move 100% with the currents under water but on the surface are affected by both wind and currents.
- Natural dispersion of MDOs will reduce the hydrocarbons available to evaporate into the air. Although this reduces the volume of hydrocarbons on the water surface, it increases the level of hydrocarbons able to be inhaled. This increased hydrocarbon vapour exposure can affect any air breathing animal including whales, dolphins, seals and turtles.
- The environmental effects of MDOs spills are not as visually obvious as those of heavy fuel oils (HFO) or crude oils. Diesel oil is considered to have a higher aquatic toxicity in comparison to many other crude oils due to the:
    - High percentage of toxic, water-soluble components (such as BTEX and PAH);
    - Higher potential to naturally entrain in the water column (compared to HFO);
    - Higher solubility in water; and
    - Higher potential to bioaccumulate in organisms.
- Diesel fuel oils are not very sticky or viscous compared to black oils. When diesel oil strands on a shoreline, it generally penetrates porous sediments quickly, but is also washed off quickly by waves.
- In open water, diesel oil spills are so rapidly diluted that fish kills are rarely observed (this is more likely in confined, shallow waters).

Oil Spill Trajectory Modelling

Oil spill trajectory modelling (OSTM) is a valuable tool widely used for risk assessment, emergency response and contingency planning where it can be particularly helpful to proponents and decision makers. By modelling a series of the most likely oil spill scenarios, decisions concerning suitable response measures and strategic locations for deploying equipment and materials can be made, and the locations at most risk can be identified.

Stochastic oil spill modelling, which has been used to inform this EIA, is created by overlaying multiple (often hundreds) of individual computer-simulated hypothetical spills. Stochastic modelling typically utilises hydrodynamic data for the location in combination with wind data. The outcomes are often presented as a probability of exposure, which is primarily used for risk assessment purposes and to understand the range of environments that could be influenced or impacted by a spill.

GB Energy commissioned RPS to undertake OSTM specific to the location and design of this drilling program (RPS, 2020). This involved modelling the loss of 155 m^3 of MDO over 6 hrs (26 m^3/hr) from a support vessel using an amalgamation of 100 random spill release sites within the Project area tracked for 20 days, using five years of wind and current data inputs (2009 to 2018 inclusive). The modelling does not take into account any spill prevention or mitigation measures that would likely be deployed in response to the spill.

This modelling work meets and exceeds the *American Society for Testing and Material Standard F2067-13 (Standard Practice for Development and Use of Oil Spill Models).*

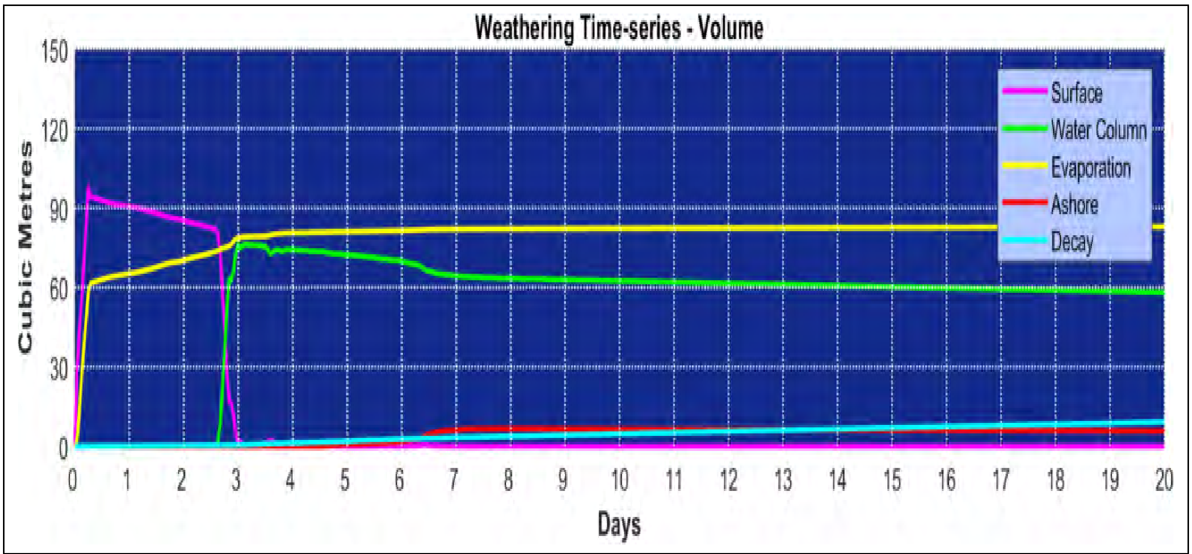


Figure 8.5. Predicted weathering and fates graph for the selected deterministic spill trajectory. Results are based on a 155 m^3 surface release of marine diesel over 6 hours, in the event of a vessel collision incident, tracked for 20 days, starting 9:00 am 30th April 2014.

MDO spill modelling

MDO characteristics

Given that vessels have yet to be contracted, the exact type of fuel to be used is unknown (it could be either MDO or marine gas oil, MGO). For the sake of conservativeness, MDO has been used for this OSTM, as this is a heavier product than MGO. The physical characteristics of the MDO are provided in Table 8.38, with the boiling ranges of the MDO provided in Table 8.39.

Table 8.38. Physical characteristics of MDO

Oil property	MDO
Density (kg/m^3)	829.1 @ 15°C
API	37.6
Dynamic viscosity (cP)	4.0 @ 25°C
Pour point (°C)	-14
Oil property category (ITOPF)	Group II
Oil persistence classification	Light persistent oil

Table 8.39. Boiling ranges of the MDO used in the OSTM

Characteristic	Volatiles (%)	Semi-volatiles (%)	Low volatiles (%)	Residuals (%)
Boiling point (°C)	<180	180-265	265-380	>380
MDO	6.0	34.6	54.4	5
	Non-persistent			*Persistent*

Determining the Spill Scenario

A vessel-to-vessel collision scenario has been selected for the OSTM. Other potential modelling scenarios were dismissed as having negligible risks or as non-credible, as discussed below:

- MODU refuelling is a closely supervised activity on board a MODU with strict controls on the transfer of fuel from support vessels to the MODU. The fuel transfer hoses are supplied by the MODU and generally have a capacity of 47 m^3 (based on a re-fuelling hose 10 cm in diameter and 60 m long). The fuel transfer pump for jack-up MODUs is typically capable of supplying up to 33 m^3/hr. AMSA's guidance (AMSA, 2015) of using the fuel transfer rate multiplied by 15 minutes of flow (for supervised operations) to estimate the volume of MDO for spill modelling significantly over-estimates how long it would take to shut down re-fuelling operations and it is more likely to be around 5 minutes maximum based on industry experience. Fifteen minutes of flow from the pumps represents a potential loss of 8.25 m^3 based on the maximum transfer pump rate. A spill of this volume would rapidly evaporate and dilute with seawater, and would not reach shorelines, causing negligible environmental impacts (NOAA, 2006). Therefore, this spill size has not been assessed further. However, controls for minimising the risk of a spill during refuelling are considered in this section for completeness.
- An errant vessel collision between a support vessel or third-party vessel with the MODU that results in a significant loss of MDO from the MODU is dismissed as a non-credible risk and is therefore not modelled. This is because:
  - The drilling location is located entirely within the Bass Strait ATBA, meaning large merchant vessels (large enough to result in MODU collapse in the event of a collision) are unlikely to be in the Project area;
  - A temporary PSZ will be gazetted around the MODU;
  - One support vessel is present on location at all times to maintain guard and intercept any errant vessels;
  - Jack-up MODU hulls are raised high above the water line (generally about 20-25 m), meaning that the tanks would not be pierced in the event of a collision with a large vessel.
  - The MDO tanks are located inboard (mud, pre-load and potable tanks typically located on the outer edge of the hull) and double-skinned, further ensuring that piercing of the MDO tanks (and loss of fuel) is even more unlikely.

Spill Location

For this assessment, 100 release sites spaced evenly within PSZ were selected, with one simulation run from each point. This removes any bias in selecting a single spill location, and is the preferred method for modelling spills from moving vessels because:

- The vessel is a moving point, so selecting just one spill location would put an undue emphasis on that location;
- The point that is selected might be the closest to one particular receptor, but it may be further from others; and
- The nearest point within the Project area to a receptor may not pose the greatest risk. Depending on the prevailing metocean conditions, it may be a point further north or south, east or west.

Spill Volume

The *Technical Guidelines for preparing Contingency Plans for Marine and Coastal Facilities* (AMSA, 2015) specify that an appropriate spill size for a vessel collision (a non-oil tanker) should be based on the volume of the largest tank, while the volume for a non-major grounding should be based on the total fuel volume of one tank. GB Energy has used this guidance in determining the volume to be modelled for this study.

Given that vessels for this activity have yet to be contracted, the exact volume of MDO to be carried by the vessels cannot be provided. A search of vessel specifications for key vessel operators supporting the oil and gas industry (Swire Pacific, Solstad, Greatship Group, Seatrucks Group, DOF, Standford Marine, Fugro, Offshore Solutions Unlimited) found numerous vessel specifications, including overall fuel storage capacity, but not individual fuel tank sizes. Swire Offshore was the only company with tank specifications publicly available. A volume of 155 m^3 was selected for this spill scenario, as this represents the average of the single largest tank across Swire's five vessel classes (15 vessels in classes B, C, D, V & W), which are considered viable options for drilling support vessels. The largest fuel tank sizes for the support vessels used on the nearby CarbonNet Gular-1 drilling campaign (in early 2020) were:

- MMA Coral – 87.2 m^3;
- MMA Leeuwin –159.4 m^3; and
- MMA Vision –70.4 m^3.

Similar sized vessels are likely to be used for this drilling program, and that the largest tank in the fleet of vessels supporting this rig in Bass Strait is 159 m^3, the 155 m^3 figure is appropriate to use given that it is an average across many vessel fleets.

An outline of the spill thresholds used for the OSTM is provided in Table 8.40. These thresholds are adopted from NOPSEMA's Bulletin #1 Oil spill modelling (April 2019) for consistency with the OSTM thresholds used by the oil and gas industry operating in Commonwealth waters.

Table 8.40. MDO spill concentration thresholds used in the OSTM study

Hydrocarbon phase	Concentration threshold	Concentration
Floating oil	Low	1 g/m^2
	Moderate	10 g/m^2
	High	50 g/m^2
Shoreline loading	Low	10 g/m^2

Hydrocarbon phase	Concentration threshold	Concentration
	Moderate	100 g/m^2
	High	1,000 g/m^2
Dissolved aromatic	Low	10 ppb
	Moderate	50 ppb
	High	400 ppb
Entrained oil	Low	10 ppb
	High	100 ppb

A summary of the parameters used for the OSTM is provided in Table 8.41.

Table 8.41. Summary of the OSTM settings

Parameter	Scenario inputs
Season	Annualised (i.e., an average of annual wind and current data from 2009-2018)
Number of randomly selected spill locations	100
Spill volume	155 m^3
Spill volume justification	Based on average of largest fuel tanks across 15 Swire Offshore vessels in five vessel classes
Release type	At sea surface
Release duration	6 hours
Release duration justification	A release of 155 m^3 would take several hours to be released from a hole of unknown diameter in a fuel tank.
Simulation length	20 days
Water temperature	In the top 25 m of the water column, the average temperature varies between 14°C to 18°C across the year.
Surface oil concentration thresholds	LOW exposure 1-10 g/m^2 (or 0.001-0.01 mm, equivalent to a rainbow to metallic sheen) MODERATE exposure: 10-50 g/m^2 (or 0.01-0.025 mm, equivalent to a metallic sheen) HIGH exposure: ≥50 g/m^2 (or >0.025 mm, equivalent to a metallic sheen to continuous true colour)
Shoreline load threshold	LOW exposure: 10-100 g/m^2 MODERATE exposure: 100-1000 g/m^2 HIGH exposure: ≥1,000 g/m^2
Dissolved aromatic dosage	LOW exposure: 10-50 ppb MODERATE exposure: 50-400 ppb

Parameter	Scenario inputs
	HIGH exposure: ≥400 ppb
Entrained dosage	LOW exposure: 10-100 ppb HIGH exposure: ≥100 ppb

A summary of the OSTM results is provided in Table 8.42.

Table 8.42. Summary of the OSTM results

Threshold	Results (based on 100 spill trajectories during annual conditions)
Sea surface contact (Figure 8.6)	
LOW exposure: 1-10 g/m^2 **(visual impact only)** (or 0.001mm, or 1 µm, equivalent to a rainbow to metallic sheen)	The greatest distance travelled from the release location is 250 km, predominantly in an east-northeast direction. There is a 8% probably of incursion into the Ninety Mile Beach MNP, and it would take 21 hours to reach the park. There is a 1% probability of incursion into Cape Howe MNP, and it would take 58 hours hours to reach the park. There is a 1% probability of incursion into Point Hicks MNP, and it would take 205 hours to reach the park. There is a 12% probability of incursion into the Upwelling East of Eden KEF, and it would take 29 hours to reach the KEF.
MODERATE exposure: 10-50 g/m^2 (or 0.01-0.050 mm, or 10-50 µm, equivalent to a metallic sheen)	The greatest distance travelled from the release location is 38 km, predominantly in a northeast direction. There is a 3% probably of incursion into the Ninety Mile Beach MNP, and it would take 21 hours to reach the park. No KEF is predicted to be contacted.
HIGH exposure: ≥50 g/m^2 (or >0.050 mm, equivalent to a metallic sheen to continuous true colour)	The greatest distance travelled from the release location is 8 km, predominantly in a southwest direction. No marine protected areas are predicted to be contacted. The KEF is not predicted to be contacted.
Shoreline (Figure 8.7)	
LOW exposure: 10-100 g/m^2 Equivalent to an oil stain/film (~2 tsp/m^2)	There is a 48% probability of shoreline contact, with a minimum time to shore of 6 hours. A maximum of 24.5 km of shoreline may be exposed to MDO.
MODERATE exposure: 100-1,000 g/m^2 Equivalent to an oil coating (~½ cup/m^2)	There is a maximum of a 32% probability of shoreline contact, with a minimum time to shore of 7 hours. A maximum of 13 km of shoreline may be exposed to MDO.
HIGH exposure: ≥1,000 g/m^2 Equivalent to oil cover (~1 litre/m^2)	There is a maximum of a 23% probability of shoreline contact, with a minimum time to shore of 10 hours. Up to 4 km of shoreline may be exposed to MDO.
Maximum volume of hydrocarbons ashore – 91.1 m^3 (Figure 8.8)	
Average volume of hydrocarbons ashore – 37 m^3 (Figure 8.9)	

Dissolved aromatic hydrocarbons (Figure 8.10)	
LOW exposure: 10-50 ppb	Dissolved hydrocarbons for the 0-10 m depth layer at the low threshold could potentially occur up to a maximum distance of 206 km east-northeast from the spill site. No dissolved hydrocarbons predicted below the 10 m depth layer. There is a 1% probability of incursion into the Ninety Mile Beach MNP, and it would take 30 hours to reach the park. There is a 2% probability of incursion into the Point Hicks MNP, and it would take 66 hours to reach the park. There is a 2% probability of incursion into the Upwelling East of Eden KEF, and it would take 33 hours to reach the KEF.
MODERATE exposure: 50-400 ppb	No predicted moderate exposure for dissolved hydrocarbons.
HIGH exposure: ≥400 ppb	No predicted high exposure for dissolved hydrocarbons.
Entrained hydrocarbons (Figure 8.11)	
LOW exposure: 10-100 ppb	Entrained hydrocarbons for the 0-10 m depth layer at the low threshold could potentially occur up to a maximum distance of 894 km east-northeast from the spill site. No entrained hydrocarbon exposure predicted below the 10 m depth layer. There is a 1% probability of incursion into the Beagle AMP, and it would take 346 hours to reach the park. There is a 6% probability of incursion into the East Gippsland AMP, and it would take 126 hours to reach the park. There is a 1% probability of incursion into the Flinders AMP, and it would take 219 hours to reach the park. There is a 50% probability of incursion into the Upwelling East of Eden KEF, and it would take 13 hours to reach the KEF. There is a 4% probability of incursion into the Big Horseshoe Canyon KEF, and it would take 139 hours to reach the KEF. There is a 2% probability of incursion into the canyons on the eastern continental slope KEF, and it would take 141 hours to reach the KEF. There is a 2% probability of incursion into the shelf rocky reefs KEF, and it would take 162 hours to reach the KEF. There is a 1% probability of incursion into the Tasman Front and eddy field KEF, and it would take 461 hours to reach the KEF. There is a 30% probability of incursion into the Cape Howe MNP, and it would take 52 hours to reach the park. There is a 21% probability of incursion into the Ninety Mile Beach MNP, and it would take 16 hours to reach the park. There is a 50% probability of incursion into the Point Hicks MNP, and it would take 31 hours to reach the park.
HIGH exposure: ≥100 ppb	Entrained hydrocarbons for the 0-10 m depth layer at the high threshold could potentially occur up to a maximum distance of 279 km east-northeast from the spill site. There is a 9% probability of incursion into the Upwelling East of Eden KEF, and it would take 13 hours to reach the KEF. There is a 4% probability of incursion into the Cape Howe

	MNP, and it would take 58 hours to reach the park. There is a 8% probability of incursion into the Ninety Mile Beach MNP, and it would take 17 hours to reach the park. There is a 8% probability of incursion into the Point Hicks MNP, and it would take 61 hours to reach the park.

Table 8.43 presents a summary of oil contact to all receptors and shorelines assessed. The highest probabilities of shoreline contact for the low, moderate and high thresholds is, as expected given their proximities to the Project area, to the Golden Beach sector (30%, 29% and 20%, respectively), Ocean Grange (12%, 7% and 1%, respectively), Seaspray (16%, 10% and 4%, respectively) and Wellington (39%, 32% and 23% respectively). The probability of shoreline contact is 9% or less for all other shoreline sectors.

Figure 8.8 illustrates the deterministic trajectory that recorded the largest area of floating MDO exposure commenced. This figure also presents the floating exposure zones over the entire simulation period (swept area) and shoreline loading. Zones of low floating MDO exposure were predicted to extend a maximum of ~85 km from the release site towards the northeast. Moderate exposure (MDO ≥10 g/m^2) extended ~38 km northeast from the release location. There was no exposure at the high threshold.

Figure 8.9 illustrates the deterministic trajectory that resulted in the largest volume of oil ashore (with the predicted volume of oil ashore being 91.1 m^3). This figure also presents the potential zones of floating exposure (swept area) and shoreline loading, over the entire simulation. Low exposure was predicted to extend a maximum of ~9.5 km (southwest) from the release site. Moderate exposure (MDO ≥10 g/m^2) extended approximately 6 km southwest of the release site. High exposure was only predicted immediately adjacent to the release site.

Table 8.43. Summary of probability of contact (above each threshold) for specified shorelines under annualised conditions, for a 155 m^3 surface release of MDO over 6 hours and tracked for 20 days, calculated from 100 spill trajectories

Shoreline sector (moving west to east along the coast)	Probability of contact (%)			Minimum time before shoreline contact (hours)			Load on shoreline (g/m^2)		Maximum length of shoreline contacted (km)			Average length of shoreline contacted (km)		
	L	M	H	L	M	H	Avg	Peak	L	M	H	L	M	H
Wellington	39	32	23	6	7	10	268.3	4,543.7	24.5	13.0	4.0	12.4	7.4	2.2
Golden Beach	30	29	20	6	7	10	341.4	4,543.7	22.0	11.5	4.0	11.3	6.1	2.3
Seaspray	16	10	4	9	13	21	142.3	1,265.5	16.5	9.5	1.5	5.6	3.9	1.0
Ocean Grange	12	7	1	10	12	14	117.1	2,235.8	9.5	5.5	2.0	4.5	3.1	2.0
Lakes Entrance (West)	1	1	-	38	38	-	637.3	637.3	3.5	1.5	-	3.5	1.5	-
Point Hicks	3	3	-	66	77	-	116.6	470.0	3.5	2.5	-	2.5	1.5	-

Legend
L = low threshold exposure, M = moderate threshold exposure, H = high threshold exposure, Avg = average

Definitions

Probability of hydrocarbon contact to the shoreline:	Calculated by dividing the number of spill trajectories contacting shorelines (at the defined threshold) at a given location (single grid cell, shoreline receptor or all shorelines) by the total number of spill trajectories. For example, a reported probability of 47% for low shoreline contact for a given grid cell indicates that of the 100 individual spill trajectories, 47 made shoreline contact at the specific grid cell equal to or greater than the low contact threshold (10 g/m^2).
Probability of contact:	The maximum predicted probability of exposure for any grid cell along the boundary for the receptor calculated from the 100 spill trajectories.
Minimum time before shoreline contact:	Determined by ranking the elapsed time before shoreline contact to a given location/grid cell (at a given reporting threshold) for each of the 100 spill trajectories, with the minimum time from all spill trajectories being presented.
Average volume of oil ashore for a single spill:	Determined by calculating the average volume of all single spill trajectories predicted to make shoreline contact based on the minimum reporting threshold.
Maximum volume of oil ashore from a single spill trajectory:	Determined by identifying the single spill trajectory that recorded the maximum volume of oil to come ashore and presenting that value.

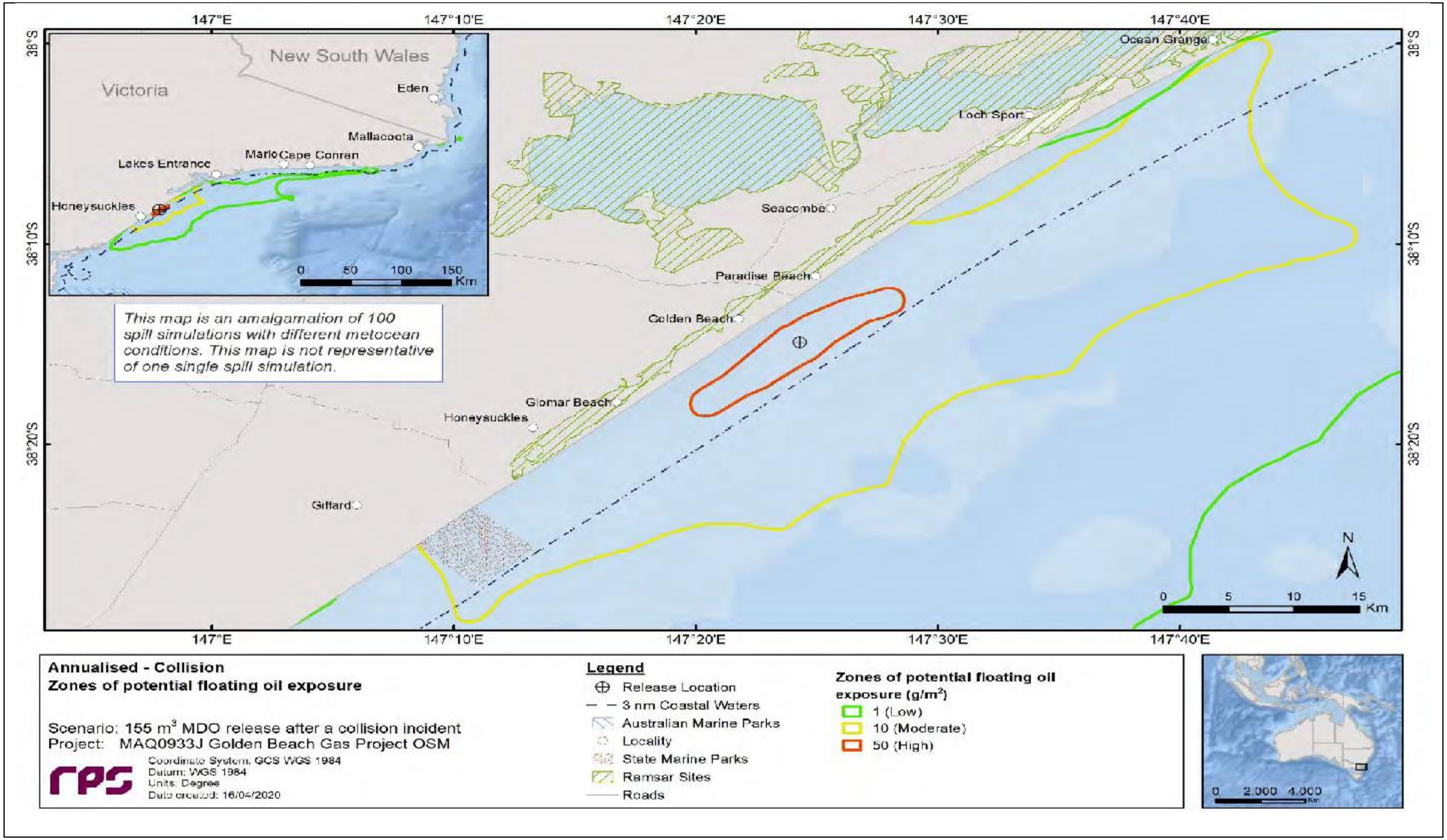


Figure 8.6. Potential zones of sea-surface exposure calculated from 100 spill trajectories under annualised metocean conditions based on a 155 m^3 surface release of MDO over 6 hours (tracked for 20 days)

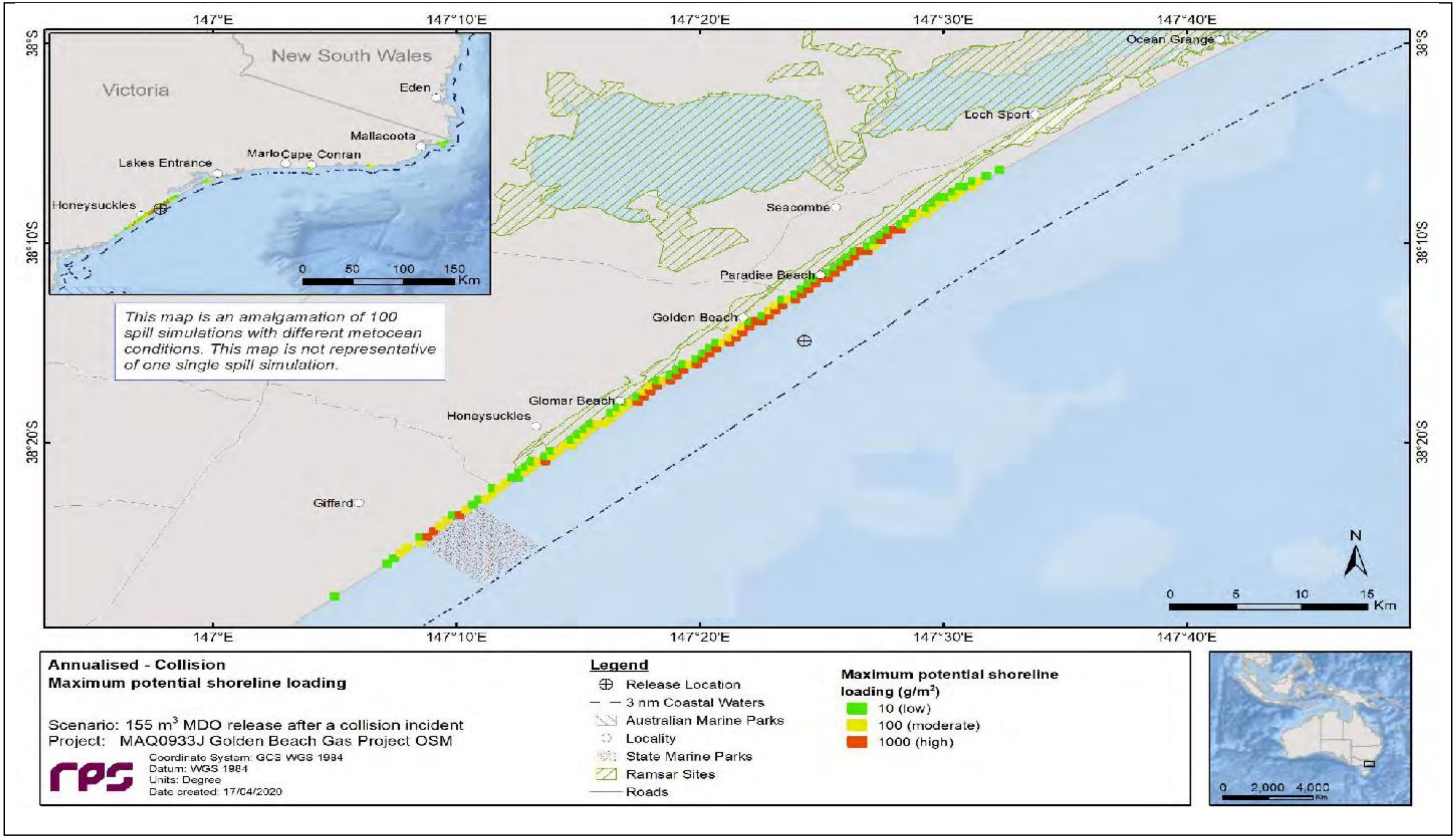


Figure 8.7. Predicted maximum shoreline loading results, calculated from 100 spill trajectories under annualised metocean conditions based on a 155 m^3 surface release of MDO over 6 hours (tracked for 20 days)

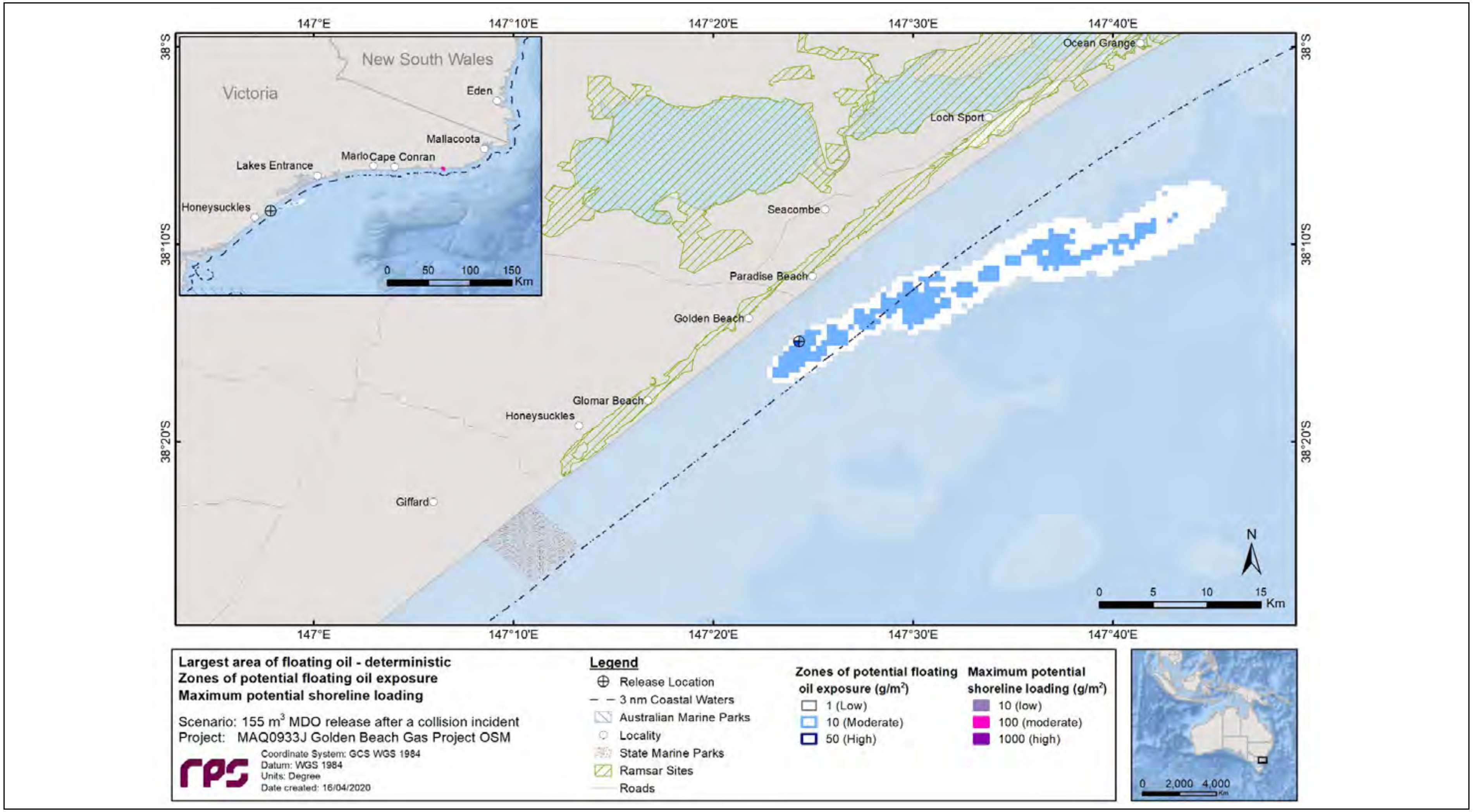


Figure 8.8. Predicted zones of potential floating hydrocarbon exposure for the deterministic spill trajectory that resulted in the largest area of MDO on the sea surface (30 April 2014), calculated from 100 spill trajectories under annualised metocean conditions based on a 155 m^3 surface release of MDO over 6 hours (tracked for 20 days)

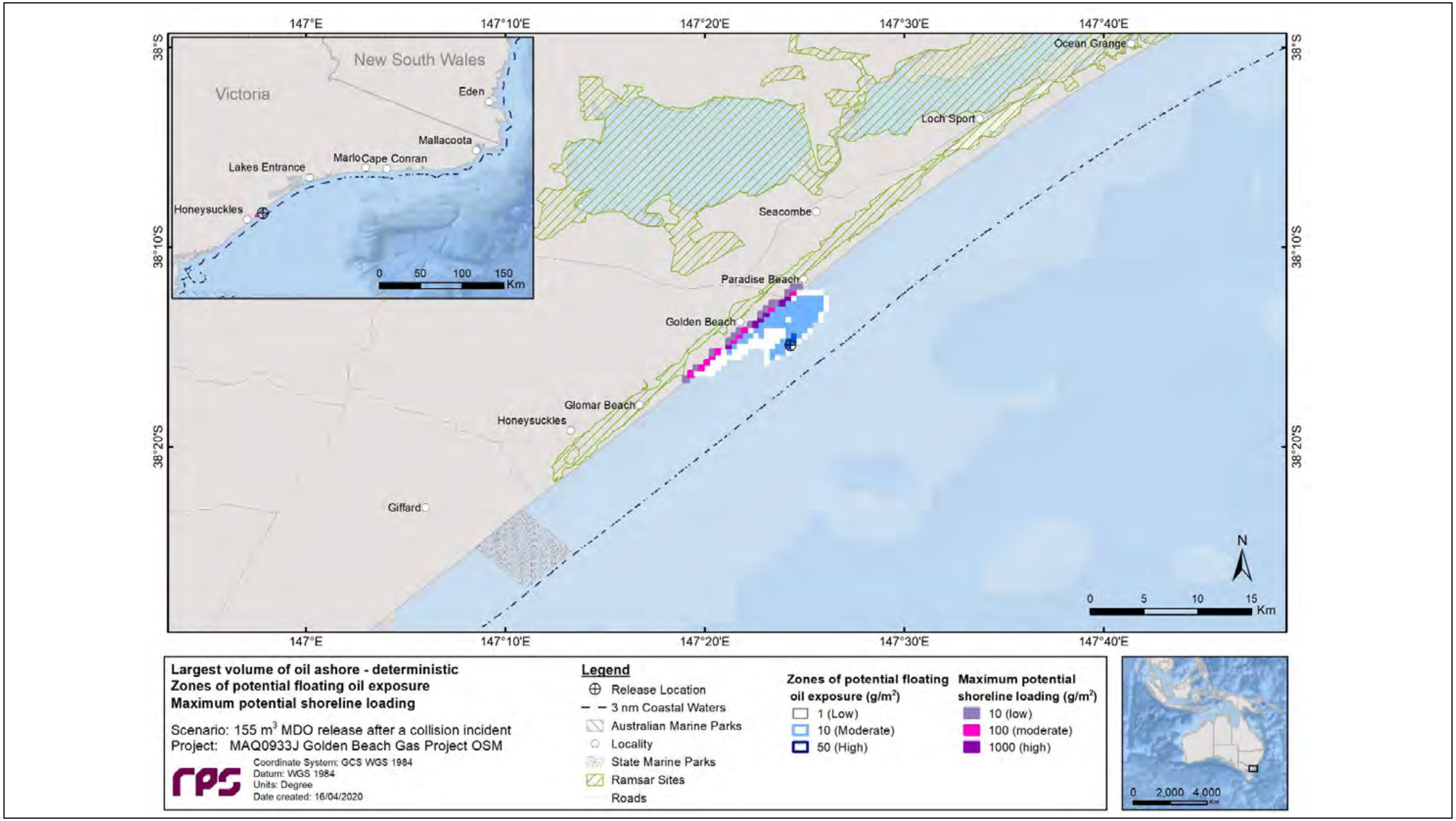


Figure 8.9. Predicted zones of potential shoreline loading for the deterministic spill trajectory that resulted in the largest volume of hydrocarbons ashore (5 January 2013), including swept area of ocean, calculated from 100 spill trajectories under annualised metocean conditions based on a 155 m^3 surface release of MDO over 6 hours (tracked for 20 days)

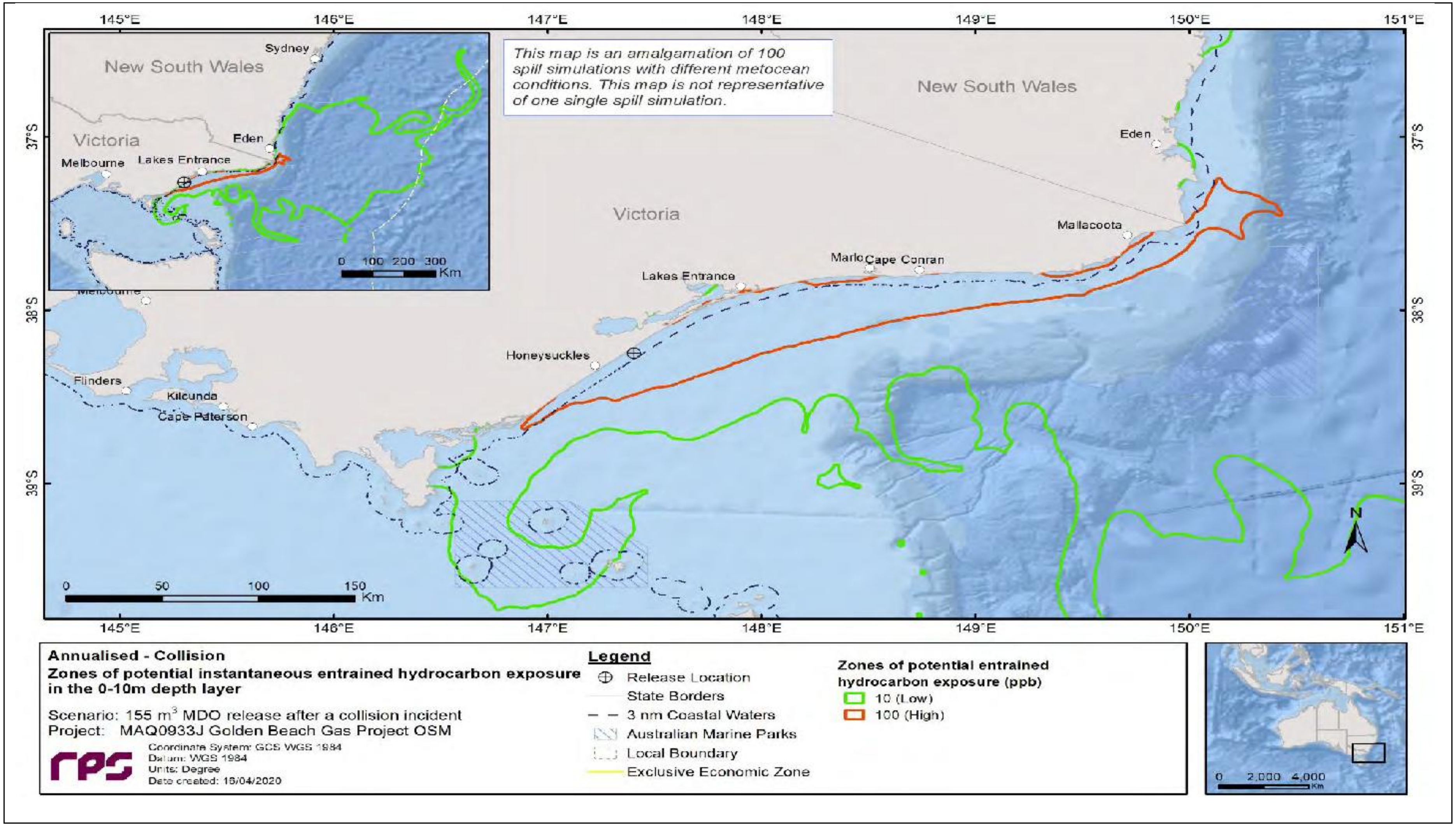


Figure 8.10. Predicted zones of potential entrained hydrocarbon exposure, calculated from 100 spill trajectories under annualised metocean conditions based on a 155 m³ surface release of MDO over 6 hours (tracked for 20 days)

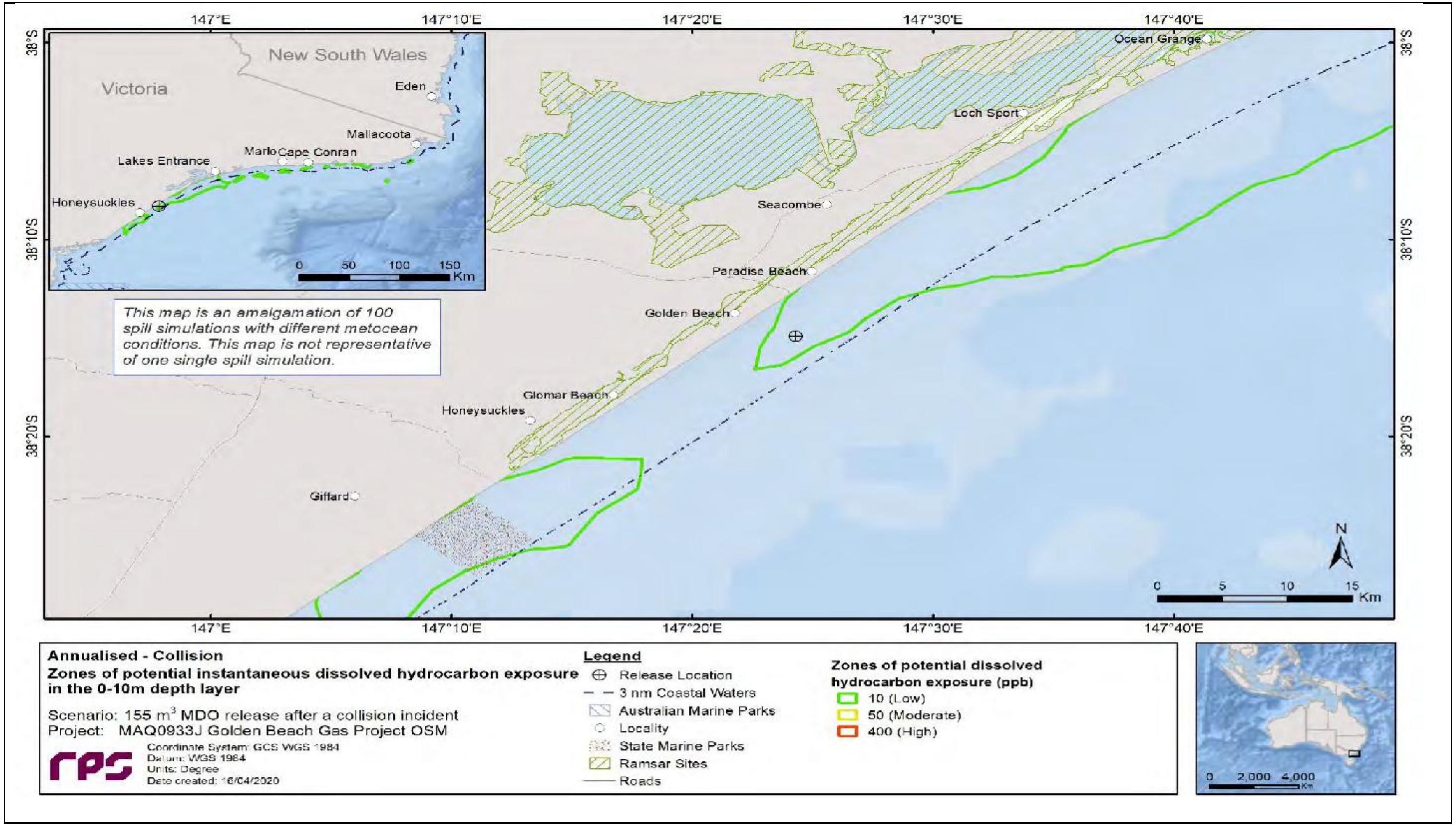


Figure 8.11. Predicted zones of potential dissolved hydrocarbon exposure, calculated from 100 spill trajectories under annualised metocean conditions based on a 155 m^3 surface release of MDO over 6 hours (tracked for 20 days)

8.15.2. Potential Environmental Risks

The known and potential impacts of an MDO spill are:

- A temporary and localised reduction in water quality;
- Injury or death of marine fauna and seabirds exposed to the MDO; and
- Habitat damage where the spill reaches shorelines.

8.15.3. EMBA

The EMBA for a 155 m^3 spill of MDO is illustrated in Figure 8.8 (taken as the extent of the moderate exposure zone). Receptors most at risk within this EMBA, whether resident or migratory, are:

- Plankton;
- Fish;
- Cetaceans;
- Pinnipeds;
- Marine reptiles;
- Avifauna; and
- Shoreline habitats.

8.15.4. Evaluation of Environmental Risks

Though MDO is a refined product and crude oils are in a natural (non-refined) state, there is very little literature that separates the impacts to the marine environment from refined hydrocarbons and crude oil. As such, the tables in this section discuss the general impacts of MDO spills on individual receptors based on the literature available for hydrocarbons in general (and MDO when specifically available). The implications of these general impacts to the receptors within the MDO EMBA are also presented in this section.

Table 8.44 provides the criteria for the sensitivity of the receptors discussed in the impact assessments in Table 8.45 to Table 8.54.

Table 8.44. Criteria used to determine receptor sensitivity in the EMBA

Sensitivity	Protected areas	Species status	BIA	Coastal sensitivity	Receptors in the EMBA
Low	State - no marine protected areas. Cth - multiple use zones are the dominant component of the protected area.	Species not threatened (or limited to only a few species of a particular faunal grouping). Present in the EMBA only occasionally or as vagrants. Populations known to recover rapidly from disturbance.	No BIA (or limited to only a few species of a particular faunal grouping).	Low sensitivity habitat, such as fine-grained beaches, exposed wave-cut platform and exposed rocky shores, with rapid recovery from oiling (~ 1 year or less). Public recreation beaches not present or not widely used. No harbours or marinas.	• Benthic assemblages. • Plankton. • Pelagic fish. • Macroalgae. • Sandy beaches. • Rocky shores.
Medium	State – no marine protected area. Cth - little to no special purpose zonation.	Species may be threatened (or some species of a particular faunal grouping). Species may or may not be present at time of activity. Some susceptibility to oiling. Populations may take a moderate time to recover from oiling.	Some intersection with one or more BIAs, generally for distribution or foraging rather than breeding.	Moderately sensitive habitat present, such as sheltered rocky rubble coasts, exposed tidal flats, gravel beaches, mixed sand and gravel beaches, with a medium recovery period from oiling (~2-5 years). Public recreation beaches present but not often used. No harbours or marinas.	• Marine reptiles. • Seabirds.
High	State - marine protected area present. Cth - special purposes zones are the dominant component of the protected area.	Species are threatened (or most species of a particular faunal grouping). Species known to be present at time of activity. Known to be susceptible to oiling. Populations may take a long time to recover from oiling.	Significant intersection with one or more BIAs, particularly with regard to breeding or migration.	Sensitive habitat present, such as mangrove, salt marshes, and sheltered tidal flats, with long recovery periods from oiling (> 5 years). Public recreation beaches present that are widely used. Busy harbours or marinas.	• Cetaceans. • Pinnipeds. • Shorebirds. • Commercial fishing. • Marine parks.

Table 8.45 Potential risks of hydrocarbons on benthic assemblages

General sensitivity to oiling – benthic assemblages	
Sensitivity rating of benthic species and communities	Low
A description of benthic fauna in the EMBA is provided in:	Section 6.3.1

Surface hydrocarbons

Benthic species are generally protected from exposure to surface hydrocarbon. The primary modes of exposure for benthic communities in oil spills include:

- Direct exposure to dispersed oil (e.g., physical smothering) where bottom discharges stay at the ocean bottom;
- Direct exposure to dispersed and non-dispersed oil (e.g., physical smothering) where oil sinks down from higher depths of the ocean;
- Direct exposure to dispersed and non-dispersed oil dissolved in sea water and/or partitioned onto sediment particles; and
- Indirect exposure to dispersed and non-dispersed oil through the food web (e.g., uptake of oiled plankton, detritus, prey, etc.) (NRDA, 2012).

Adult marine invertebrates and larvae usually reside within benthic substrates and pelagic waters, rarely reaching the water's surface in their life cycle (to breed, breathe and feed). Therefore, surface hydrocarbons are not considered to pose a high risk to marine invertebrates except at locations where surface oil reaches shorelines.

Acute or chronic exposure, through surface contact, and/or ingestion can result in toxicological risks. However, the presence of an exoskeleton (e.g., crustaceans) will reduce the impact of hydrocarbon absorption through the surface membrane. Other invertebrates with no exoskeleton and larval forms may be more prone to impacts from pelagic hydrocarbons.

Water column/seabed hydrocarbons

Entrained and dissolved hydrocarbons can have negative impacts on marine invertebrates and associated larval forms, while impacts to adult species is reduced as a result of the presence of an exoskeleton. Localised impacts to larval stages may occur which could impact on population recruitment that year. If invertebrates are contaminated by hydrocarbons, tissue taint can remain for several months, although taint may eventually be lost. For example, it has been demonstrated that it took 2-5 months for lobsters to lose their taint when exposed to a light hydrocarbon (NOAA, 2002).

Exposure to microscopic oil droplets may also impact aquatic biota either mechanically (especially filter feeders) or act as a conduit for exposure to semi-soluble hydrocarbons (that might be taken up by the gills or digestive tract) (McCay-French, 2009). Toxicity is primarily attributed to water soluble PAHs, specifically the substituted naphthalene (C_2 and C_3) as the higher C-ring compounds become insoluble and are not bioavailable. ANZECC/ARMCANZ (2000) identifies the following
96-hr LC_{50} concentrations for naphthalene (a key primary PAH dissolved phase toxicant in crude oils):

- For the bivalve mollusc, *Katelysia opima*, a concentration of 57,000 ppb; and
- For six species of marine crustaceans, a concentration between 850 and 5,700 ppb.

Other possible impacts from the presence of dispersed and non-dispersed oil include effects of oxygen depletion in bottom waters due to bacterial metabolism of oil (and/or dispersants), and light deprivation under surface oil (NRDA, 2012).

Surveys undertaken after the Montara well blowout in the Timor Sea in 2009 found no obvious visual signs of major disturbance at Barracouta and Vulcan

shoals located approximately 40 km and 20 km from the blowout location (Heyward *et al*., 2010). These sites occur about 20-30 m below the water line in otherwise deep waters (generally >150 m water depth). Later sampling indicated the presence of low-level severely degraded oil at some shoals, though in the absence of pre-impact data, this could not be directly linked to the Montara spill. Levels of hydrocarbons in the sediments were, in any case, several orders of magnitude lower than levels at which biological effects become possible (Heyward *et al.,* 2012; Gagnon & Rawson, 2011). Studies undertaken since the Macondo well blowout in the Gulf of Mexico (GoM) in 2010 have shown that fewer than 2% of the more than 8,000 sediment samples collected exceeded the EPA sediment toxicity benchmark for aquatic life, and these were largely limited to the area close to the wellhead (BP, 2015). Studies of offshore benthic seaweeds in the northwest GoM prior to and after the Macondo well blowout at Sackett and Ewing banks (in water depths of 55-75 m) found a dramatic die-off of seaweeds after the spill (60 species pre-spill compared with 10 species post-spill) (Felder *et al*., 2014). Benthic decapod assemblages (crabs, lobsters, prawns) associated with the seaweeds and benthic substrate also showed a strong decline in abundance at both banks post-spill (species richness on Ewing Bank reduced by 42% and on Sackett Bank by 29%), though it is noted that these banks are exposed to influences from Mississippi River discharges that vary year to year, so definitive links to the oil spill are not possible. It is noted, however, that petroleum residues were observed on Ewing Bank and it is possible that this may have caused localized mortalities, reduced the fecundity of surviving female decapods or reduced recruitment (Felder *et al*., 2014). Felder et al (2014) also notes that freshly caught soft-sediment decapod samples caught in early and mid-2011 near the spill site exhibited lesions that were severe enough to cause appendage loss and mortality. Water quality in benthic habitats exposed to entrained hydrocarbons would be expected to return to background conditions within weeks to months of contact. Several studies have indicated that rapid recovery rates of water quality in benthic habitats may occur even in cases of heavy oiling (Committee on Oil in the Sea, 2003).			
Potential risks from this activity			
Sea surface	Water column		Shoreline
Not applicable.	Only contact at the low threshold for entrained phase MDO was predicted in waters 0-10 m with no contact predicted in the 10-20 m depth layer. In nearshore waters, where there is interaction with the benthic environment, the probability of contact is 1 to 2%. At this low threshold, the consequence (ecosystem function) of toxic or sublethal impacts to	For the dissolved phase, only contact at the low threshold was predicted in waters 0-10 m and no contact in the 10-20 m depth layer. In nearshore waters, where there is interaction with the benthic environment, the probability of contact is 1 to 2%. At this low threshold, the consequence of toxic or sublethal impacts to benthic fauna (ecosystem function) or habitats is **minor.** Contact at the low and high thresholds was predicted in waters 0-10 m below the surface, and no contact predicted with the 10-20 m depth layer. In nearshore waters, where there is interaction with the benthic environment, the probability of low exposure ranges from 1 to 46%. There is a 4%,	There is a 39%, 32% and 23% probability of low, moderate and high contact respectively, with the Wellington shoreline sectors. Intertidal benthic species among the sandy sediments would be exposed to MDO (albeit slightly weathered). Resident fauna such as worms, molluscs and crustaceans may suffer lethal impacts where high and moderate hydrocarbon loadings penetrate into the sediments and persist, especially in highly productive sheltered shorelines where hydrocarbon is more likely to be retained. As all of the shoreline predicted to potentially be exposed to hydrocarbon loading is sandy shoreline, these impacts are unlikely to occur except for at very isolated sections of the shoreline. Long-term depletion of intertidal fauna could have an adverse effect on birds or fish that use

	benthic fauna or habitats is **minor.**	8% and 12% probability of high exposure in nearshore waters at Gabo Island and the East Gippsland and Wellington shoreline sectors, respectively. Where the seabed is deeper than 10 m, there is no modelled exposure to hydrocarbons. It is unlikely that the localised and temporary effects of MDO on benthic species that occur in water depths of less than 10 m will have a toxic effect because the exposed coast is subject to significant wave action that weathers and disperses the hydrocarbons. Any mortality that does occur in affected areas is likely to be temporary with recruitment from unaffected areas likely to occur. At the low threshold, the consequences of an MDO spill to benthic fauna (ecosystem function) or habitats is **negligible.** At the high threshold, the consequence of an MDO spill to benthic fauna populations (ecosystem function) or habitats is **moderate.**	this habitat as feeding grounds. Where MDO loading is heavy, impacts on nearshore benthic fauna could be significant. While MDO penetrates porous sediments (such as sand) quickly, it is also washed off quickly (and weathered within sediments) by waves (NOAA, 2012), thus minimising impacts to intertidal fauna. It is predicted that the consequence (ecosystem function) of an MDO spill on benthic assemblages will be **moderate.**.

Table 8.46 Potential risks of hydrocarbons on macroalgal communities

<table>
<tr><th colspan="3">General sensitivity to oiling – macroalgal communities</th></tr>
<tr><td colspan="2">Sensitivity rating of macroalgal communities</td><td>Low</td></tr>
<tr><td colspan="2">A description of macroalgal species in the EMBA is provided in:</td><td>Section 6.3.2</td></tr>
<tr><td colspan="3">Macroalgae are generally limited to growing on intertidal and subtidal rocky substrata in shallow waters to 10 m depth. As such, they may be exposed to subsurface entrained and dissolved hydrocarbons, as well as to surface hydrocarbons if present in intertidal habitats as opposed to subtidal habitats.
Smothering, fouling and asphyxiation are some of the physical effects that have been documented from oil contamination in marine plants (Blumer, 1971; Cintron et al., 1981). In macroalgae, oil can act as a physical barrier for the diffusion of carbon dioxide across cell walls (O'Brian & Dixon, 1976). The effect of hydrocarbons however is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to algae, which will vary depending on the oil's physical state and relative 'stickiness'. The morphological features of macroalgae, such as the presence of a mucilage layer or the presence of fine 'hairs' will influence the amount of hydrocarbon that will adhere to the algae. A review of field studies conducted after spill events by Connell et al (1981) indicated a high degree of variability in the level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. The rapid recovery of algae was attributed to the fact that for most algae, new growth is produced from near the base of the plant while the distal parts (which would be exposed to the oil contamination) are continually lost. Other studies have indicated that oiled kelp beds had a 90% recovery within 3-4 years of impact, however full recovery to pre-spill diversity may not occur for long periods after the spill (French-McCay, 2004).
Intertidal macroalgal beds are more prone to oil spills than subtidal beds because although the mucous coating prevents oil adherence, oil that is trapped in the upper canopy can increase the persistence of the oil, which impacts upon site-attached species. Additionally, when oil sticks to dry fronds on the shore, they can become overweight and break as a result of wave action (IPIECA, 2002).
The toxicity of macroalgae to hydrocarbons varies for the different macroalgal life stages, with water-soluble hydrocarbons more toxic to macroalgae (Van Overbeek & Blondeau, 1954; Kauss et al., 1973; cited in O'Brien and Dixon, 1976). Toxic effect concentrations for hydrocarbons and algae have varied greatly among species and studies, ranging 0.002–10,000 ppm (Lewis & Pryor, 2013). The sensitivity of gametes, larva and zygote stages however have all proven more responsive to petroleum oil exposure than adult growth stages (Thursby & Steele, 2003; Lewis & Pryor, 2013).
Macrophytes, including seagrasses and macroalgae, require light to photosynthesise. So in addition to the potential impacts from direct smothering or exposure to entrained and dissolved hydrocarbons, the presence of entrained hydrocarbons within the water column can affect light qualities and the ability of macrophytes to photosynthesise.</td></tr>
<tr><th colspan="3">Potential risks from this activity</th></tr>
<tr><td>Sea surface</td><td>Water column</td><td>Shoreline</td></tr>
<tr><td colspan="3">Emergent or floating vegetation in the intertidal and subtidal zone along the coast of eastern Victoria may be exposed to high concentrations of entrained hydrocarbon. Where concentrations of high exposure occur, macroalgal communities are likely to be impacted in the manner described above.
There is a 4% and 8% probability of high exposure entrained hydrocarbons at the Cape Howe MNP and Point Hicks MNP, respectively, where there is potential for the Giant Kelp Marine Forests TEC to occur based on the presence of suitable rocky substrate. There are no other areas of high threshold entrained hydrocarbon exposure in nearshore areas (i.e., <30 m deep) where Giant Kelp Marine Forests potentially occur.
Strong wave-action, an exposed coastline and the light characteristics of MDO all assist in the rapid dispersal and dilution of the MDO, meaning that there</td></tr>
</table>

is a low risk of MDO persisting long enough to cause toxic (and therefore lethal or sub-lethal) impacts to intertidal macroalgal communities. At the high threshold, the consequence (ecosystem function) of this MDO spill scenario to macroalgal communities is **minor.**

Because MDO will be highly weathered and in small volumes if it reached the sites of possible occurrence of the Giant Kelp Marine Forests TEC, a spill will not have a 'significant' impact on the Giant Kelp Marine Forests TEC (see Section 6.4.5) when assessed against the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013), which are:

- Reduce the extent of an ecological community.
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.
- Adversely affect habitat critical to the survival of an ecological community.
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  – Assisting invasive species, that are harmful to the listed ecological community, to become established, or
  – Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.
- Interfere with the recovery of an ecological community.

Table 8.47. Potential risks of hydrocarbons on plankton

General sensitivity to oiling - plankton	
Sensitivity rating of plankton	Low
A description of plankton communities in the EMBA is provided in:	Section 6.3.3
Plankton is found in nearshore and open waters beneath the surface in the water column. These organisms migrate vertically through the water column to feed in surface waters at night (NRDA, 2012). As they move close to the sea surface it is possible that they may be exposed to both surface hydrocarbons but to a greater extent, hydrocarbons dissolved or entrained in the water column. Phytoplankton is typically not sensitive to the impacts of oil, though they do accumulate it rapidly due to their small size and high surface area to volume ratio (Hook *et al*., 2016). If phytoplankton is exposed to hydrocarbons at the sea surface, this may directly affect their ability to photosynthesize which could have implications for the next trophic level in the food chain (e.g., small fish) (Hook *et al*., 2016). In addition, the presence of surface hydrocarbons may result in a reduction of light penetrating the water column, which could affect the rate of photosynthesis for phytoplankton in instances where there is prolonged presence of surface hydrocarbons over an extensive area such that the phytoplankton was restricted from exposure to light. Oil can affect the rate of photosynthesis and inhibit growth in phytoplankton, depending on the concentration range. For example, photosynthesis is stimulated by low concentrations of oil in the water column (10-30 ppb), but become progressively inhibited above 50 ppb. Conversely, photosynthesis can be stimulated below 100 ppb for exposure to weathered oil (Volkman *et al*., 2004). Zooplankton (microscopic animals such as rotifers, copepods and krill that feed on phytoplankton) are vulnerable to hydrocarbons due to their small size and high surface area to volume ratio, along with (in many cases) their high lipid content (that facilitates hydrocarbon uptake) (Hook *et al*., 2016). Water column organisms that come into contact with oil risk exposure through ingestion, inhalation and dermal contact (NRDA, 2012), which can cause immediate mortality or declines in egg production and hatching rates along with a decline in swimming speeds (Hook *et al*., 2016). Plankton is generally abundant in the upper layers of the water column and acts as the basis for the marine food web, meaning that a MDO spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Variations in the temporal scale of oceanographic processes typical of the ecosystem have a greater influence on plankton communities than the direct effect of spilt hydrocarbons. This is because reproduction by survivors or migration from unaffected areas would be likely to rapidly replenish any losses from permanent zooplankton (Volkman *et al*., 2004). Field observations from oil spills show minimal or transient effects on marine plankton (Volkman *et al*., 2004). Once background water quality conditions have re-established, the plankton community will take weeks to months to recover (ITOPF, 2011a), allowing for seasonal influences on the assemblage characteristics.	
Potential risks from this activity	
Sea surface & water column	Shoreline
Plankton found in open waters of the EMBA is widely represented within Bass Strait. Plankton in the upper water column (less than 10 m from the sea surface) is likely to be directly (e.g., through smothering and ingestion) and indirectly (e.g., toxicity from decrease in water quality and bioaccumulation) affected by dissolved and entrained hydrocarbons. Once background water quality conditions are re-established, plankton populations are expected to recover rapidly due to the	Not applicable.

recruitment of plankton from surrounding waters and reproduction by survivors. The overall consequence (ecosystem function) of this MDO spill scenario on plankton is **moderate**.	

Table 8.48. Potential risks of hydrocarbons on pelagic fish

General sensitivity to oiling – pelagic fish	
Sensitivity rating of pelagic fish:	Low
A description of pelagic fish in the EMBA is provided in:	Section 6.3.4

The behaviours and habitat preferences of fish species determine their potential for exposure to hydrocarbons and the resulting impacts. Demersal species may be susceptible to oiled sediments, particularly species that are site-restricted. Pelagic species that occupy the water column are more susceptible to entrained and dissolved hydrocarbons, however generally these species are highly mobile and as such are not likely to suffer extended exposure due to their patterns of movement. The exception would be in areas such as reefs and other seabed features where species are less likely to move away into open waters (i.e., they area site-attached). Fish are exposed to hydrocarbon droplets through a variety of pathways, including:

- Direct dermal contact (e.g., swimming through oil or waters with elevated dissolved hydrocarbon concentrations and other constituents, with diffusion across their gills (Hook *et al*., 2016));
- Ingestion (e.g., directly or via food base, fish that have recently ingested contaminated prey may themselves be a source of contamination for their predators); and
- Inhalation (e.g., elevated dissolved contaminant concentrations in water passing over the gills).

Exposure to hydrocarbons at the surface or entrained or dissolved in the water column can be toxic to fish. Studies have shown a range of impacts including changes in abundance, decreased size, inhibited swimming ability, changes to oxygen consumption and respiration, changes to reproduction, immune system responses, DNA damage, visible skin and organ lesions, and increased parasitism. However, many fish species can metabolise toxic hydrocarbons, which reduces the risk of bioaccumulation of contaminants in the food web (and human exposure to contaminants through the consumption of seafood) (NRDA, 2012).

Sub-lethal impacts in adult fish include altered heart and respiratory rates, gill hyperplasia, enlarged liver, reduced growth, fin erosion, impaired endocrine systems, behavioural modifications and alterations in feeding, migration, reproduction, swimming, schooling and burrowing behaviour (Kennish, 1996). However, pelagic fish are highly mobile and unlikely to remain in the area of a spill for long enough to be exposed to sub-lethal doses of hydrocarbons.

Fish are most vulnerable to hydrocarbon discharges during their embryonic, larval and juvenile life stages. Eggs and larvae of many fish species are highly sensitive to oil exposure, resulting in decreased spawning success and abnormal larval development (see Table 8.47 'Plankton').

Since fish and sharks do not generally break the sea surface, the impacts of surface hydrocarbons to fish and shark species are unlikely to occur. Near the sea surface, fish are able to detect and avoid contact with surface slicks meaning fish mortalities rarely occur in the event of a hydrocarbon spill in open waters (Volkman *et al*., 2004). As a result, wide-ranging pelagic fish of the open ocean generally are not highly susceptible to impacts from surface hydrocarbons. Adult fish kills reported after oil spills occur mainly to shallow water, near-shore benthic species (Volkman *et al*., 2004).

Hydrocarbon in the water column can physically affect reef fish (that have high site fidelity and cannot move out of harm's way) exposed for an extended duration (weeks to months) by coating of gills, leading to lethal and sub-lethal effects from reduced oxygen exchange and coating of body surfaces that may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food, leading to reduced growth (Volkman *et al*., 2004).

The threshold value for species toxicity in the water column is based on global data from French et al. (1999) and French-McCay (2002, 2003), which showed that species sensitivity (fish and invertebrates) to dissolved aromatics exposure >4 days (96-hour LC50) under different environmental conditions varied from 6 to 400 µg/L (ppb), with an average of 50 ppb. This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae). Based on scientific literature, a minimum threshold of 6 ppb over 96 hours or equivalent was used to assess in-water low exposure zones, respectively (Engelhardt, 1983; Clark, 1984; Geraci and St Aubin, 1988; Jenssen, 1994; Tsvetnenko, 1998). French-McCay (2002) indicates that an average 96-hour LC_{50} of 50 ppb and 400 ppb could serve as an acute lethal threshold to 50% and 97.5% to biota, respectively.

Studies of oil impacts on bony fishes report that light, volatile oils are likely to be more toxic to fish. Many studies conclude that exposure to PAHs and soluble compounds are responsible for the majority of toxic impacts observed in fish (e.g., Carls et al., 2008; Ramachandran et al., 2004). A range of lethal and sub-lethal effects to fish in the larval stage has been reported at water-accommodated fraction (WAF) hydrocarbon concentrations (48–hour and 96-hour exposures) of 0.001 to 0.018 ppm during laboratory exposures (Carls *et al*., 2008; Gala *et al*., 2001). In contrast, wave tank exposures reported much higher lethal concentrations (14-day LC_{50}) up to 1.9 ppm for herring embryos and up to 4.3 ppm for juvenile cod (Lee *et al*., 2011).

Toxicity in adult fish has been reported in response to crude oils, HFO and diesel (Holdway, 2002; Shigenaka, 2011). Uptake of hydrocarbons has been demonstrated in bony fish after exposure to WAF of between 24 and 48 hours. Danion et al (2011) observed PAH uptake of 148 µg/kg-1 after 48-hour exposures to PAH from Arabian Crude at high concentrations of 770 ppm. Davis et al (2002) report detectable tainting of fish flesh after a 24-hour exposure at crude concentrations of 0.1 ppm, marine fuel oil concentrations of 0.33 ppm and diesel concentrations of 0.25 ppm. The majority of studies, either from laboratory trials or of fish collected after spill events (including the Hebei Spirit, Macondo, and Sea Empress spills) find evidence of elimination of PAHs in fish tissues returning to reference levels within two months of exposure (Challenger and Mauseth, 2011; Davis *et al*., 2002; Gagnon & Rawson, 2011; Gohlke *et al*., 2011; Jung *et al*., 2011; Law *et al*., 1997; Rawson *et al*., 2011).

The toxicity of dissolved hydrocarbons and dispersed oil to fish species has been the subject of a number of laboratory studies (AMSA, 1998). Generally, concentrations in the range of 0.1–0.4 mg/L dispersed oil have been shown to cause fish deaths in laboratory experiments (96-hour LC50). No reported studies of the impacts of oil spills on cartilaginous fish (including sharks, rays and sawfish) were found in the literature. It is not known how the data on the sensitivity of bony fishes would relate to toxicity in cartilaginous fishes.

The assessment of effects on fish species in the Timor Sea as a result of the Montara well blowout (a light gas condensate), conducted from November 2009 to November 2010 undertaken by Gagnon & Rawson (2011), found that of the species studied (mostly goldband snapper *Pristipomoides multidens*, red emperor *Lutjanus sebae*, rainbow runner *Elegatis bipinnulata* and Spanish mackerel *Scomberomorus commerson*), all 781 specimens were in good physical health at all sites. Results show that:

- Phase 1 study (November 2009, immediately after the blowout ceased) - indicated that in the short-term, fish were exposed to and metabolised petroleum hydrocarbons, however no consistent adverse effects on fish health or their reproductive activity were detected.
- Phase 2 study (March 2010, 5 months after the blowout ceased) – indicated continuing exposure to petroleum hydrocarbons, as detected by elevated liver detoxification enzymes and PAH biliary metabolites in three out of four species collected close to the MODU, and elevated oxidative DNA damage.
- Phase 3 study (November 2010, 12 months after the blowout ceased) – showed a trend towards a return to reference levels with often, but not always, comparable biomarker levels in fish collected from reference and impacted sites. This evidence of exposure to petroleum hydrocarbons at sites close to the spill location suggest an ongoing trend toward a return to normal biochemistry/physiology (Gagnon & Rawson, 2011).

The main finding of the Gagnon & Rawson (2011) study concluded that there were no detectable petroleum hydrocarbons found in the fish muscle samples, limited ill effects were detected in a small number of individual fish, and no consistent adverse effects of exposure on fish health could be detected within two weeks following the end of the well release. Notwithstanding, fishes from close to the Montara well, collected seven months after the

discharge began, showed continuing exposure to hydrocarbons in terms of biomarker responses. Two years after the discharge, biomarker levels in fishes had mostly returned to reference levels, except for liver size. However this was potentially attributed to local nutrient enrichment, or to past exposure to hydrocarbons. Fishes near Heyward Shoal, approximately 100 km southwest of the Montara well, had elevated biomarker responses indicating exposure to hydrocarbons, but were collected close to the Cornea natural hydrocarbon seep. Studies on the Montara discharge have shown recovery in terms of the abundance and composition of fishes, and toxicological and physiological responses of fishes. Sampling from January 2010 to June 2011 by the University of South Alabama and Dauphin Island Sea Lab found no significant evidence of diseased fish in reef populations off Alabama or the western Florida Panhandle as a result of the Macondo well blowout in the GoM (BP, 2014). No reports of oil spills in open waters have been reported to cause fish kills (though mortality in aquaculture pens has), which is likely to be because vertebrates can rapidly metabolise and excrete hydrocarbons (Hook *et al*., 2016). Recovery of fish assemblages depends on the intensity and duration of an unplanned discharge, the composition of the discharge and whether dispersants are used, as each of these factors influences the level of exposure to potential toxicants. Recovery would also depend on the life cycle attributes of fishes. Species that are abundant, short-lived and highly fecund may recover rapidly. However less abundant, long-lived species may take longer to recover. The range of movement of fishes will also influence recovery. The nature of the receiving environment would influence the level of impact on fishes.		
Potential risks from this activity		
Sea surface	Water column	Shoreline
There is a small area in which moderate exposure (38 km) and high exposure (8 km) threshold MDO travels from the spill site on the sea surface. Fish species in the water column and syngnathid species associated with rafts of floating seaweed may come into contact with surface oil, however the maximum distance of moderate exposure threshold from the release site (representing the point at which harmful effects may be encountered) represents a relatively small area of the sea surface in comparison to the wider Bass Strait. However, the majority of fish species tend to remain in the mid-pelagic zone and are not likely to come into contact with floating hydrocarbons on the sea surface. Due to this reduced likelihood of exposure for the majority of fish species present in the EMBA, the consequence (ecosystem function, threatened and migratory species) of MDO on the sea surface to fish is **minor.**	There is up to a 2% probability of low exposure to dissolved hydrocarbons in the EMBA and no predicted areas of moderate or high exposure. There is up to an 8% probability of high exposure to entrained hydrocarbons at MNPs including Cape Howe, Ninety Mile Beach and Point Hicks. This threshold of exposure represents the possibility of sublethal impacts to chronically exposed fish species. However, NOAA (2013) and ITOPF (2011a) state that hydrocarbon spills in open water are so rapidly diluted that fish kills are rarely observed. Fish such as the great white shark, shortfin mako and porbeagle shark spend most of their time in the water column (rather than surface waters), meaning they are more likely to be exposed to entrained and dissolved hydrocarbons than surface hydrocarbons (though dissolved hydrocarbons are not predicted to reach the moderate or high thresholds that may cause sublethal impacts). As highly mobile species, they are unlikely to remain in one area for a long period of time, which minimises the risk that they would be exposed to toxic levels of hydrocarbons for a length of time necessary to impart a lethal impact. In addition, the waters of Bass Strait are generally well-mixed and, along with the high and rapid rate of MDO weathering, the consequence (ecosystem function, threatened and migratory species) of an MDO spill to fish in the water column is **minor**.	Not applicable.

Table 8.49. Potential risks of hydrocarbons on cetaceans

General sensitivity to oiling - cetaceans	
Sensitivity rating of cetaceans:	High
A description of cetaceans in the EMBA is provided in:	Section 6.3.5

Whales and dolphins can be exposed to the chemicals in oil through:

- Internal exposure by consuming oil or contaminated prey;
- Inhaling volatile oil compounds when surfacing to breathe;
- Dermal contact, by swimming in oil and having oil directly on the skin and body; and
- Maternal transfer of contaminants to embryos (NRDA, 2012; Hook *et al.*, 2016).

The effects of this exposure include:

- Hypothermia due to conductance changes in skin, resulting in metabolic shock (expected to be more problematic for non-cetaceans in colder waters);
- Toxic effects and secondary organ dysfunction due to ingestion of oil;
- Congested lungs;
- Damaged airways;
- Interstitial emphysema due to inhalation of oil droplets and vapour;
- Gastrointestinal ulceration and haemorrhaging due to ingestion of oil during grooming and feeding;
- Eye and skin lesions from continuous exposure to oil;
- Decreased body mass due to restricted diet; and
- Stress due to oil exposure and behavioural changes.

French-McCay (2009) identifies that a 10-25 µm oil thickness threshold has the potential to impart a lethal dose on marine species, however also estimates a probability of 0.1% mortality to cetaceans if they encounter these thresholds based on the proportion of the time spent at surface. Direct surface oil contact with hydrocarbons is considered to have little deleterious effect on whales, possibly due to the skin's effectiveness as a barrier to toxicity, and effect of oil on cetacean skin is probably minor and temporary (Geraci & St Aubin, 1988). Cetaceans in particular have mostly smooth skins with limited areas of pelage (hair covered skin) or rough surfaces such as barnacled skin. Oil tends to adhere to rough surfaces, hair or calluses of animals, so contact with hydrocarbons by whales and dolphins may cause only minor hydrocarbon adherence.

The physical impacts from ingested hydrocarbon with subsequent lethal or sub-lethal impacts are both applicable to entrained oil. However, the susceptibility of cetaceans varies with feeding habits. Baleen whales (such as blue, southern right and humpback whales) are not particularly susceptible to ingestion of oil in the water column, but are susceptible to oil at the sea surface as they feed by skimming the surface. Oil may stick to the baleen while they 'filter feed' near slicks. Sticky, tar-like residues are particularly likely to foul the baleen plates.

The inhalation of oil droplets, vapours and fumes is a distinct possibility if whales surface in slicks to breathe. Exposure to hydrocarbons in this way could

damage mucous membranes, damage airways or even cause death. Toothed whales and dolphins may be susceptible to ingestion of dissolved and entrained oil as they gulp feed at depth. There are reports of declines in the health of individual pods of killer whales (a toothed whale species), though not the population as a whole, in Prince William Sound after the Exxon Valdez vessel spill (heavy oil) (Hook *et al*., 2016). It has been stated that pelagic species will avoid hydrocarbon, mainly because of its noxious odours, but this has not been proven. The strong attraction to specific areas for breeding or feeding (e.g., use of the Warrnambool coastline as a nursery area for southern right whales) may override any tendency for cetaceans to avoid the noxious presence of hydrocarbons. So weathered or tar-like oil residues can still present a problem by fouling baleen whales feeding systems. Dolphin populations from Barataria Bay, Louisianna, USA, which were exposed to prolonged and continuous oiling from the Macondo oil spill in 2010, had higher incidences of lung and kidney disease than those in the other urbanised environments (Hook *et al*., 2016). The spill may have also contributed to unusually high perinatal mortality in bottlenose dolphins (Hook *et al*., 2016). As highly mobile species, in general it is very unlikely that cetaceans will be constantly exposed to concentrations of hydrocarbons in the water column for continuous durations (e.g., >96 hours) that would lead to chronic toxicity effects.		
Potential risks from this activity		
Sea surface	Water column	Shoreline
There is a small area in which moderate exposure (38 km) and high exposure (8 km) threshold hydrocarbons travel from the spill site on the sea surface. This area overlaps the foraging BIA for pygmy blue whales and known core migration range of southern right whales. There is a chance that pygmy blue and southern right whales may be present in the EMBA depending on the time of year that a spill occurs. If present, these species (and other cetaceans) may be exposed to hydrocarbons in the manner described above. If large quantities of zooplankton exposed to the spill were ingested, chronic toxicity impacts to some individual cetaceans may occur if they are feeding duration their migration through the Project area and EMBA. Biological consequences of physical contact with very localised areas of high concentrations (maximum 8 km from the release site) of hydrocarbons at the sea surface are unlikely to lead to any long-term population impacts. Evaporation of the hydrocarbons is expected to occur rapidly in this scenario with 83 m^3 (53%) of the modelled 155 m^3 evaporating within 20 days of the spill occurring, thus reducing the duration of the hydrocarbons persisting on the	The OSTM shows a large area of dissolved and entrained phase hydrocarbons at low threshold would occur through eastern Bass Strait. At the low threshold for dissolved hydrocarbons (10 ppb), water quality triggers are exceeded, but there are no toxicity effects to cetaceans. There is no area affected by dissolved hydrocarbons above the low threshold, which means the risk to cetaceans from dissolved hydrocarbons is very low. High threshold hydrocarbons entrained in the water column could potentially occur up to a maximum distance of 279 km from the spill site. Highly mobile and transient species such as cetaceans moving through an area of hydrocarbons at the high exposure may experience some of the impacts described above. The OSTM predicts that after 20 days, 52% (80 m^3) of the spill will have evaporated whilst 35% (55 m^3) was predicted to remain in the water column. Thus, high exposure thresholds over significant areas of the sea are not likely to persist over a duration of time necessary to destabilise population dynamics. The oceanographic conditions of Bass Strait, the light nature of the MDO and the low concentration of hydrocarbons in the water column means the consequence (threatened and migratory species) to cetacean populations is **moderate.**	Not applicable.

sea surface. In comparison to the range of the BIAs of the whale species identified, the duration and extent of sea surface hydrocarbons is negligible and does not represent a long-term threat at the population level of cetaceans migrating or foraging in the EMBA. The consequence (threatened and migratory species) to cetacean populations from MDO at the surface is **moderate.**		

This hydrocarbon spill scenario will not have a 'significant' impact on threatened cetcean species (see Section 6.3.8) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), which are:	
• Lead to a long-term decrease in the size of a population.	A spill would not lead to a long-term decrease in the size of a population given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO and the low likelihood of a large portion of a cetacean population being present in the spill area at any one time.
• Reduce the area of occupancy of the species.	Given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO, the area of occupancy may be temporarily reduced (noting that cetaceans may not necessarily avoid a spill at the surface or in the water column), but there will be no long-term reduction in the area of occupancy.
• Fragment an existing population into two or more populations.	In the event of an MDO spill, cetaceans have access to an expansive area of unpolluted waters. A spill would not be expected to split up a single population into two or more populations. A spill does not move quickly enough to result in a migrating population splitting to avoid a spill.
• Adversely affect habitat critical to the survival of a species.	The water quality of the Project area and EMBA would be temporarily reduced in the event of an MDO spill. However, only a small portion of the MDO entrains or dissolves in the water column where cetaceans spend the majority of their time (apart from surfacing to breath). The Project area and EMBA form only a small portion of cetacean migration routes, so this habitat is not critical to their survival; they would be exposed to MDO for a very short period of time if a spill occurred during migration (minutes to hours).
• Disrupt the breeding cycle of a population.	Most of the cetacean species known to occur in the Project area and EMBA are not known to breed within the Project area or the EMBA. Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, it is highly unlikely that the breeding cycle of a cetacean population will be disrupted.
• Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The water quality of the Project area and EMBA would be temporarily reduced in the event of an MDO spill. Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, the duration of reduced water quality will be temporarily. Marine

	habitat will not be modified, destroyed, removed, isolated or decreased to the extent that one or more cetacean species will decline.
• Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	The endangered cetaceans that may migrate through the Project area and EMBA are the pygmy blue whale and southern right whale (there are no critically endangered cetaceans listed on the databases informing this assessment). An MDO spill is highly unlikely to result in the introduction and spread of IMS that are harmful to these species. Vessels that may be involved in the 'monitor and evaluate' spill response strategy will be subject to strict IMS controls to ensure that ballast water is of 'low risk' and that hulls are free of IMS.
• Introduce disease that may cause the species to decline.	The risks of toxic impacts to individual cetaceans or populations is minor due to the rapid weathering of MDO. The small extent of a single spill further reduces the risk to a small area. As such, it is unlikely that there would be a large number of 'oiled' cetaceans that may then become susceptible to disease.
• Interfere with the recovery of the species.	For all the reasons outlined above, an MDO spill will not interfere with the recovery of a seabird species.

Table 8.50. Potential risks of hydrocarbons on pinnipeds

General sensitivity to oiling - pinnipeds	
Sensitivity rating of pinnipeds:	High
A description of pinnipeds in the EMBA is provided in:	Section 6.3.6

Pinnipeds are potentially impacted by hydrocarbons at the sea surface, water column and shoreline.

Sea surface oil

Pinnipeds are vulnerable to hydrocarbon exposure on the sea surface 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 and regularly haul out on to beaches. Pinnipeds are also sensitive as they will stay near established colonies and haul-out areas, meaning they are less likely to practice avoidance behaviours. This is corroborated by Geraci and St. Aubins (1988) who suggest seals, sea-lions and fur-seals have been observed swimming in oil slicks during a number of documented spills.

Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. As a result of exposure to surface oils, pinnipeds, with their relatively large, protruding eyes are particularly vulnerable to effects such as irritation to mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, and anal and urogenital orifices. Hook et al (2016) reports that seals appear not to be very sensitive to contact with oil, but instead to the toxic impacts from the inhalation of volatile components.

For some pinnipeds, fur is an effective thermal barrier because it traps air and repels water. Petroleum stuck to fur reduces its insulative value by removing natural oils that waterproof the pelage. Consequently, the rate of heat transfer through fur seal pelts can double after oiling (Geraci & St. Aubin, 1988), adding an energetic burden to the animal. Kooyman et al (1976) suggest that in fact, fouling of approximately one-third of the body surface resulted in 50% greater heat loss in fur seals immersed in water at various temperatures. Fur-seals (e.g., Australian and New Zealand fur-seals) are particularly vulnerable due to the likelihood of oil adhering to fur. Heavy oil coating and tar deposits on fur-seals may result in reduced swimming ability and lack of mobility out of the water. Davis and Anderson (1976) observed two gray seal pups drowning, their "flippers stuck to the sides of their bodies such that they were unable to swim".

However, pinnipeds other than fur-seals (e.g., southern elephant seal) are less threatened by thermal effects of fouling, if at all. Oil has no effect on the relatively poor insulative capacity of sea-lion and bearded and ringed seal pelts; oiled Weddell seal samples show some increase in conductance (Oritsland, 1975; Kooyman *et al*., 1976; 1977).

In-water oil

Ingested hydrocarbons can irritate or destroy epithelial cells that line the stomach and intestine, thereby affecting motility, digestion and absorption. However, pinnipeds have been found to have the enzyme systems necessary to convert absorbed hydrocarbons into polar metabolites, which can be excreted in urine (Engelhardt, 1982; Addison & Brodie, 1984; Addison *et al*., 1986). Geraci & St. Aubin (1988) suggest that a small phocid weighing 50 kg might have to ingest approximately 1 litre of oil to be at risk.

Volkman et al (1994) report that benzene and naphthalene ingested by seals is quickly absorbed into the blood through the gut, causing acute stress, with damage to the liver considered likely. If ingested in large volumes, hydrocarbons may not be completely metabolised, which may result in death.

<u>Shoreline oil</u> Breeding colonies (used to birth and nurse until pups are weaned) are particularly sensitive to hydrocarbon spills (Higgins & Gass, 1993). Pinnipeds are further at risk because of their tendency to stay near established colonies and haul-out areas and consequently are unlikely to practice oil avoidance behaviours. ITOPF (2011a) report that species that rely on fur to regulate their body temperature (such as fur-seals) are the most vulnerable to oil as the animals may die from hypothermia or overheating, depending on the season, if the fur becomes matted with oil. It is reported that most pinnipeds scratch themselves vigorously with their flippers and do not lick or groom themselves, so are less likely to ingest oil from skin surfaces (Geraci & St. Aubin, 1988). However, mothers trying to clean an oiled pup may ingest oil. All pinnipeds examined to date have the enzyme systems necessary to convert absorbed hydrocarbons into polar metabolites, which can be excreted in urine (Engelhardt, 1982; Addison and Brodie, 1984; Addison *et al*., 1986). The Long Term Environmental Impact and Recovery report for the Iron Barren oil spill (in Tasmania, 1995) concluded that “The number of seal pups born at Tenth Island in 1995 was reduced when compared to previous years. There was a strong relationship between the productivity of the seal colonies and the proximity of the islands to the oil spill wherein the islands close to the spill showed reduced pup production and those islands more distant to the oil spill did not” (Tasmanian SMPC, 1999). Pinnipeds are further at risk because they appear to rely on scent to establish a mother-pup bond (Sandegren, 1970; Fogden, 1971), and consequently oil-coated pups may not be recognisable to their mothers. This is only theorised, with studies and research indicating interaction between mothers and oiled pups were normal (Davis and Anderson, 1976; Davies, 1949; Shaughnessy & Chapman, 1984). Australian sea-lions have ‘naturally poor recovery abilities’ due to ‘unusual reproductive biology and life history’ (TSSC, 2005). Due to the extreme philopatry of females and limited dispersal of males between breeding colonies, the removal of only a few individuals annually may increase the likelihood of decline and potentially lead to the extinction of some of the smaller colonies. Extinction of breeding colonies has the potential to further reduce genetic diversity and the already limited genetic flow between colonies. This, in turn, may weaken the genetic resilience of the species and impact on its ability to cope with other natural or anthropogenic impacts. In addition, the extreme philopatry of females suggests that extinction of breeding colonies may lead to a contraction of the range of the species as re-colonisation of breeding sites via immigration is limited. For the reasons outlined above, small breeding colonies are under particular pressure of survival from even low levels of anthropogenic mortality.

Potential risks from this activity		
Sea surface	Water column	Shoreline
The foraging range for fur-seals may be temporarily exposed to low concentrations of hydrocarbons at the sea surface, which is predicted to travel up to a maximum distance of 250 km from the spill location. As fur-seals forage for prey within the water column rather than at the sea surface, exposure to oil at the sea surface will only result when resting at the surface. Depending on the duration of time spent at the sea surface,	There is a 1% to 2% probability of low exposure to dissolved hydrocarbons between the Wellington and East Gippsland sectors of the coastline and no predicted areas of moderate or high dissolved hydrocarbons. Thus, impacts to fur-seals from dissolved hydrocarbons are not expected.	There is no risk of MDO stranding on shorelines known to be used by fur-seals as breeding or haul-out sites. As such, it is unlikely that oiling of fur-seals will occur on shorelines in the EMBA. The nearest site of significance is Rag Island off the east coast of

exposure may result in irritation to mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, and anal and urogenital orifices. Given the very small potential maximum area of moderate (38 km) and high (8 km) exposure threshold at the sea surface, acute or chronic toxicity impacts are not likely for multiple individuals across multiple colonies. The highly mobile nature of the pinniped species likely to be present means areas on the sea surface impacted by low hydrocarbon exposure can be avoided. The closest fur-seal colonies are located at Rag Island and The Skerries, outside the areas of potential moderate and high exposure thresholds. Given the generally brief time spent at the sea surface by pinnipeds and the rapid weathering of the MDO, the consequence (threatened and migratory species) to populations present in Bass Strait is **minor.**	There is up to an 8% probability of high exposure to entrained hydrocarbons at MNPs including Cape Howe, Ninety Mile Beach and Point Hicks. These levels may have sub-lethal effects to sensitive species and are likely to overlap with fur-seal foraging ranges. Given that fur-seals forage for prey within the water column, exposure to hydrocarbons may occur (either via ingestion of contaminated prey or direct contact with oil droplets) though at generally low concentrations and a smaller extent at high concentration. The consequence (threatened and migratory species) of exposure to hydrocarbons in the water column is **moderate** for individuals and **minor** for populations.	Wilsons Promontory (100 km from the release site and outside the MDO surface oil EMBA). Given the generally rocky nature of preferred haul-out sites (and the lack of such habitat within the surface oil EMBA) and the ability of these sites to self-clean and not retain high concentrations of hydrocarbons, the consequence (threatened and migratory species) of oiling of pinnipeds at shorelines is **minor.**

Table 8.51. Potential risks of hydrocarbons on marine reptiles

General sensitivity to oiling – marine reptiles	
Sensitivity rating of marine reptiles:	Medium
A description of turtles in the EMBA is provided in:	Section 6.3.7

Marine reptiles can be exposed to hydrocarbons through ingestion of contaminated prey, inhalation or dermal exposure (Hook *et al.*, 2016).

Sea turtles are vulnerable to the effects of oil at all life stages—eggs, post-hatchlings, juveniles, and adults in nearshore waters. Several aspects of sea turtle biology and behaviour place them at particular risk, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large pre-dive inhalations. Effects of oil on turtles include increased egg mortality and developmental defects, direct mortality due to oiling in hatchlings, juveniles, and adults; and negative impacts to the skin, blood, digestive and immune systems, and salt glands. Oil exposure affects different turtle life stages in different ways. Each turtle life stage frequents a habitat with notable potential to be impacted during an oil spill. Thus, information on oil toxicity needs to be organized by life stage. Turtles may be exposed to chemicals in oil in two ways:

- Internally – eating or swallowing oil, consuming prey containing oil-based chemicals, or inhaling of volatile oil related compounds; and
- Externally – swimming in oil or dispersants, or oil or dispersants on skin and body.

Records of oiled wildlife during spills rarely include marine turtles, even from areas where they are known to be relatively abundant (Short, 2011). An exception to this was the large number of marine turtles collected (613 dead and 536 live) during the Macondo spill in the GoM, although many of these animals did not show any sign of oil exposure (NOAA, 2013). Of the dead turtles found, 3.4% were visibly oiled and 85% of the live turtles found were oiled (NOAA, 2013). Of the captured animals, 88% of the live turtles were later released, suggesting that oiling does not inevitably lead to mortality.

Impacts to sea snakes during marine hydrocarbon spills are known from limited assessments, undertaken following the Montara spill in the Timor Sea in 2009. Two dead sea snakes were collected during the incident, one of which was concluded to have died as a result of exposure to the oil, with evidence of inhaled and ingested oil and elevated concentrations of PAHs in muscle tissues. The second snake showed evidence of ingestion by oil but no accumulation in tissues or damage to internal organs and it was concluded that the oil was unlikely to be the cause of death (Curtin University, 2009; 2010).

There is potential for contamination of turtle eggs to result in similar toxic impacts to developing embryos as has been observed in birds. Studies on freshwater snapping turtles showed uptake of PAHs from contaminated nest sediments, but no impacts on hatching success or juvenile health following exposure of eggs to dispersed weathered light crude (Rowe *et al*., 2009). However, other studies found evidence that exposure of freshwater turtle embryos to PAHs results in deformities (Bell *et al*., 2006, Van Meter *et al*., 2006).

Turtles may experience oiling impacts on nesting beaches and eggs through chemical exposure, resulting in decreased survival to hatching and developmental defects in hatchlings. Turtle hatchlings may be more vulnerable to smothering as they emerge from the nests and make their way over the intertidal area to the open water (AMSA, 2015). Hatchlings that contact oil residues while crossing a beach can exhibit a range of effects including impaired movement and bodily functions (Shigenaka, 2003). Hatchlings sticky with oily residues may also have more difficulty crawling and swimming, rendering them more vulnerable to predation.

Ingested oil may cause harm to the internal organs of turtles. Oil covering their bodies may interfere with breathing because they inhale large volumes of air to dive. Oil can enter cavities such as the eyes, nostrils, or mouth. Turtles may experience oiling impacts on nesting beaches when they come ashore to lay their eggs, and their eggs may be exposed during incubation, potentially resulting in increased egg mortality and/or possibly developmental defects in

hatchlings.	
Potential risks from this activity	
Sea surface & water column	Shoreline
Some individual transient marine reptiles may come into contact with localised areas of high MDO exposure on the sea surface and entrained in the water column. However, this high concentration is small in area and temporary before weathering and mixing disperses and dilutes the concentrations to non-harmful levels. Due to the absence of turtle BIAs in Bass Strait and the low number of turtles migrating through Victorian waters in general, the consequence (threatened and migratory species) to marine reptiles (individuals or populations) is **minor.**	There are no turtle nesting beaches within the EMBA, so impacts to turtles from shoreline oiling will **not occur**.

Table 8.52. Potential risks of hydrocarbons on seabirds and shorebirds

General sensitivity to oiling – seabirds and shorebirds	
Sensitivity rating of seabirds:	High
Sensitivity rating of shorebirds:	High
A description of seabirds and shorebirds in the EMBA is provided in:	Section 6.3.8
Seabirds and shorebirds are sensitive to the impacts of oiling, with their vulnerability arising from the fact that they cross the air-water interface to feed, while their shoreline habitats may also be oiled (Hook *et al*., 2016). Species that raft together in large flocks on the sea surface are particularly at risk (ITOPF, 2011a). Birds foraging at sea have the potential to directly interact with oil on the sea surface some considerable distance from breeding sites in the course of normal foraging activities. Species most at risk include those that readily rest on the sea surface (such as shearwaters) and surface plunging species such as terns and boobies. As seabirds are top order predators, any impact on other marine life (e.g., pelagic fish) may disrupt and limit food supply both for the maintenance of adults and the provisioning of young. In the case of seabirds, direct contact with hydrocarbons is likely to foul plumage, which may result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair water-proofing (ITOPF, 2011a). A bird suffering from cold, exhaustion and a loss of buoyancy (resulting from fouling of plumage) may dehydrate, drown or starve (ITOPF, 2011a; DSEWPC, 2011a; AMSA, 2013). It may also result in impaired navigation and flight performance (Hook *et al*., 2016). Increased heat loss as a result of a loss of water-proofing results in an increased metabolism of food reserves in the body, which is not countered by a corresponding increase in food intake, and may lead to emaciation (DSEPWC, 2011). The greatest vulnerability in this case occurs when birds are feeding or resting at the sea surface (Peakall *et al*., 1987). In a review of 45 marine hydrocarbon spills, there was no correlation between the numbers of bird deaths and the volume of the spill (Burger, 1993). Toxic effects of hydrocarbons on birds may result where the oil is ingested as the bird attempts to preen its feathers, and the preening process may spread the oil over otherwise clean areas of the body (ITOPF, 2011a). Whether this toxicity ultimately results in mortality will depend on the amount of hydrocarbons consumed and other factors relating to the health and sensitivity of the bird. Birds that are coated in oil also suffer from damage to external tissues including skin and eyes, as well as internal tissue irritation in their lungs and stomachs. Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos. Engelhardt (1983), Clark (1984), Geraci & St Aubin (1988) and Jenssen (1994) indicated that the threshold thickness of oil that could impart a lethal dose to some intersecting wildlife individual is 10 µm (~10 g/m^2). Scholten et al (1996) indicates that a layer 25 µm thick would be harmful for most birds that contact the slick. Shorebirds are likely to be exposed to oil when it directly impacts the intertidal zone due to their feeding habitats. Shorebird species foraging for invertebrates on exposed sand and mud flats at lower tides will be at potential risk of both direct impacts through contamination of individual birds (ingestion or soiling of feathers) and indirect impacts through the contamination of foraging areas that may result in a reduction in available prey items (Clarke, 2010). Breeding seabirds may be directly exposed to oil via a number of potential pathways. Any direct impact of oil on terrestrial habitats has the potential to contaminate birds present at the breeding sites (Clarke, 2010). Bird eggs may also be damaged if an oiled adult sits on the nest. Fresh crude was shown to be more toxic than weathered crude, which had a medial lethal dose of 21.3 mg/egg (Clarke, 2010). Penguins may be especially vulnerable to oil because they spend a high portion of their time in the water and readily lose insulation and buoyancy if their feathers are oiled (Hook *et al*., 2016). The Iron Baron vessel spill (325 tonnes of bunker fuel in Tasmania in 1995) is estimated to have resulted in the	

death of up to 20,000 penguins (Hook *et al*., 2016).		
Potential risks from this activity		
Surface oiling	Water column	Shoreline
The threatened bird species likely to occur in the EMBA, such as albatross and petrels, forage over an extensive area and are distributed over a wide geographic area. Seabirds rafting, resting, diving or feeding at sea have the potential to come into contact with moderate to high exposure levels of MDO on the sea surface. These concentrations are generally considered detrimental to birds because of ingestion from preening of contaminated feathers, loss of thermal protection and hypothermia from matted feathers. However, rapid weathering will limit the duration of toxicity impacts and thus the number of seabirds that may come in to contact with the surface hydrocarbons. The absence of breeding colonies or nesting areas in the EMBA for most of the seabirds known to occur in the region (particularly albatross and petrels) limits potential exposure to spilled MDO. The overall consequence (threatened and migratory species) to seabirds is **moderate.**	The seabirds known to occur in the EMBA would spend only seconds at a time diving for fish in the top 0-10 m of the water column. Consequently, contact with MDO at any exposure level would be brief (even after numerous dives). The weathering of MDO and well-mixed waters of Bass Strait will aid in diluting and dispersing the hydrocarbons and thus reduce its concentration over time. The consequence (threatened and migratory species) to seabirds and shorebirds is **moderate**.	The average length of shoreline predicted to be exposed to MDO that may have biological impacts to birds (>100 g/m^2) is 6 km, with an average volume of 37 m^3. This section of coastline, between Seaspray and seaward of Loch Sport, comprises wide sandy beaches that provides habitat for shorebird species such as hooded plovers, terns, snipes and sandpipers. MDO is unlikely to persist on the surface of sandy beaches as it quickly penetrates porous sediments, which therefore limits the duration of exposure to shorebirds. Shorebirds foraging for food in intertidal areas or along the high tide mark and splash zone may encounter weathered hydrocarbons that may be brought back to nests. Hydrocarbon entering the sandy nests of hooded plovers, terns or other bird species is likely to percolate through the sand and not accumulate in the feathers of adults or young. Toxicity effects from ingestion of contaminated prey caught in the intertidal zone or from direct exposure or transport back to nests are unlikely to occur, as the volatile components are likely to have weathered prior to stranding. The populations of seabird and shorebird species within the EMBA have a wide geographic range, meaning that impacts to individuals or a population at one location will not necessarily extend to populations at other unimpacted locations. The consequence (threatened and migratory species) of shoreline stranding of MDO to shorebirds is **moderate.**

This hydrocarbon spill scenario will not have a 'significant' impact on migratory <u>shorebird</u> species (see Section 6.3.8) when assessed against the EPBC Act *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act-listed migratory shorebird species Policy Statement 3.21* (DoEE, 2017), which are:	
• Loss of habitat.	The sandy beaches of the EMBA will not be lost in the event of an MDO spill.
• Degradation of habitat leading to a substantial reduction in migratory shorebird numbers.	Shoreline quality will temporarily decrease but given the behaviour of MDO and nature of the shoreline, there will be no long-term degradation.
• Increased disturbance leading to a substantial reduction in migratory shorebird numbers.	MDO will rapidly percolate through sandy beach sediments, resulting in only short-term disturbance. The most likely shoreline response option will be to monitor and evaluate (rather than actively undertake a clean-up), further reducing the potential for disturbance to shorebirds.
• Direct mortality of birds leading to a substantial reduction in migratory shorebird numbers.	Depending on the nature of the spill, how it weathers and the location of shoreline loading, there is a low risk of direct mortality of birds. No one area of the Ninety Mile Beach, particularly the shoreline closest to the Project area, has high concentrations or a high percentage of a population of any migratory shorebird species. As such, a substantial reduction in migratory shorebird numbers is highly unlikely to occur.
This hydrocarbon spill scenario will not have a 'significant' impact on threatened <u>seabird</u> species (see Section 6.3.8) when assessed against the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013), which are:	
• Lead to a long-term decrease in the size of a population.	A spill would not lead to a long-term decrease in the size of a population given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO and the low likelihood of a large portion of a seabird population being present in the spill area at any one time.
• Reduce the area of occupancy of the species.	Given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO and the abundance of suitable nearby habitat, sea surface water quality will temporarily decrease and therefore the area of occupancy will be temporarily reduced but there will be no long-term reduction in the area of occupancy.
• Fragment an existing population into two or more populations.	In the event of an MDO spill, seabirds have access to an expansive area of unpolluted waters. A spill would not fragment an existing population given the small area of 'swept ocean' from a single spill.
• Adversely affect habitat critical to the survival of a species.	The marine waters of the Project area and EMBA are not critical to the survival or any seabirds. Similar marine habitat occurs all through Bass Strait and the Southern Ocean.
• Disrupt the breeding cycle of a population.	Most of the seabird species known to occur in the Project area and EMBA (e.g., albatross, petrels, shearwaters) breed outside of Australia or well beyond the EMBA. Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, it is highly unlikely that the breeding cycle of a seabird population will be disrupted.

• Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, the quality of marine waters in the area of the spill will be temporarily reduced. However, marine habitat will not be modified, destroyed, removed, isolated or decreased to the extent that one or more seabird species will decline. Most of the seabird species known to occur in the Project area and EMBA (e.g., albatross, petrels, shearwaters) breed outside of Australia or well beyond the EMBA. This being the case, the risk of adults bringing contaminated prey back to nests to feed chicks is non-existent. For the species that do breed in Australian waters and parts of the EMBA, it is unlikely that MDO or MDO-affected prey would be brought back to the nest in quantities significant enough to result in mortality of chicks and the loss of a generation.
• Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	There are several EPBC Act-listed endangered and critically endangered seabirds that may occur in the Project area and/or EMBA. An MDO spill is highly unlikely to result in the introduction and spread of IMS that are harmful to these species. Vessels that may be involved in the 'monitor and evaluate' spill response strategy will be subject to strict IMS controls to ensure that ballast water is of 'low risk' and that hulls are free of IMS.
• Introduce disease that may cause the species to decline.	The risks of toxic impacts to individual birds or populations is minor due to the rapid weathering of MDO. The small extent of a single spill further reduces the risk to a small area. As such, it is unlikely that there would be a large number of 'oiled' birds that may then become susceptible to disease.
• Interfere with the recovery of the species.	For all the reasons outlined above, an MDO spill will not interfere with the recovery of a seabird species.
The project will not impact on the objectives of the *Draft Wildlife Conservation Plan for Seabirds* (DAWE, 2019), which are: 1. International cooperation and collaboration occur to support the survival of seabirds and their habitats outside Australian jurisdiction. 2. Seabirds and their habitats are protected and managed in Australia. 3. The long-term survival of seabirds and their habitats is achieved through supporting priority research programs, coordinating monitoring, on-ground management and conservation. 4. Awareness of the importance of conserving seabirds and their habitats is increased through a strategic approach to community education and capacity building to support monitoring and on-ground management.	

Table 8.53. Potential risks of hydrocarbons on sandy beaches

General sensitivity to oiling – sandy beaches	
Sensitivity rating of sandy beaches (environmental):	Low
Sensitivity rating of sandy beaches (social):	Medium
A description of sandy beaches in the EMBA is provided in:	Section 6.2.1

Sandy beaches are regularly exposed to wave action and have low sediment total organic carbon and therefore generally low abundance of marine life (Hook *et al.*, 2016). The low concentration of total organic carbon, the large particle size of sand and the properties of MDO means that any MDO deposited on the beach would not be retained on the surface. However, sandy beaches (as is the case with the Ninety Mile Beach) are important socio-economically, so an oil spill reaching this type of shoreline may attract attention that is disproportionate to its sensitivity (Hook *et al.*, 2016).

Depth of penetration in sandy sediment is influenced by:

- Particle size – penetration is great in coarser sediments (such as beach sand) compared to mud (in estuaries and tidal flats).
- Oil viscosity – MDO quickly penetrates sandy sediments.
- Drainage – coarse beach sands allow for rapid drainage (it may reach depths greater than one metre in coarse well-drained sediments).
- Animal burrows and root pores – penetration into fine sediments is increased if there are burrows of animals such as worms, or pores left where plant roots have decayed.

Areas of heavy oiling (>1,000 g/m^2 threshold) would likely result in acute toxicity, and death, of many invertebrate communities, especially where oil penetrates into sediments through animal burrows (IPIECA, 1999). However, these communities would be likely to rapidly recover (recruitment from unaffected individuals and recruitment from nearby areas) as oil is removed from the environment. The results of exposure to oil may be acute (e.g., die off of amphipods and replacement by more tolerant species such as worms) or chronic (i.e., gradual accumulation of oil and genetic damage) (Hook *et al.*, 2016).

For example, following the Sea Empress spill (in west Wales, 1996) many amphipods (sandhoppers), cockles and razor shells were killed. There were mass strandings on many beaches of both intertidal species (such as cockles) and shallow sub-tidal species. Similar mass strandings occurred after the Amoco Cadiz spill (in Brittany, France, 1978) (IPIECA, 1999). Following the Sea Empress spill, populations of mud snails recovered within a few months but some amphipod populations had not returned to normal after one year. Opportunists such as some species of worm may actually show a dramatic short-term increase following an oil spill (IPIECA, 1999).

Long-term depletion of sediment fauna could have an adverse effect on birds or fish that use tidal flats as feeding grounds (IPIECA, 1999).

In March 2014, small volumes of crude oil from an unidentified source (confirmed to not be offshore oil and gas production facilities) washed up along a 7-km section of sandy beach on the Victorian Gippsland coast as small (a few millimetres thick) granular balls (Gippsland Times, 2014; ABC News, 2014). AMSA (2014b) reported that no impacts were observed over the course of two months following the incident.

The Macondo well blowout resulted in oil washing up on sandy beaches of the Alabama coastline. The natural movement of sand and water through the beach system continually transformed and re-distributed oil within the beach system, and 18 months after the event, mobile remnant oil remained in various states of weathering buried at different depths in the beaches (Hayworth *et al.*, 2011). Other results from beach sampling undertaken at Dauphin Island,

Alabama, in May (pre-impact) and September 2011 (post-impact) found a large shift in the diversity and abundance of microbial species. Post-spill, sampling indicated that species composition was almost exclusively dominated by a few species of fungi. DNA analyses revealed that the 'before' and 'after' communities at the same sites weren't closely related to each other (Bik *et al*., 2012). Similar studies found that oil deposited on the beaches caused a shift in the community structure toward a hydrocarbonoclastic consortium (petroleum hydrocarbon degrading microorganisms) (Lamendella *et al*., 2014).
Potential risks from this activity
Shoreline
The shoreline predicted to be exposed to moderate to high MDO loadings/volumes occur between Seaspray and seaward of Loch Sport. This area of coastline is exposed, comprising wide sandy beaches and is subject to strong wave action. This would assist in natural degradation of MDO and pushing MDO residues down into the porous beach sediments and away from the surface. In so doing, the MDO residues may result in toxicity impacts to invertebrate species living in the beach sediments and may impact on shorebird species feeding on these invertebrates. Areas of low exposure to shoreline loading are not expected to exhibit environmental harm. Due to the exposed nature of the shoreline and the nature of MDO, long-term toxicity or smothering effects in areas of moderate to high MDO exposure are not expected and natural weathering should be sufficient to aid in recovering communities rapidly. The consequence of short-term reductions in tourism and other human uses of the beach is **moderate**, and may occur as a result of temporary beach closures to protect human health or due to perceptions of a polluted environment, rather than a requirement to protect the public from persistent pollution.

Table 8.54. Potential risks of hydrocarbons to commercial fishing

General sensitivity to oiling – commercial fishing	
Sensitivity rating of commercial fisheries:	High
A description of commercial fisheries in the EMBA is provided in:	Section 6.6.3

Commercial fishing has the potential to be impacted through exclusion zones associated with the spill, the spill response and subsequent reduction in fishing effort. Exclusion zones may impede access to commercial fishing areas, for a short period of time, and nets and lines may become oiled. The impacts to commercial fishing from a public perception perspective however, may be much more significant and longer term than the spill itself.

Fishing areas may be closed for fishing for shorter or longer periods because of the risks of the catch being tainted by oil. Concentrations of petroleum contaminants in fish and crustacean and mollusc tissues could pose a significant potential for adverse human health effects, and until these products from nearshore fisheries have been cleared by the health authorities, they could be restricted for sale and human consumption. Indirectly, the fisheries sector will suffer a heavy loss if consumers are either stopped from using or unwilling to buy fish and shellfish from the region affected by the spill.

Impacts to fish stocks have the potential for reduction in profits for commercial fisheries, and exclusion zones exclude fishing effort. Davis et al (2002) report detectable tainting of fish flesh after a 24-hour exposure at crude concentrations of 0.1 ppm, marine fuel oil concentrations of 0.33 ppm and diesel concentrations of 0.25 ppm.

The Montara spill (as the most recent [2009] example of a large hydrocarbon spill in Australian waters) occurred over an area fished by the Northern Demersal Scalefish Managed Fishery (with 11 licences held by 7 operators), with goldband snapper, red emperor, saddletail snapper and yellow spotted rockcod being the key species fished (PTTEP, 2013). As a precautionary measure, the WA Department of Fisheries advised the commercial fishing fleet to avoid fishing in oil-affected waters. Testing of fish caught in areas of visible oil slick (November 2009) found that there were no detectable petroleum hydrocarbons in fish muscle samples, suggesting fish were safe for human consumption. In the short-term, fish had metabolised petroleum hydrocarbons. Limited ill effects were detected in a small number of individual fish only (PTTEP, 2013). No consistent effects of exposure on fish health could be detected within two weeks following the end of the well release. Follow up sampling in areas affected by the spill during 2010 and 2011 (PTTEP, 2013) found negligible ongoing environmental impacts from the spill.

Since testing began in the month after the Macondo well blowout in the GoM (2010), levels of oil contamination residue in seafood consistently tested 100 to 1,000 times lower than safety thresholds established by the USA FDA, and every sample tested was found to be far below the FDA's safety threshold for dispersant compounds (BP, 2015). FDA testing of oysters found oil contamination residues to be 10 to 100 times below safety thresholds (BP, 2014). Sampling data shows that post-spill fish populations in the GoM since 2011 were generally consistent with pre-spill ranges and for many shellfish species, commercial landings in the GoM in 2011 were comparable to pre-spill levels. In 2012, shrimp (prawn) and blue crab landings were within 2.0% of 2007-09 landings. Recreational fishing harvests in 2011, 2012 and 2013 exceeded landings from 2007-09 (BP, 2014).

In the event of an MDO spill, a temporary fisheries closure may be put in place by the VFA (or voluntarily by the fishers themselves). Oil may foul the hulls of fishing vessels and associated equipment, such as gill nets. A temporary fisheries closure, combined with oil tainting of target species (actual or perceived), may lead to financial losses to fisheries and economic losses for individual licence holders. Fisheries closures and the flow on losses from the lack of income derived from these fisheries are likely to have short-term but widespread socio-economic consequences, such as reduced employment (in fisheries service industries, such as tackle and bait supplies, fuel, marine mechanical services, accommodation and so forth).

Potential risks from this activity			
Fishery	Surface oiling	Water column	Shoreline
General	A short-term fishing exclusion zone may be implemented by the VFA. Given the small and temporary nature of a surface slick at a threshold that may result in ecological impacts and the low fishing intensity in the EMBA, the consequence (business) to fisheries in terms of lost catches (and associated income) is **minor.**	As illustrated in Figure 8.8 and Figure 8.9, there is the probability of exposure to dissolved (low exposure only) and entrained (low and high) hydrocarbons in the water column. In general, depuration of hydrocarbons from fish tissue is rapid and thus the consequence (business) to fisheries (in terms of reduced catch or tainted catch) from hydrocarbon exposure in the water column is **minor.** However, a short-term fishing exclusion zone and taint monitoring program may be implemented by fishery management authorities, which may have **moderate** consequences for fishing operators.	There is a 2% probability of high threshold contact with the Lakes Entrance coastline sector by entrained hydrocarbons, which is the port within the EMBA where fishing vessels may be moored. Some staining or coating of vessel hulls may occur.
Victorian fisheries (those known to occur within the 155 m^3 MDO EMBA)			
Scallop	No impacts due to their benthic habitat.	Hydrocarbons are not expected to accumulate among benthic sediments in areas fished for scallops. Therefore, the consequence to this fishery and its catch species is **negligible.**	As per ‘general.’
Abalone	No impacts due to their benthic habitat.	The most heavily fished areas of the fishery are located off the east coast of Victoria, which may be exposed to areas of low exposure entrained and dissolved hydrocarbons. A temporary closure of the area affected by hydrocarbons may be implemented. This is expected to be of **minor** consequence (business) to the overall function and long-term viability of the fishery or its catch species.	As per ‘general’.
Rock lobster	No impacts due to their benthic habitat. There is a low risk of rock lobster pot buoys accumulating hydrocarbons if they are set at the time of a spill. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This	The OSTM indicates the maximum extent of low to high exposure of the benthic layer to entrained hydrocarbons (in 0-10 m water depths) occurs in the nearshore environment along the Wellington and East Gippsland sectors of the coastline. These waters are likely to be fished for rock lobster where rocky reef is	As per ‘general.’

	is of **moderate** consequence (business) to the fishery.	present, which occurs in discontinuous sections parallel to the coastline. Impacts to this fishery may eventuate in the form of a temporary and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. The consequence (business) to this fishery is **minor.**	
Wrasse	No impacts due to their pelagic habitat.	The entrained and dissolved EMBA intersects large areas of the wrasse fishery. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence (business) to the overall function of the fishery or its catch species.	As per 'general'.
Ocean access	No impacts due to their pelagic habitat. Vessel hulls have a low risk of accumulating hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	This fishery has access to the entire Victorian coastline (except for bays and reserves), so only a part of the available fishing grounds is exposed to high exposure entrained MDO. There are no areas of moderate or high exposure to dissolved hydrocarbons. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence (business) to the overall function of the fishery or its catch species.	As per 'general.'
Ocean purse seine			As per 'general.'
Inshore trawl	No impacts to fish due to their benthic habitat. Warp wires may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	This fishery has access to the entire Victorian coastline (except for bays and reserves), so only a part of the available fishing grounds is exposed to high exposure entrained and dissolved MDO. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence (business) to the overall function and long-term viability of the fishery or its catch	As per 'general.'

		species.	
Commonwealth fisheries (those within the 155 m^3 MDO EMBA)			
SESS – gillnet & shark hook	Surface buoys marking gillnet locations may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	Based on 2018-19 data, the EMBA intersects areas of moderate to high fishing intensity. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence (business) to the overall function of the fishery or its catch species in the long-term.	As per 'general.'
SESS – Commonwealth trawl sector	Warp wires may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	Based on 2018-19 data, the EMBA intersects areas of moderate to high fishing intensity. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence (business) to the overall function of the fishery or its catch species in the long-term.	As per 'general.'

8.15.5. Risks to MNES

A 155 m^3 MDO spill during this activity will not have a 'significant' risk to MNES, as outlined in Table 8.55.

Table 8.55. Risks to MNES from an MDO release

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore. It is unlikely that MDO of high enough concentration will enter the lakes system (through the Lakes Entrance channel) to result in significant impacts. Any oil reaching the entrance will be highly weathered.
Listed threatened species (see Section 6.3)	No	See Table 8.49 and table 8.52. Impacts to threatened and migratory marine species will not be 'significant as assessed against the EPBC Act Policy Statement 3.2. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds. This is detailed in Table 8.45 to Table 8.54.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas:		
- AMPs (see Section 6.4.1)	No	No AMPs are impacted by the EMBA. The nearest AMP (Beagle) is 49 km to the southwest from the nearest boundary of the EMBA.
- TECs (see Section 6.4.5)	No	Areas of the subtropical and temperate coastal saltmarsh TEC are intersected by the EMBA. However, this TEC is distributed along much of the central and eastern Victorian coast and into NSW. Therefore, no significant impact on the TEC is expected. Potential occurrence of the Giant Kelp Marine Forests of South east Australia TEC is also intersected by the EMBA at Point Hicks and Mallacoota. However, this TEC is distributed along much of the Tasmanian and western Victorian coast. Therefore, no significant impact, in accordance with the Significant Impact Guidelines 1.1, is expected on the TEC (see Table 8.46).
- KEFs (see Section 6.4.7)	No	There is a 9% probability of contact of high threshold entrained hydrocarbons with the Upwelling East of Eden KEF. This is not expected to significantly impact the function of the KEF.

8.15.6. Risk Assessment

Table 8.56 presents the risk assessment for an MDO spill.

Table 8.56. Risk assessment for an MDO spill

Summary		
Summary of risks	Pollution of sea surface, water column and shoreline. Injury or death of marine fauna, avifauna and macroalgae through ingestion or contact. Contamination of fish stocks and potential closure of fisheries.	
Extent of risk	As illustrated in Figure 8.6 to Figure 8.9. Up to: • 250 km for MDO on the sea surface; • 24.5 km of shoreline contact (maximum of 91.1 m^3); • 894 km for entrained MDO; and • 206 km for dissolved MDO.	
Duration of risk	Short-term – days to weeks, depending on level of contact, location and receptor.	
Level of certainty of risk	HIGH – spill source volumes are limited in size, the environmental impact of MDO is well understood, a credible spill volume has been modelled and a very conservative threshold has been selected to define the EMBA.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Preventative controls as per 'Interference with Third-party vessels.' Additional controls are provided here.		
Prevent		
No MDO is spilled to sea.	GB Energy supplies the support vessels with detailed bathymetry data from the Project area (obtained during the geophysical survey) for inclusion in their navigation systems so that combined with their draft, groundings can be avoided.	Vessel inspections verify that the Project area bathymetry data is loaded into the vessel navigation systems.
	The MODU Bunkering Procedure will be implemented in order to prevent an MDO spill. This will include (but is not limited to): • A Job Safety Analysis (JSA) and PTW is signed off for each bunkering event, taking into account spill response considerations.	PTW and JSA records for bunkering indicate that spill considerations were taken into account.
	• Ensuring that the dry-break refuelling hose couplings assembly is in order to minimise the risk of a spill and hose floats are installed on the refuelling hose so that a hose leak is quickly and easily visible.	A completed pre-refuelling checklist confirms that dry-break refuelling hose couplings and hose floats are installed on the refuelling hose assembly.

	• Ensuring that communications (visual and/or audio) between the MODU and the vessel will be tested by the MODU Chief Mate and Vessel Master prior to bunkering commencing.	PTW indicates that communications were tested between both vessels.
	• Ensuring that fuel transfer hoses are replaced in accordance with the PMS or when they are visibly degraded.	Hose register and PMS indicates regular replacement of fuel hoses.
	• The bunkering operation is supervised at all times.	Visual inspection (as noted in completed bunkering checklist) verifies that bunkering was supervised.
	• Ensuring that bunkering only commences during daylight hours and in calm sea conditions.	A completed pre-refuelling checklist confirms that bunkering commenced in daylight hours and in calm sea conditions.
	• Ensuring that tank level indicators and level alarms are provided in the control room for the bunkering tanks.	A completed pre-refuelling checklist confirms that the tank level alarms are functional.
Minimise *Preparedness*		
MODU and support vessel crews are prepared to respond to a spill.	The MODU and vessels have approved SMPEPs (or equivalent appropriate to class) that is implemented in the event of a large MDO spill.	Current SMPEPs are available.
	In accordance with the SMPEP, oil spill response kits are available in relevant locations, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for MDO spills to deck record that the spill is cleaned up using SMPEP resources.
	Within 4 weeks prior to the MODU and support vessels mobilising to site, a desktop oil spill response exercise will be conducted to test interfaces between the SMPEPs, OPEP, VicPlan and NatPlan.	OPEP Exercise Report records verify oil spill response exercise has been undertaken.
Reporting		
Reporting and monitoring of an MDO spill will take place in accordance with the EP and OPEP.	GB Energy will report the spill to regulatory authorities within 2 hours of becoming aware of the spill.	Incident reports verify that contact with regulatory agencies was made within 2 hours of GB Energy becoming aware of the spill.
Response		

Vessel Master will initiate action to reduce fuel loss in the event of a tank rupture.	The Vessel Master will authorise actions in accordance with the relevant SMPEP (or equivalent according to class) and the activity-specific OPEP to limit the release of MDO.	Daily operations reports verify that the SMPEP and OPEP were implemented.
	The MODU and vessels have approved SMPEPs (or equivalent appropriate to class) that is implemented in the event of a large MDO spill.	Spill incident report verifies that the actions taken were in accordance with the SMPEP.

Risk assessment (initial)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Moderate	Unlikely	Low
Macroalgal communities	Minor	Unlikely	Low
Plankton	Moderate	Unlikely	Low
Pelagic fish	Minor	Unlikely	Low
Cetaceans	Moderate	Unlikely	Low
Pinnipeds	Moderate	Unlikely	Low
Marine reptiles	Minor	Unlikely	Low
Seabirds	Moderate	Unlikely	Low
Shorebirds	Moderate	Unlikely	Low
Sandy beaches	Moderate	Unlikely	Low
Commercial fisheries	Minor	Unlikely	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
No MDO is spilled to sea.	No support vessel refuelling will be undertaken at sea (this will be done in port).	Bunker log verifies that refuelling was undertaken in port.
MODU and support vessel crews are prepared to respond to a spill.	MODU and support vessel crews are trained in spill response techniques in accordance with their SMPEP.	Training records verify that all marine crew are trained in spill response.

Risk assessment (residual)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Moderate	Rare	Low
Macroalgal communities	Minor	Rare	Very low
Plankton	Moderate	Rare	Low
Pelagic fish	Minor	Rare	Very ow
Cetaceans	Moderate	Rare	Low
Pinnipeds	Moderate	Rare	Low
Marine reptiles	Minor	Rare	Very low
Seabirds	Moderate	Rare	Low

Shorebirds	Moderate	Rare	Low
Sandy beaches	Moderate	Rare	Low
Commercial fisheries	Minor	Rare	Very low
Environmental Monitoring			
• As per the OPEP.			
Record Keeping			
• Vessel crew induction presentation. • Vessel crew training records. • MODU bunkering procedure. • Bunkering PTWs, JSAs, inspection checklists. • Hose register. • Oil spill response exercise records. • SMPEPs. • Incident reports. • OPEP daily operations reports.			

8.16. Dry Gas Release from Loss of Well Containment

8.16.1. Risk Pathway

In the highly unlikely event of a loss of well containment (LoWC) taking place during the drilling phase, dry gas will be released. This release would be more likely to occur at surface rather than subsea because the BOP is at the surface on the MODU. However, there may be a scenario where the release does occur subsea (e.g., drill pipe failure).

Risks to MODU and support vessel personnel from a LoWC will be addressed in the MODU Safety Case and Safety Case Revision that will be submitted to NOPSEMA prior to drilling for approval.

Gas Plume Modelling

GB Energy commissioned RPS to undertake gas plume dispersion and fate modelling of a topside gas release resulting from a LoWC (RPS, 2020b). The assessment focussed on dry gas only as no liquid-phase hydrocarbons are expected to be encountered in the reservoir (see Section 3.4.4). Consequently, the results are more relevant to human health than the marine environment. Nevertheless, the results are included here for completeness given that a well blowout is generally the most significant environmental risk for a drilling campaign.

Determining Release Scenario

The release scenario is based on the most credible (yet highly unlikely) scenario of a topside release following BOP failure. The release volume is based on a flow rate of 147 MMscf/day, with the release duration being 100 days. This duration represents the time predicted to kill the well (i.e., source a drill rig, mobilise it, drill a relief well and stop the flow of gas).

Methodology

As described in RPS (2020b), air dispersion modelling was undertaken using the Phast gas dispersion model. Air dispersion modelling considered the dispersion and transport of gas in the air based on atmospheric conditions (air stability) and defined wind speeds and directions. In this scenario, gas was released at the surface and did not travel through the water column from the subsea infrastructure.

The Phast model provides a number of options for outdoor release directions. For this analysis, a vertical release with impingement (a partial obstruction of the gas flow) and a vertical release without impingement (no partial obstruction of the gas flow) were selected. Impingement of the discharging gas may occur where the discharging jet is obstructed locally at the source by equipment or structures. The vertical release with impingement case gives longer dispersion distances because the momentum is assumed to be reduced compared with the initial value. This is considered an appropriate approach for the modelling, which considered the potential for flammable gas concentrations to be generated within minutes of release commencing. This reduces the initial fluid dilution rate which then results in a longer dispersion release.

Key flammability thresholds relevant to the dispersion of the gas in the atmosphere are summarised in Table 8.57.

Table 8.57. Key flammability thresholds

Property	Definition	Value
Lower flammability limit (LFL)	The lower end of the concentration range over which the flammable gas can be ignited.	4.7% (47,070 ppm)
Half Lower flammability limit (HLFL)	Because the modelling calculates for spatially-averaged gas concentrations (at the spatial scale of the model) and plumes are likely to be non-homogenous – with higher and lower concentration patches within a given space, a further threshold of 50% LEL was applied as indicative of potentially-flammable concentrations to guard against the occurrence of higher concentration patches.	2.35% (25,535 ppm)
Upper flammability limit (UFL)	The highest concentration of a gas that will produce a flash of fire when an ignition source is present. At concentrations greater than this, the mixture is too rich to burn.	17.6% (176,513 ppm)

Six weather conditions representative of those in the Gippsland Basin and summarised in Table 8.58 were adopted as modelling inputs. The dispersion modelling was conducted for the representative wind speeds, at various Pasquill stabilities (stabilities of atmospheric turbulence). For the subsea releases, the hydrocarbon fluid temperature is assumed to arrive at the ambient water temperature at the sea surface.

Table 8.58. Weather categories used as modelling inputs

Weather	Wind Speed (knots)	Pasquill Stability Class	Ambient Air Temperature (°C)	Relative Humidity (%)	Solar Radiation (kW/m^2)	Surface Water Temperature (°C)
2A/B	2.0	Unstable - as with A only less sunny and windier	17	0.77	0.42	15
4F	4.0	Stable - night with moderate clouds and light/moderate wind	17	0.77	0.42	15

Weather	Wind Speed (knots)	Pasquill Stability Class	Ambient Air Temperature (°C)	Relative Humidity (%)	Solar Radiation (kW/m^2)	Surface Water Temperature (°C)
6B	6.0	Unstable - as with A/B only less sunny and windier	17	0.77	0.42	15
8.6D	8.6	Neutral - little sun and high wind or overcast/windy night	17	0.77	0.42	15
12.7D	12.7	Neutral - little sun and high wind or overcast/windy night	17	0.77	0.42	15
15.6D	15.6	Neutral - little sun and high wind or overcast/windy night	17	0.77	0.42	15

Note: All sources, target distances and elevations have been estimated by using the water surface as the common point of origin. The water surface has been chosen as the physical effects are impacted by weather as the elevation above the water surface increases.

The zones of concern (ZOC) relating to potential human-health effects were calculated based on the criteria summarised in Table 8.59.

Under some Codes of Practice for working in confined spaces, such as those onboard vessels, concentration of any flammable gas, vapour or mist in the atmosphere must be less than 5% of LEL, unless a suitably calibrated, continuous-monitoring flammable gas detector is used in the space. The minimum threshold for the lowest ZOC Level 1 was set as 0.25% methane (2,500 ppm) on this basis.

The codes also stipulate that if concentrations are equal to or greater than 10% of the LEL, workers must be immediately removed from the space. During the Deepwater Horizon (MC52) response in the Gulf of Mexico in 2010, a trigger level of 10% LEL was set to activate control measures by vessel crew to reduce the LEL to less than 10% (i.e, moving the vessel upwind, notifying standby boats with water cannons). Thus, 10% LEL (0.5% methane; 5,000 ppm) was set to trigger ZOC Level 2.

In very high hydrocarbon gas clouds, oxygen levels can be depleted, which may cause dizziness or asphyxiation. Concentrations exceeding 20% LEL may trigger symptoms of dizziness and fainting. Consequently, 20% LEL was set as the lower threshold for ZOC Level 3.

ZOC Level 4 corresponds to 50% LEL and ZOC level 5 corresponds to 100% LEL.

Where concentrations of methane range between 15%-25%, UFL would be exceeded, indicating that risks of ignition will be lowered. However, impaired judgement and performance would be triggered by depletion of oxygen concentrations. The lower level of this range (15% methane; 150,000 ppm) was applied as the trigger for ZOC 6.

At methane concentrations between 25%-50%, available oxygen would be reduced to concentrations that would trigger fainting, with risk of death if exposure continues. The lower concentration (25% methane; 250,000 ppm) was applied as the lower threshold for defining ZOC 7.

Imminent death for anyone without breathing apparatus would be triggered at methane concentrations exceeding 50% (500,000 ppm), which is the concentration applied as ZOC Level 8.

Table 8.59. ZOC criteria for methane gas used in the modelling

Criteria for methane gas ZOC	ZOC level	Percent of LEL	Atmospheric concentration (Vol%)	Atmospheric concentration (Vol%)
UFL exceed and imminent death for anyone without breathing apparatus	8	UFL Exceeded	50-100%	500,000-1,000,000
UFL exceeded and serious oxygen depletion and fainting	7	UFL Exceeded	25-50%	250,000-500,000
UFL exceeded, oxygen depletion and impaired human performance	6	UFL Exceeded	15-25%	150,000-250,000
Flammable limit exceeded; explosion possible if ignition source is present.	5	LEL-UFL	5-15%	50,000-150,000
Some patches of higher concentration gas within explosive range could exist in plume	4	50-100%	2.5-5%	25,000-50,000
Exceeds VOC trigger for onset of dizziness and fainting	3	20-50%	1-2.5%	10,000-25,000
Trigger for Immediate removal of personnel from workspace.	2	10-20%	0.5-1%	5,000-10,000
Level for concern for contaminated workspace if not monitored.	1	5-10%	0.25-0.5%	2,500-5,000

Results

Table 8.60 presents the results for each weather condition modelled for the LoWC with impingement, noting that weather condition 2A/B always resulted in the largest vertical dispersion (Figure 8.12) and weather condition 15.6D always resulted in the largest horizontal dispersion (Figure 8.13). Figure 8.14 illustrates the dispersion for all weather conditions combined.

Maximum concentrations were calculated to remain below ZOC 7, so no results are presented for ZOC 7 and ZOC 8. This means that personnel on the drill rig would not be exposed to methane gas concentrations likely to result in fainting or death.

Table 8.60. Predicted atmospheric dispersion of dry gas from a topside release <u>with</u> impingement (all weather scenarios)

Dimensional plane	UFL distance	LFL distance	50% LFL distance	20% LFL distance	10% LFL distance	5% LFL distance
	ZOC 6	ZOC 5	ZOC 4	ZOC 3	ZOC 2	ZOC 1
	All distances measured in metres					
Weather 2.0A/B						
Horizontal	1.2	5.9	13	Not modelled		
Vertical	49	74	92			
Weather 4.0F						
Horizontal	1.4	7.6	19	Not modelled		
Vertical	45	58	66			
Weather 6.0B						
Horizontal	1.4	7.1	15	Not modelled		
Vertical	45	57	66			
Weather 8.6D						
Horizontal	1.6	8.9	22	65	133	257
Vertical	43	54	62	74	84	98
Weather 12.7D						
Horizontal	1.7	9.6	24	Not modelled		
Vertical	42	50	56			
Weather 15.6D						
Horizontal	1.7	10	25	70	138	255
Vertical	41	49	54	61	69	79

Maximum distance travelled is indicated in red

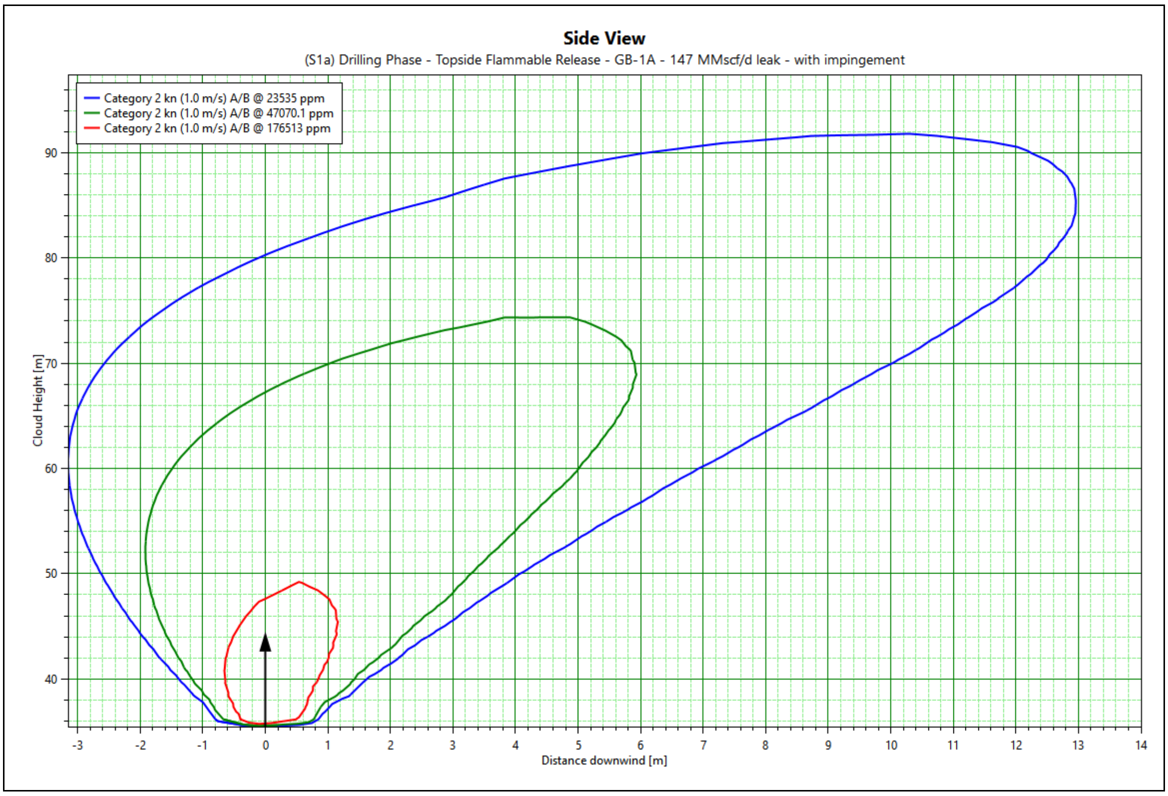


Figure 8.12. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) with impingement under the 2.0A/B weather conditions

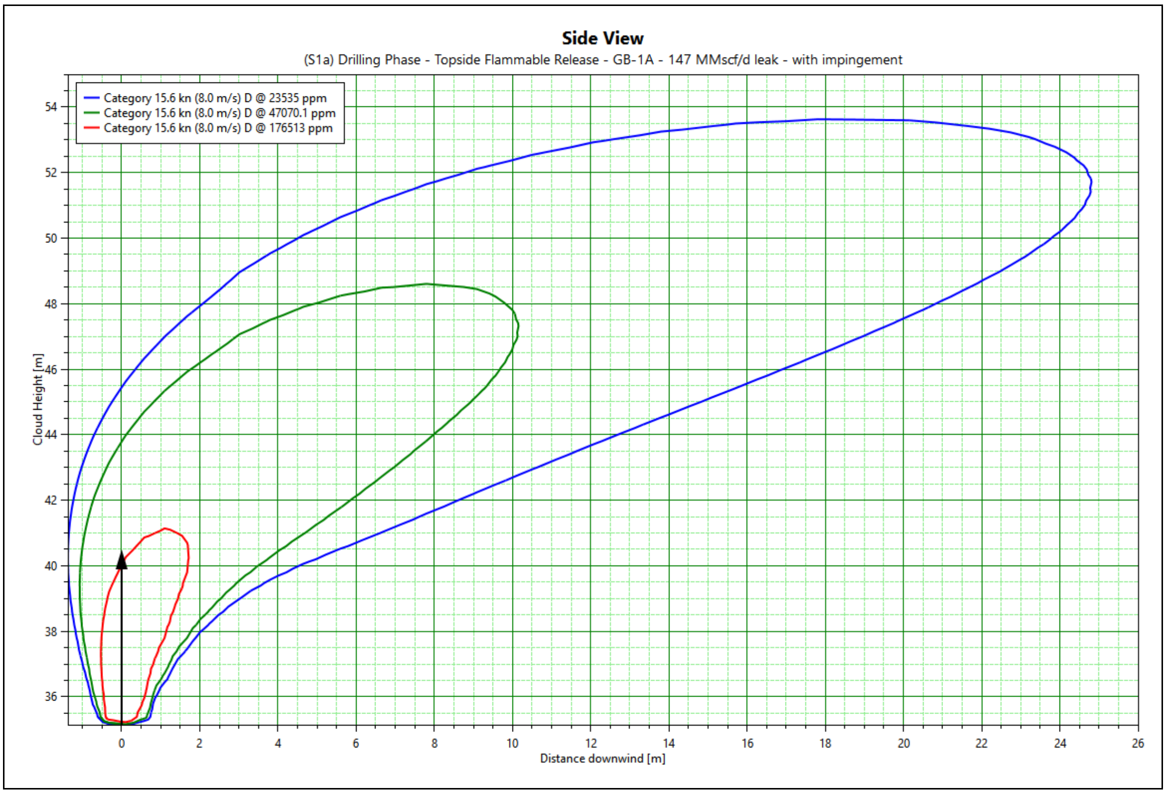


Figure 8.13. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) with impingement under the 15.6D weather conditions

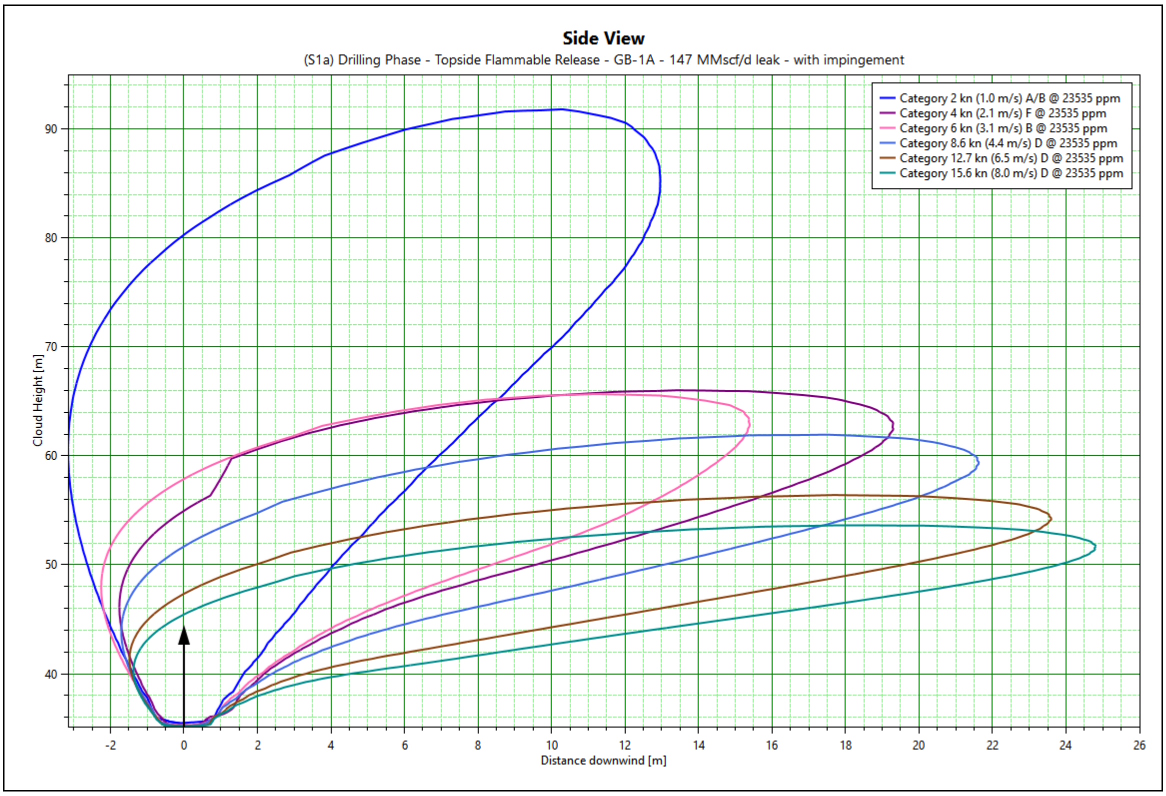


Figure 8.14. Predicted atmospheric dispersion for the 50% LFL (ZOC 4) with impingement for all weather conditions

Table 8.61 presents the results for each weather condition modelled for the LoWC without impingement, noting that weather condition 2A/B always resulted in the largest vertical dispersion (Figure 8.15) and weather condition 15.6D always resulted in the largest horizontal dispersion (Figure 8.16). Figure 8.17 illustrates the dispersion for all weather conditions combined.

Maximum concentrations were calculated to remain below ZOC 7, so no results are presented for ZOC 7 and ZOC 8. This means that personnel on the drill rig would not be exposed to methane gas concentrations likely to result in fainting or death.

Table 8.61. Predicted atmospheric dispersion of dry gas from a topside release without impingement (all weather scenarios)

Dimensional plane	UFL distance	LFL distance	50% LFL distance	20% LFL distance	10% LFL distance	5% LFL distance
	ZOC 6	ZOC 5	ZOC 4	ZOC 3	ZOC 2	ZOC 1
	All distances measured in metres					
Weather 2.0A/B						
Horizontal	0.5	2.5	5.6	Not modelled		
Vertical	43	67	89			
Weather 4.0F						
Horizontal	0.6	2.9	7.1	Not modelled		
Vertical	43	59	68			
Weather 6.0B						
Horizontal	0.5	3.1	7.0	Not modelled		
Vertical	43	58	69			
Weather 8.6D						
Horizontal	0.6	3.6	8.5	26	61	134
Vertical	42	55	65	81	96	113
Weather 12.7D						
Horizontal	0.7	3.9	9.1	Not modelled		
Vertical	41	52	59			
Weather 15.6D						
Horizontal	0.7	4.0	9.4	29	67	140
Vertical	41	50	57	68	78	88

Maximum distance travelled is indicated in red

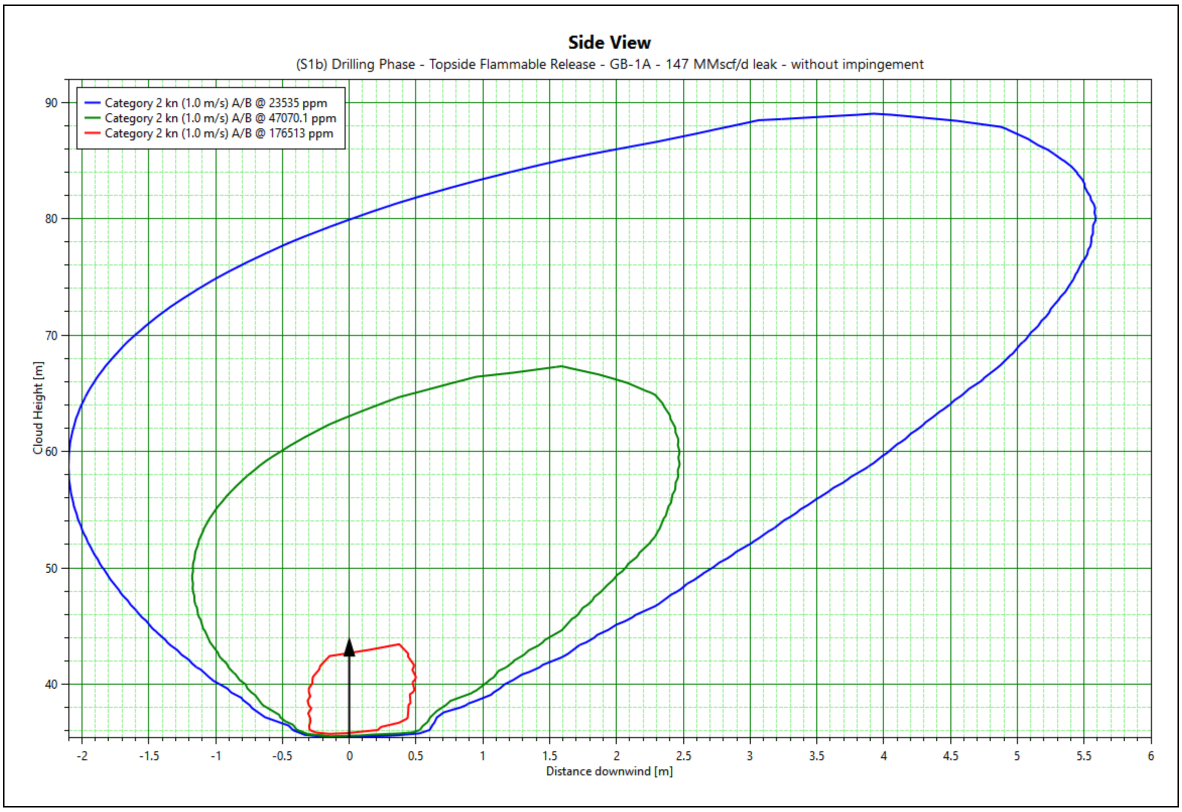


Figure 8.15. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) <u>without</u> impingement under the 2.0A/B weather conditions

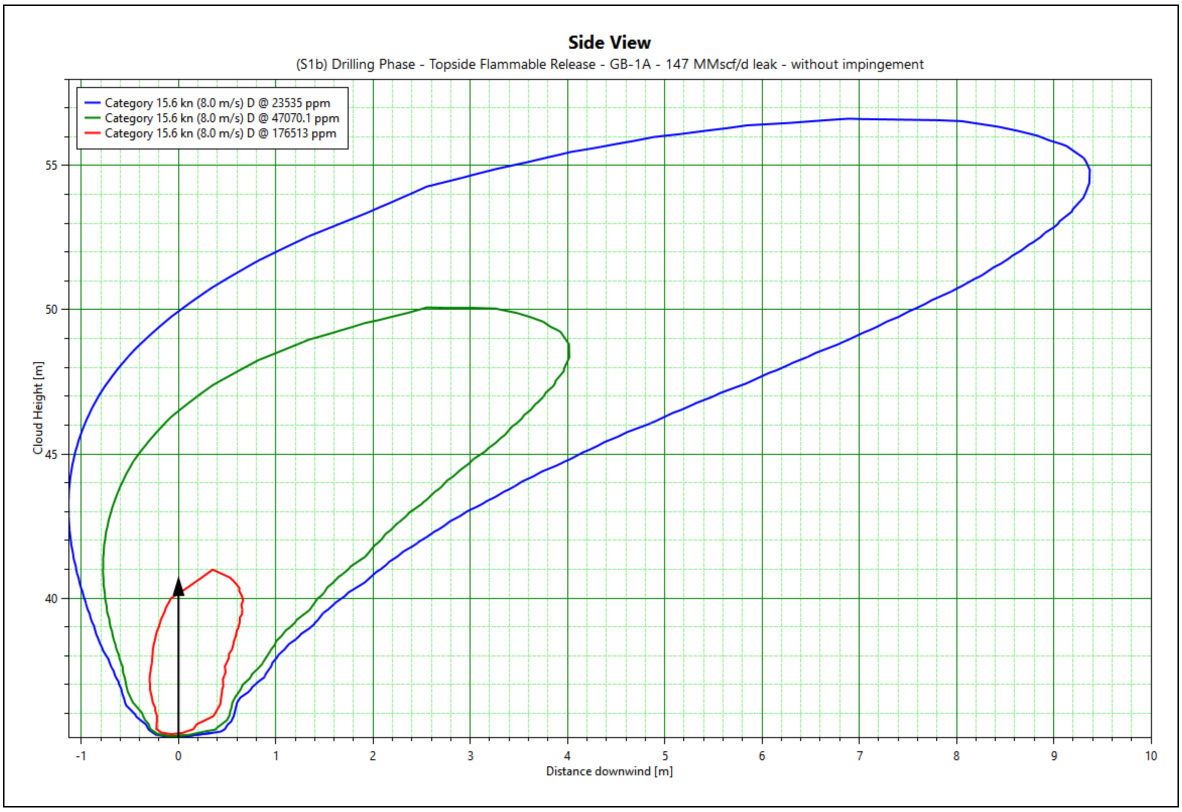


Figure 8.16. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) <u>without</u> impingement under the 15.6D weather conditions

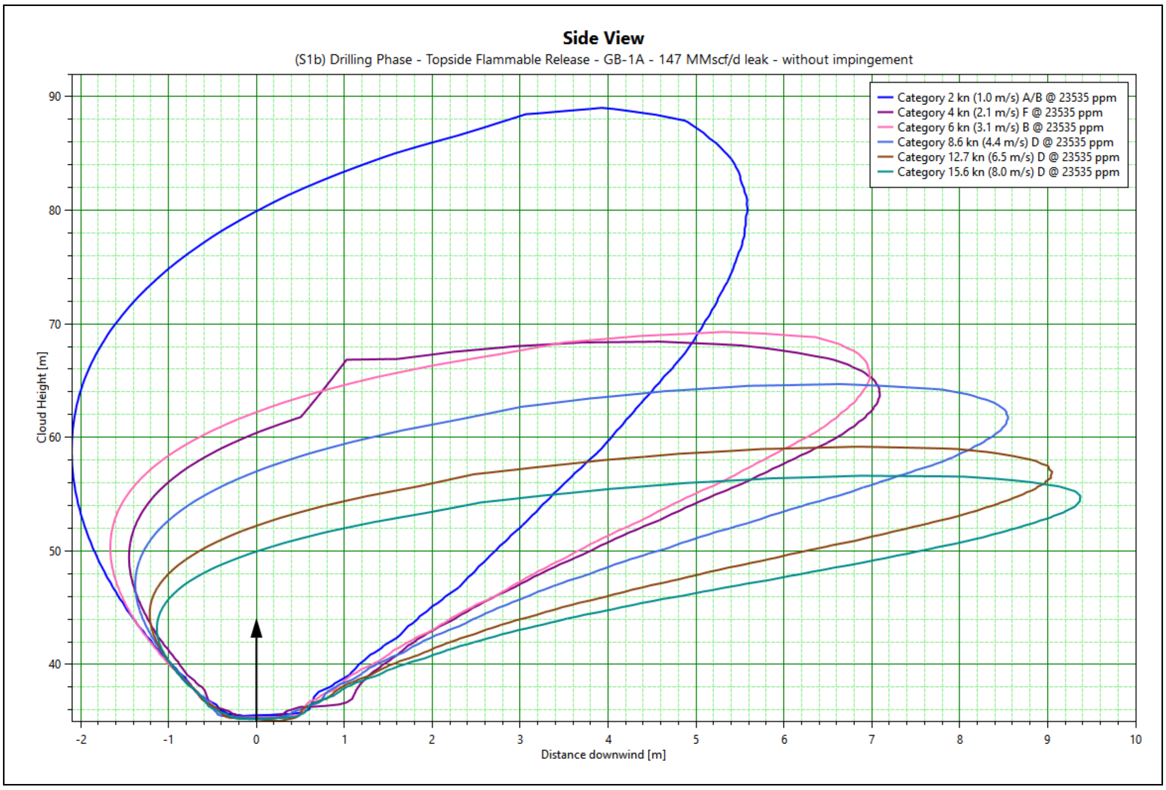


Figure 8.17. Predicted atmospheric dispersion for the 50% LFL (ZOC 4) without impingement for all weather conditions

8.16.2. Potential Environmental Risks

The environmental risk of a dry gas release is:

- Emission of methane (see Section 8.5).

The modelling indicates that at the modelled release location, there is no risk of dry gas at dangerous concentrations reaching people who may be gathered on the beach or residents in Golden Beach.

8.16.3. EMBA

Once the gas plume has been released at the surface, the prevailing weather conditions (e.g., wind speed and direction) determine how far and in what concentrations the plume moves, as presented in Table 8.60 and Table 8.61.

8.16.4. Evaluation of Environmental Risks

After release at the surface, the maximum extent of the LFL extends 74 m vertically and 10 m horizontally with impingement and 67 m vertically and 4 m horizontally without impingement. Gas at harmful concentration to human health is therefore not predicted to reach the shore or the closest occupied houses.

The risk to MODU personnel present while undertaking drilling will be addressed in the MODU Safety Case and Safety Case Revision.

The evaluation of environmental risks associated with atmospheric emissions (e.g., methane's contribution to GHG emissions) is similar to that described in Section 8.5.4.

8.16.5. Risks to MNES

The loss of well containment will not have a ‘significant’ impact to MNES, as outlined in Table 8.62.

Table 8.62. Risks to MNES from a loss of well containment

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore. Harmful gas concentrations are not predicted to reach the shore.
Listed threatened species (see Section 6.3)	No	The temporary and relatively narrow extent of gas at harmful concentrations in the atmosphere means that threatened and migratory marine species are unlikely to be exposed. Impacts to threatened and migratory marine species will not be significant given the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming or flying through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	There are no AMPs predicted to be contacted by the gas plume at the 50% LFL concentration.
- TECs (see Section 6.4.5)	No	There are no TECs predicted to be contacted by the gas plume at the 50% LFL concentration.
- KEFs (see Section 6.4.7)	No	There are no KEFs predicted to be contacted by the gas plume at the 50% LFL concentration.

8.16.6. Risk Assessment

Table 8.63 presents the risk assessment for the loss of well containment.

Table 8.63. Risk assessment for the loss of well containment

Summary	
Summary of risks	Fauna death in the atmosphere Release of atmospheric emissions and flammable gas to.
Extent of risk	<100 m vertically and <50 m horizontally from the release location.
Duration of risk	Temporary.

<table>
<tr><td>Level of certainty of risk</td><td colspan="2">HIGH – the impacts of gas releases to the atmosphere are well understood.</td></tr>
<tr><td colspan="3">Initial mitigation measures</td></tr>
<tr><td>Performance outcome</td><td>Performance standard (control)</td><td>Measurement criteria</td></tr>
<tr><td colspan="3">Note: these performance standards related to the drilling activities only. Design elements preventing the uncontrolled release of dry gas are not detailed here.</td></tr>
<tr><td>There is no LoWC.</td><td>An independent survey ensures the BOP is compliant with API Standard 53 (Blowout Prevention Equipment Systems for Drilling Wells) to verify it is functional and reliable.</td><td>Survey report is available and confirms that the BOP meets the standard.</td></tr>
<tr><td rowspan="6">The well is safely drilled in accordance with designs and documents prepared specifically for the project.
The well is physically isolated from the environment.</td><td>The following plans are implemented in order to minimise the possibility of a well blowout:
• WOMP (NOPSEMA-accepted).
• Safety Case and/or Safety Case revision (NOPSEMA-accepted).
• Drilling Program.
• Well control bridging document between the MODU contractor and GB Energy.
• Drilling fluid program.
• Cement program.
• Well Test Program.
• BOP testing procedure.</td><td>Daily operator, third-party contractor and pre-tower meetings (and daily reports from key third-party contractors) confirm that the requirements of each plan are widely communicated and safely implemented.</td></tr>
<tr><td>The BOP is installed with the riser and is not removed until drilling is complete in order to prevent a well blowout.</td><td>BOP records indicate BOP is installed with the riser.</td></tr>
<tr><td>The BOP is pressure tested prior to deployment, upon initial latch-up with the wellhead and every 21 days in accordance with API Standard 53. The BOP is function tested every 7 days.</td><td>BOP testing records confirm testing is performed to schedule.</td></tr>
<tr><td>The well casing is pressure tested after installation prior to drilling ahead.</td><td>DDR confirms that tests were performed and pressure test charts show tests are acceptable.</td></tr>
<tr><td>The driller continuously monitors mud flow parameters (pressure, pump rate, return liquid volumes, alarms, etc) to ensure that the primary well control barrier (the mud system) is operating as designed.</td><td>Mud logs verify that the drilling fluid program is being implemented.</td></tr>
<tr><td>Cement testing (for strength, etc) will take place in accordance with the Cement Program prior to downhole use to ensure it will cure properly and isolate the well from formations.</td><td>Cement Job Report confirms that tests were performed to schedule.</td></tr>
<tr><td>Minimise</td><td></td><td></td></tr>
</table>

The well will be drilled by qualified and experienced drillers.	The OIM, Driller, Assistant Driller and GB Energy Drilling Supervisor are trained and qualified to IWCF/IADC WellCap well control standards so that well control emergencies are efficiently and properly managed.	Training records and certificates confirm these personnel are qualified and trained in well control.
Two barriers are in place during drilling operations within the reservoir.	The Drilling Supervisor monitors and ensures that two barriers are maintained at all times after installation of the BOP.	DDRs verify that two barriers have been maintained in the well.
Restore		
Response		
The flow of hydrocarbons will be stopped in accordance with existing plans.	The Blowout Contingency Plan (BCP) will be implemented to contain the well flow.	DDRs and incident investigation reports verify that the plan is appropriately implemented.
	The relief well is drilled in accordance with the BCP.	Operation Log verifies relief well is drilled in accordance with the Relief Well Plan.
Reporting		
A well blowout will be promptly reported to external parties.	GB Energy will report the incident to NOPSEMA and DJPR (ERR) within 2 hours of the loss of well containment.	Incident reports and logs confirm that regulatory authorities were notified within 2 hours of the incident.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Unlikely	Very low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Regular well control drills are undertaken in order to keep the drilling crew familiar with response procedures.	The GBE Drilling Supervisor will run at least one (frequency determined by the Emergency Response Plan [ERP] well control exercise (e.g., BOP drill) during the drilling campaign in accordance with the Drilling Program.	Training records show that relevant crew receive regular well control training.
Key MODU contractor and GB Energy personnel are familiar with their roles in a well blowout response.	A desktop emergency response exercise is undertaken within 4 weeks prior to drilling commencing.	Desktop spill response exercise report is available, confirming readiness of personnel to appropriately respond.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Rare	Very low
Environmental Monitoring		

• BOP pressure and function testing. • Well casing testing.
Record Keeping
• BOP survey report. • Daily operator, third-party contractor and pre-tower meeting records. • Subsea engineering BOP records. • DDRs. • Mud logs. • Cement job reports. • Training records and certificates. • Desktop spill response exercise report. • Incident reports.

8.17. RISK: Oil Spill Response Activities

This section assesses the responses to the MDO spill response strategies that will be outlined in the OPEP. Table 8.64 summarises the strategies available to respond to MDO spills, and whether they are applicable for this activity. It is important to note that the risk assessment for oil spill response activities assesses the risks of the response activities themselves (and how they can be avoided, minimised or mitigated); it does not infer that the response activities reduce the risk of a spill occurring. The risk assessment reflects the fact that spill response activities, can (depending on the type of hydrocarbon and receptors contacted) sometimes have a greater environmental impact than the spill itself.

It is also important to note that while a gas release will not involve the release of liquid hydrocarbons, it is essential to implement any means necessary to stop the gas release, as unburned methane is a source of GHG and also presents a safety risk.

Other than undertaking source control (drilling a relief well), there are no response activities relevant to a surface or subsea dry gas release given the volume and flow duration outlined in Section 2.5.

Table 8.64. Suitability of response options for this activity

Response option	Description	Assessment	Suitable for this activity?
Source control	Limit the flow of MDO from the vessel.	Can be achieved through implementation of the vessel-specific SMPEP.	Yes
	Limit the flow of gas from the well.	Can be achieved through implementation of the BCP.	Yes
Surveillance and tracking	Direct observation – aerial or marine, vector calculations; OSTM, use of satellite-tracking buoys.	MDO spreads rapidly to thin layers. Maintains situational awareness. Aerial is more effective than vessel to inform spill response.	Yes
Natural degradation	This response occurs regardless of intervention.	For MDO spills, natural degradation is often the best response, in so far as it avoids the additional impacts	Yes

Response option	Description	Assessment	Suitable for this activity?
		associated with intervention activities.	
Dispersant application	Breaks down surface spill and draws MDO droplets into upper layers of water column. Increases biodegradation and weathering.	MDO, while having a small persistent fraction, spreads rapidly to thin layers. Dispersant application can result in punch-through where dispersant passes into the water column without breaking oil layer down.	No
In-situ burning (ISB)	Controlled ISB involves the controlled burning of MDO in order to rapidly reduce the volume of oil on the water's surface, thereby reducing its spread to sensitive receptors.	ISB is only suitable for use on hydrocarbons >1-2 mm thick, with calm waves and light winds. It also requires fire-resistant booming (which is not readily available in Australia). MDO rapidly spreads to less than 10 µm (0.01 mm), making this response unsuitable.	No
Containment and recovery	Use of booms and skimmers to contain MDO in the open ocean or in nearshore environments. Relies on calm conditions and thicknesses >10 µm to collect.	MDO spreads rapidly to less than 10 µm, usually in less time than is required to deploy this equipment.	No
Protection and deflection	Booms and skimmers are deployed to protect environmental sensitivities, such as estuary inlets. Environmental conditions such as strong currents and waves can limit the application of this response.	MDO has persistent components and has the potential to reach shorelines. Effective in protecting open estuaries that have environmental sensitivities (aquatic vegetation, recreational users).	Yes
Shoreline clean-up	Where shoreline impact is predicted, shoreline clean-up assessment technique (SCAT) assessment is initiated. If SCAT and Net Environmental Benefit Analysis (NEBA) assess clean-up to have a net environment benefit, clean-up can be initiated. Shoreline clean-up can take several forms, including manual removal, mechanical removal, washing and vacuum recovery.	MDO residues quickly infiltrate sand where it is susceptible to remobilisation by wave action (reworking) until it has naturally degraded. This quick infiltration of sediments makes it very difficult to recover without also recovering vast quantities of shoreline sediments. MDO does not discolour shoreline as much as other hydrocarbon types. Manual collection techniques are likely to have limited effectiveness.	Possible, but unlikely
Oiled wildlife response	Consists of capturing, cleaning and rehabilitating oiled wildlife. It may also	Given the small area of MDO at moderate and high thresholds (that may cause	Yes

Response option	Description	Assessment	Suitable for this activity?
	include hazing or pre-spill captive management.	impacts to wildlife), large-scale wildlife response is not predicted. There is the potential for individual birds to be affected along adjacent shorelines.	

In the absence of Victorian guidelines, each of the responses identified as being suitable for this activity is assessed in accordance with the NOPSEMA Oil Pollution Risk Management Guidance Note (GN1488, Rev 2, February 2018) to ensure the risks associated with the responses are reduced to ALARP and acceptable levels.

Source control and natural degradation are not assessed here, as the former does not introduce any risks additional to the spilled MDO or routine drilling, and the latter is a natural process that takes place regardless of human intervention.

The three levels of marine incidents are detailed in Table 8.65, using guidance from the State Maritime Emergencies (non-search and rescue) Plan (EMV, 2016) (herein referred to as Maritime Emergencies NSR Plan) and The National Plan (AMSA, 2014a). The scenario of a 155 m^3 MDO spill falls into a Level 3 category.

Table 8.65. Suitability of response options for MDO spills

Guidance	Level 1	Level 2	Level 3
	Local, first strike	State	National
Oil volume (guide only)	Less than 10 tonnes.	10-100 tonnes.	Greater than 100 tonnes.
Hazardous and noxious substance	Nature and/or size of substance is unlikely to cause evacuation of the area. Exclusion area limited to immediate site.	Nature and/or size of substance is likely to cause evacuation. Exclusion area beyond to immediate site.	Nature and/or size of substance requires evacuation. Exclusion area beyond to immediate site.
Wildlife	Fewer than 50 birds.	Fewer than five cetaceans. Fewer than 25 seals. 50-200 birds.	More than five cetaceans. More than 25 seals. More than 200 birds.
Incident Management Team (IMT) requirements	One to three people.	Functional groups required, working from an incident control centre (ICC).	
Clean-up	Use of vessel resources.	Resources beyond those of local response required.	State, national and possibly international resources required.
Environmental impacts	Localised, minimal.	Adverse consequences.	Significant consequences.
Spill duration	Up to 72 hours.	More than 72 hours, but not greater than 2-3 weeks.	Likely to exceed 2 weeks, recovery make take months to years.

8.17.1. Relief Well Drilling

Depending on the circumstances of the well blowout, the drilling of a relief well may be required to kill the well and stop the blowout.

As outlined in Section 3.2.13, a relief well would be drilled in accordance with the BCP developed by GB Energy. It is estimated that it would take in the order of 100 days to kill the well, including mobilising a MODU to the location.

Scope of the Activity

The scope of activities involved with drilling a relief well is the same as drilling a standard well. The drilling process and sequence for a relief well will not deviate dramatically from the description provided throughout Chapter 2, though it may more deviated due to the need to drill from outside the 500-m radius PSZ.

A relief well is typically drilled as a straight hole down to a planned kick-off point, where it is turned toward the target well using directional drilling technology and tools to get within 30-60 m of the original well. The aim is to align the two wellbores at an incident angle of 3-5° for the eventual intersect rather than aiming directly at the blowout wellbore. The drilling assembly is then pulled and a magnetic proximity ranging tool is run on wireline to determine relative distance and bearing from the target well. Directional drilling continues to about half the distance to the planned intersection, and another magnetic ranging run is made to update relative distance and bearing. Once the target well is penetrated, dynamic kill commences by pumping mud and/or cement downhole to seal the original well bore.

Availability

GB Energy will establish a contract with a specialist well control company that allows it to access personnel and equipment to respond to a well control response anywhere in the world. This includes relief well drilling operations.

While the specialist well control contractor mobilises a MODU and personnel to attend to the well blowout, the BCP will be revised by GB Energy (in consultation with the well control contractor) ahead of drilling to take account of the well particulars.

Ensuring a MODU is capable of performing the required work scope in a safe and efficient manner has a significant impact on the overall success of well management projects. GB Energy is committed to providing the necessary funds to ensure that a relief well drilling response is adequately implemented.

Hazards

The hazards associated with drilling a relief well are the same as drilling a standard well, as per those outlined throughout Sections 8.1 to 8.16 of this report.

Impacts and Risks of the Response Activity

The environmental impacts and risks associated with drilling a relief well are the same as drilling a standard well, as per those outlined throughout Sections 8.1 to 8.16 of this report.

Evaluation of Environmental Impacts and Risks

The evaluation of environmental impacts and risks associated with drilling a relief well are the same as drilling a standard well, as per those outlined throughout Sections 8.1 to 8.16 of this report.

Environmental Impact and Risk Assessment

Table 8.66 presents the impact and risk assessment for relief well drilling.

Table 8.66. Impact and risk assessment for relief well drilling

Summary		
Summary of impacts and risks	As per those described throughout Sections 8.1 to 8.16.	
Extent of impacts and risks	As per those described throughout Sections 8.1 to 8.16, but generally localised.	
Duration of impacts and risks	For the duration of the blowout – up to 100 days.	
Level of certainty of impacts and risks	HIGH. The impacts and risks associated with drilling are well understood.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		
Preparedness		
A relief well plan is in place.	GB Energy has in place a BCP that describes the scope of activities, MODU specifications and schedule and relief well schematic.	The BCP is available and current.
	Relevant stakeholders (such as nearby titleholders and government maritime agencies) will be consulted on the exact location of the relief well prior to drilling to ensure their current or planned operations are not compromised.	Consultation records verify that consultation about the relief well location was discussed with relevant stakeholders.
A MODU, well engineering and well control specialists are readily mobilised to location.	Contract is in place between GB Energy and a well control specialist to ensure mobilisation of well control specialist personnel upon request.	The contract between GB Energy and a well control specialist is available and current.
OPEP resources are readily available.	An OPEP readiness review exercise is undertaken within 4 weeks prior to drilling to verify that relief well resources are available for mobilisation.	OPEP readiness review exercise report verifies that resources are available.
Restore		
Response		

Well kill is undertaken in accordance with established procedures.	The relief well drilling is undertaken in accordance with the RWP.	Incident logs verify that the plan is implemented.
Planned and unplanned MODU activities		
The EPO and EPS for impacts and risks associated with MODU activities are addressed throughout Sections 8.1 to 8.16 of this report. The risks associated with drilling a relief well are no different to drilling a standard well because the MODU selected for the relief well will also be a jack-up MODU (due to the shallow water depths of the Project area) and the seabed conditions at the relief well condition are no different to those described.		
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor (ecosystem function)	Unlikely	Low
Additional mitigation measures		
No additional mitigation measures identified.		
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor (ecosystem function)	Unlikely	Low
Environmental Monitoring		
As per Sections 8.1 to 8.16.		
Record Keeping		
• BCP. • Contracts and agreements with third parties. • OPEP exercise drill report. • Incident logs.		

8.17.2. Surveillance and Tracking

Scope of the Activity

Ongoing surveillance and tracking of the MDO spill is critical for maintaining situational awareness and to complement and support the other response activities. In some situations, surveillance and tracking may be the primary response strategy if natural dispersion and weathering processes are effective in reducing the volume of MDO reaching sensitive receptors.

It is the responsibility of GB Energy's Oil Spill Response Team (OSRT) to undertake operational monitoring during the spill event to inform the operational response, with support from the Control Agency (DJPR-EMB). Operational monitoring includes the following:

- Aerial observation;
- Vessel-based observation;
- OSTM (either computer-based or manual vector analysis); and
- Utilisation of satellite-tracking buoys.

Availability

The GB Energy OSRT will be led and directed by an Incident Controller sourced from the Oil Spill Response Company of Australia Pty Ltd (ORCA). Response team arrangements will be described in the OPEP.

The DJPR-EMB maintains operational monitoring capability and implements operational monitoring for Level 2 or 3 vessel-based incidents, as outlined in the Maritime Emergencies NSR Plan (EMV, 2016). The DJPR-EMB can also call upon the national resources of AMSA. The resources available to GB Energy for surveillance and tracking are outlined in Table 8.67.

Hazards

The hazards associated with surveillance and tracking are:

- Additional vessel activity (over a greater area than the Project area);
- Physical presence of oil spill tracking buoy/s; and
- Sound generated by aircraft use.

Impacts and Risks of the Response Activity

The impacts and risks associated with surveillance and tracking are:

- Routine and non-routine impacts and risks associated with vessel operations (as outlined throughout Chapter 8); and
- Noise disturbance to marine fauna and shoreline species by aerial flights.

Table 8.67. Resources available for surveillance and tracking

Resource required	AMSA resources	DJPR resources	GBE resources
Aviation	AMSA has agreements in place to deploy fixed wing aerial dispersant capabilities, but not surveillance per se.	Access to Emergency Management Victoria's (EMV's) State Aircraft Unit. Air support can be mobilised within 4 hours of request. Additionally, NatPlan resources can be activated.	GB Energy will make use of locally sourced fixed or rotary wing services (e.g., from Sale) to be deployed.
Trained observers	Trained oil on water observers are available through the National Response Team (NRT). AMSA can also request the assistance of Australian Marine Oil Spill Centre's (AMOSC) Core Group personnel (>120 oil and gas industry personnel nation-wide) who are available 24/7 to respond to marine oil spills.	EMV's State Response Team (SRT) or AMSA Search and Rescue resources would be called upon. These resources are available within 4 hours of request. The SRT has 10 State Emergency Service (SES) volunteers and one DJPR staff member that are trained in oil on water observation.	Trained oil on water observers are available through ORCA.

Resource required	AMSA resources	DJPR resources	GBE resources
Vessel-based observations	Vessels of opportunity based in nearby ports, such as Lakes Entrance, Port Albert and Port Welshpool would be engaged as required. The Lakes Entrance Harbour Master would be the first point of contact to determine resources immediately available.		
Oil spill tracking buoys	Due to the proximity of the drill site to the shoreline (3.3 km), and the rapid evaporation or entrainment of MDO, the use of tracker buoys and satellite monitoring is unlikely to be effective and therefore not recommended. Tracker buoy location is generally only accurate to 500 m and it is likely that any deployed tracker buoy will respond to local swells or tidal movements and give a potentially misleading picture of hydrocarbon slick movement.		
OSTM	AMSA has a contract in place with RPS and is available 24/7. OSTM can generally be provided within 4 hours of request.	Available through AMSA upon request.	GB Energy can contract RPS direct if required.

Evaluation of Environmental Impacts and Risks

The impacts and risks associated with routine and non-routine MODU and support vessel operations are assessed in Sections 8.1 to 8.16 and are not repeated here. In addition to these impacts and risks are those associated with the presence of aerial resources. These are discussed below.

Helicopter operations produce strong underwater sounds for brief periods when the helicopter is directly overhead (Richardson *et al*., 1995). Sound generated from helicopter operations is typically below 500 Hz and sound pressure in the water directly below a helicopter is greatest at the surface but diminishes quickly with depth. Reports for a Bell 214ST (stated to be one of the noisiest) identify that noise is audible in the air for four minutes before the helicopter passed over underwater hydrophones. The helicopter was audible underwater for only 38 seconds at 3 m depth and 11 seconds at 8 m depth (Richardson *et al*., 1995).

Sound levels from helicopters are not expected to cause physical damage to marine fauna, however temporary behavioural changes (avoidance) in species (cetaceans, turtles, fish) may be observed.

The behavioural reaction of cetaceans to circling aircraft (fixed wing or helicopter) is sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS, 2001; Richardson *et al*., 1995). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animals. The effect on whales seems transient, and occasional over-flights probably have no long-term consequences (NMFS, 2001). Richardson et al (1995) identifies for Californian sea lions (an Octariid similar to fur seals) the following behaviours to flight sound:

- Jets above an altitude of 305 m produced no reaction and below that height caused limited movement but no major reaction;
- Light aircraft directly overhead at altitudes of <150-180 m elicited alert reactions; and

- Helicopters above 305 m usually caused no observable response while those below caused the pinnipeds to raise their heads, often causing some movement and occasionally caused rushes by some animals into the water.

Aerial surveillance flights will operate at between 300 – 500 m altitudes when undertaking observation activities (AMSA, 2003). In accordance with the EPBC Regulations (Part 8), a fixed-wing aircraft will maintain a buffer of 300 m from a cetacean and a helicopter will maintain 500 m from a cetacean. Any noise produced by surveillance aircraft is localised and temporary as they are in constant movement. On this basis impact to marine mammals is expected to be temporary, localised and recoverable.

Environmental Impact and Risk Assessment

Table 8.68 presents the impact and risk assessment for surveillance and tracking activities.

Table 8.68. Risk assessment for surveillance and tracking

Summary		
Summary of risks	Disturbance to marine and coastal fauna and habitats.	
Extent of risks	Localised (immediately around vessel or boom).	
Duration of risks	Short-term (days to weeks).	
Level of certainty of risks	HIGH. The impacts associated with boom deployment are well understood, however an operational NEBA undertaken at the time of a spill will confirm the suitability of activities with respect the particular receptors in the path of an oil slick.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise *Preparedness*		
GB Energy maintains capability to implement surveillance and tracking in a Level 2 or 3 spill event.	Access to operational response capabilities is maintained through ORCA and access to the Maritime Emergencies Non-search and Rescue (NSR) Plan.	Agreements and/or correspondence verify currency.
	GB Energy participates in regular desktop drills to test response capabilities.	Exercise drill reports are available verifying that response capabilities are maintained.
	GB Energy ensures that ORCA undertakes regular inspection and testing of its oil spill response equipment (for booming, this is related to booms, anchors and associated equipment).	Inspection reports verify that resources are maintained operationally ready to respond to a spill.
	Within 4 weeks prior to the MODU and support vessels mobilising to site, a desktop oil spill response exercise will be conducted to test interfaces between the SMPEPs, OPEP, NatPlan and VicPlan.	Exercise report records verify oil spill response exercise has been undertaken.

Restore		
Response		
Undertake surveillance and tracking operations appropriate to the nature and scale of the predicted or observed shoreline impacts.	Visual observations from the vessels are initiated immediately following a spill.	Incident report verifies that visual observations from vessels commenced immediately.
	An Incident Action Plan (IAP) is prepared by the IMT Planning Officer within the first 24 hours after the spill starts, which is used to guide response activities.	The IAP is available and daily reports verify it is implemented.
	Visual observations from aircraft are initiated within 12 hours of request (subject to daylight hours).	Incident report verifies that visual observations from the air commenced within 12 hours of the request.
Real-time OSTM is undertaken to identify the likely trajectory and fate of a spill based on the actual spill location.	Vectoring undertaken by an onsite spill assessor within 3 hours of spill report.	Incident records verify IMT Planning Unit commenced vector analysis within 3 hours of the spill.
	Real-time OSTM results are provided by RPS to GB Energy within 4 hours of notification of the spill.	Incident report verifies that OSTM was provided within 4 hours of spill notification.
Activity controls		
Surveillance activities maintain legislated buffer distances to prevent disturbance to fauna.	Surveillance aircraft will ensure buffer distances of 500 m (helicopters) and 300 m (fixed wing) are maintained around cetaceans in accordance with EPBC Regulations 2000 (Part 8).	Flight instructions document these constraints.

Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor (ecosystem function)	Rare	Very low
Additional mitigation measures		
No additional mitigation measures identified.		
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor (ecosystem function)	Rare	Very low

Environmental Monitoring

- As per the OPEP.

Record Keeping

- Agreement with ORCA,
- Exercise drill report.
- Inspection records.
- Flight instructions.
- IAP.
- Incident reports.
- Daily operations reports.

8.17.3. Protection and Deflection

Scope of the Activity

Protection and deflection involves deploying boom to protect coastal sensitivities from the impacts of oil. This response will be activated onshore and in nearshore waters where surveillance and tracking activities identify that coastal areas of high or moderate sensitivity are likely to be impacted by MDO. In brief:

- Deflection booming – is deployed to deflect/divert the oil to a suitable collection point on the shoreline or at sea (generally to a less sensitive area than the receptor being protected) for subsequent removal.
- Protection booming – is deployed to hold the oil back away from environmental or socio-economic sensitivities (e.g., river mouths, shorebird nesting sites, seal haul-out sites).

Various anchoring methods are required depending on the type of boom and its location. For example, when used on the shoreline itself, boom skirts are replaced with water-filled chambers designed to allow the boom to settle on an exposed shoreline at low tide. Table 8.69 briefly outlines the protection and deflection booming techniques available, their constraints and environmental effects. In general, these booming techniques are only suitable in calm, low-energy environments.

Table 8.69. Summary of oil spill shoreline deflection and protection techniques

Technique	Description	Limitations	Potential environmental effects
Nearshore			
Exclusion	Boom is deployed across or around sensitive areas and anchored in place. Approaching oil is deflected or contained by boom.	Cannot operate in: • Currents >1 knot (varies depending on the angle the boom can be deployed in). • Breaking waves >50 cm. • Water depth >20 m.	Minor disturbance to substrate at shoreline anchor points.
Redirection towards shoreline	Single or multiple booms are deployed from the shoreline at an angle towards the approaching slick and anchored or held in place with a work boat. Oil is diverted towards the shoreline for recovery.	Cannot operate in: • Currents >2 knots. • Breaking waves >50 cm.	Minor disturbance to substrate at shoreline anchor points and can cause heavy shoreline oiling at down-stream end of boom (collection point).
Redirection away from shoreline	Single or multiple booms are deployed from the shoreline at an angle away from the approaching slick and anchored or held in place with a work boat. Oil is deflected away from the shoreline where it may be contained for recovery.	Cannot operate in: • Currents >2 knots. • Breaking waves >50 cm.	Minor disturbance to substrate at shoreline anchor points, could affect unprotected downstream areas.

Technique	Description	Limitations	Potential environmental effects
Onshore			
Intertidal/ shoreline boom	Boom can be deployed across or along the shore, on the beach or in the water, to contain oil. Designed for use where the water level will change. Water-filled chambers provide a seal as the boom grounds and a skirt when afloat. Can prevent remobilisation of stranded oil.	Cannot operate in: • Currents >1 knot (varies depending on the angle the boom can be deployed in). • Breaking waves >50 cm.	Minor disturbance to substrate at anchor points. Can cause heavy oiling if oil concentrated by the booming strategy. Disturbance to beaches and dune system from vehicle and foot access and associated amenities.
Beach barriers, berms	A berm is constructed along the mean high-water level. The berm should be covered with plastic or geotextile sheeting to minimize wave erosion and oil penetration or burial.	Cannot operate in: • Breaking waves >30 cm. • Strong currents.	Disturbs upper 50 – 60 cm of foreshore zone. Disturbance to beaches and dune system from vehicle and foot access and associated amenities.
Sumps and trenches	Dug by machinery to contain and collect oil for recovery as it is washed ashore. Prevents or minimizes remobilization of stranded oil. Likely would have to be lined to prevent penetration or mixing of oil and sediment by wave action.	Cannot operate in: • Coarse sediments such as cobble and boulders. • Breaking waves >30 cm.	Disturbance of the substrate and, if not lined, greater oil penetration. Disturbance to beaches and dune system from vehicle and foot access and associated amenities.

Protection Priorities

There are no estuaries within the 155 m^3 MDO spill EMBA, so deflection and protection booming is not likely to be required.

Availability

GB Energy maintains operational monitoring capability and implements operational monitoring for Level 2 or 3 vessel-based incidents, as outlined in the State Maritime Emergencies NSR (EMV, 2016). The resources available for protection and deflection activities are outlined in Table 8.70.

Table 8.70. Summary of oil spill shoreline deflection and protection techniques

Resource required	AMSA resources	DJPR resources*	GBE resources*
ICC	Potential ICC locations available at: • Golden Beach – hall, 40+ people, furnished, amenities, communications. • Lakes Entrance – 15-20 people, furnished, amenities, communications. • Marlo CFA complex – 20+ people, furnished, amenities,		

Resource required	AMSA resources	DJPR resources*	GBE resources*
	communications. • Bairnsdale – Gippsland Ports boardroom, 10-15 people, furnished, amenities, communications.		
Trained oil spill response personnel	Would call on resources of the NRT.	Would call on SRT resources, consisting of personnel across a range of state agencies. There are 7 trained boom deployment personnel available from the Gippsland Port Authority.	Via ORCA. Seven boom deployment personnel.
Vessels	Trained oil spill responders are available through the NRT. AMSA can also request the assistance of AMOSC's Core Group personnel (>120 oil and gas industry personnel nation-wide) who are available 24/7 to respond to marine oil spills.	**Lakes Entrance** 1 x Slogger, Burrunan PM737 vessel with trailer. Multiple ramps and jetties with all-weather access. **Port of Hastings** 1 x Slogger vessel, MB555 with trailer. 1 x Slogger vessel, MB554 with trailer. 1 x barge, Trochus MB553. All-weather boat ramp for boats up to 7 m. Vessels of opportunity available at Barry Beach Marine Terminal, Lakes Entrance, Port Albert, Port Welshpool, Port Franklin and Mallacoota.	VoO.
Booming equipment	As above.	**Lakes Entrance** 195 m GP800 Duraboom (fence boom). 200 m curtain inflatable boom. 100 m land-sea boom. 100 m curtain, solid flotation boom. **Port of Hastings** 400 m curtain, solid flotation boom. 200 m curtain inflatable boom. 100 m land-sea boom. 200 m self-inflating zoom boom. 5 x 15 kg boom anchors. Various snare booms (absorbents).	Via ORCA (see Section 4.9.3 of OPEP). Boom and skimmers.

Resource required	AMSA resources	DJPR resources*	GBE resources*
Recovery and containment	As above.	**Lakes Entrance** 1 x multi-head skimmer, LAM 12. 2 x 5 tonne capacity portable oil storage. **Port Welshpool** 1 x multi-head skimmer (Aqua guard), 5 tonnes, containerised. 1 x 5 tonne capacity portable oil storage. **Port of Hastings** 1 x weir skimmer (Foilex), 30 t. 1 x multi-head skimmer, LAM 12. 2 x Flexidams (10 t capacity).	Via ORCA (see Section 4.9.3 of OPEP). Boom and skimmers.
Decontamination kit	As above.	**Lakes Entrance** Aluminium container with trailer. Shoreline clean-up kit, with double-axle trailer. **Port Welshpool** Shoreline clean-up kit, with double-axle trailer.	Via ORCA.

* Equipment listed in this table is for the closest depots. Additional resources are available from SMEP resources in Melbourne and at Esso's Long Island Point facility and Barry Beach Marine Terminal.

Hazards

The hazards associated with protection and deflection booming are:

- Additional vessel activity;
- Boom deployment and management; and
- Waste collection.

Impacts and Risks of the Response Activity

The impacts and risks associated with protection and deflection booming are:

- Routine and non-routine impacts and risks associated with vessel operations (as outlined throughout this chapter);
- Damage to nearshore habitats from inshore shallow draught vessel activities and boom anchoring;
- Damage to shoreline environments from vehicle, machinery and/or foot access and associated land use (e.g., waste storage);
- Deeper mixing of hydrocarbons within beach sediments; and
- Secondary contamination of the shoreline (e.g., from personnel movement).

Evaluation of Environmental Impacts and Risks

The known and potential impacts associated with routine and non-routine vessel operations are assessed throughout Sections 8.1 to 8.16 and are not repeated here.

The nature of disturbance to the shoreline from vehicle and foot access (and associated land use activities such as equipment laydown areas, ablution facilities for responders, etc) is dependent on the location and scale of activities in any given area.

A booming layout strategy for the estuaries in the EMBA has not been prepared, as the OSTM indicates it is not required. GB Energy will prepare an operational NEBA at the time of a spill if any estuaries in the path of an MDO spill are open, tailored to the conditions at the time.

The following impacts may eventuate in the event of deploying protection and deflection booming:

- Damage to nearshore habitats (such as seagrass meadows) from inshore shallow draught vessel activities and boom anchoring may temporarily alter the dynamics of local ecosystems. Sandy habitats are generally able to quickly self-repair due to tidal movements that replenish sand.
- Damage to shoreline environments from vehicle and foot access and associated land use may disturb Aboriginal cultural heritage areas (such as shell middens), and temporarily disturb shoreline bird feeding, nesting, roosting or breeding activities, which may in turn impact on local population dynamics. Coastal vegetation disturbed as a result of gaining access to response sites is likely to regenerate once disturbance has ceased (or can be actively revegetated if natural regeneration is not successful). Shoreline access may also result in soil compaction and erosion, which may result in poor vegetation growth or vegetation death.
- As a result of digging trenches along the beach to trap oil, together with vehicle and foot access along the shore, oil may mix deeper into the beach sediments than it would normally. This has the potential to increase the duration of exposure to toxic components of the oil by delaying the natural weathering process, though constant wave action along the exposed coastline encourages rapid weathering.
- Secondary contamination of the shoreline may occur through vehicle, equipment and foot access spreading oil along and immediately behind the shoreline in areas not originally oiled. This exposes more habitat, flora and fauna to oiling than originally impacted by the spill itself, with the associated impacts of smothering (toxicity is unlikely with weathered MDO), together with potentially creating larger recreational activity exclusion zones.

Environmental Risk Assessment

Table 8.71 presents the risk assessment for protection and deflection booming activities.

Table 8.71. Risk assessment for protection and deflection booming

Summary	
Summary of risks	Disturbance to marine and coastal fauna and habitats, and to coastal Aboriginal cultural heritage.
Extent of risks	On-water: Localised – immediately around vessel or boom. Shoreline: Secondary oiling may spread for some distance from the response location/s, but is not possible to quantify.

Duration of risks	Short-term – days to weeks.	
Level of certainty of risks	HIGH – the impacts associated with boom deployment are well understood, however an operational NEBA undertaken at the time of a spill will confirm the suitability of activities with respect the particular receptors in the path of an oil slick.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise *Preparedness*		
GB Energy maintains capability to implement protection and deflection booming in a Level 2 or 3 spill event.	As per 'surveillance and tracking'.	As per 'surveillance and tracking'.
Restore *Response*		
Undertake protection and deflection booming operations appropriate to the nature and scale of the predicted or observed shoreline impacts.	Within 6 hrs of spill event notification, SCAT have mobilised to areas of predicted impact (daylight permitting) in consultation with East Gippsland Shire Council. SCAT information and the status of estuaries is provided to IMT for inclusion in operational NEBA.	Incident log verifies SCAT resources have mobilised in suitable timeframes.
	An operational NEBA is prepared by the IMT to determine the net benefits of the booming strategy for the estuarine areas predicted to be contacted by MDO within 4 hours of receiving OSTM.	The operational NEBA is available and was undertaken prior to the deployment of equipment.
	Personnel and equipment resources are deployed to site to undertake the protection and deflection activities within timeframes outlined in the IAP.	Incident report verifies that personnel and equipment were mobilised within timeframes outlined in the IAP.
	Booming operations continue until such time as no further sheen is visible on the sea surface, at the direction of the IMT Leader.	Incident logs verify the continued use of booming until there is no further visible sheen.
Activity controls		
Response crews are made aware of coastal sensitivities prior to commencing work.	Environmental briefings are conducted prior to work commencing in order to identify risks and suitable controls.	Briefing records are available.
Impacts to fauna, native vegetation and habitats are prevented.	Access to estuarine areas is via established tracks. Access outside of existing tracks and pathways is determined in consultation with local DELWP representatives.	Incident records verify consultation has occurred and controls implemented.

	Vessels do not anchor in and booms are not anchored to areas of OSRA-mapped or visible kelp forest, reef, sponge gardens or seagrass meadows.	Incident records verify anchoring takes place in non-sensitive environments.
	Adequate monitoring personnel are in place at booming locations to maintain and attend to the operability of booms, including the release of fauna caught in booms (where safe to do so).	Incident logs verify that monitoring personnel are in place to maintain booms.
	Vessel Masters maintain the following buffer distances around cetaceans (in accordance with the Australian Guidelines for Whale and Dolphin Watching for sea-faring activities): • 'Caution zone' (300 m either side of whales and 150 m either side of dolphins) – vessels must operate at no wake speed in this zone. • 'No approach zone' (100 m either side of whales and 50 m either side of dolphins) – vessels should not enter this zone and should not wait in front of the direction	Incident logs verify no approaches to cetaceans.

Risk assessment (initial)			
Receptor	Consequence	Likelihood	Risk rating
Nearshore habitat (ecosystem function)	Minor	Unlikely	Low
Shoreline habitat (ecosystem function)	Minor	Unlikely	Low
Fauna disturbance (ecosystem function)	Minor	Unlikely	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
No spills of recovered oil or oily water to the environment.	Waste storage tanks and hoses are located within a contained, impervious area. Spill kits are available at oil recovery area and it is under supervision and secured from public access.	Incident records verify waste storage facility has been appropriately set-up and supervised.
	Collected waste is disposed in accordance with Victorian EPA waste disposal requirements.	EPA Waste Transport Certificates verify use of appropriate disposal locations.

Risk assessment (residual)			
Receptor	Consequence	Likelihood	Risk rating
Nearshore habitat (ecosystem function)	Minor	Rare	Very low

Shoreline habitat (ecosystem function)	Minor	Rare	Very low
Fauna disturbance (ecosystem function)	Minor	Rare	Very low
Environmental Monitoring			
As per the OPEP.			
Record Keeping			
• Contracts and agreements with third parties. • Exercise drill report. • Inspection records. • Incident reports. • Operational NEBA. • Briefing records. • Photos. • Daily operations reports. • EPA Waste Transport Certificates.			

8.17.4. Shoreline Assessment and Clean-up

Scope of the Activity

SCAT

A clean-up response will be preceded by a SCAT survey. NOAA (2010) describes this process as the systematic approach to collecting data on shoreline oiling conditions using the following steps:

- Conduct reconnaissance survey;
- Segment the shore;
- Assign teams and conduct shoreline surveys;
- Develop clean-up guidelines and endpoints;
- Submit reports and sketches to Planning Section (of the IMT);
- Monitor effectiveness of clean-up;
- Conduct post-clean-up inspections; and
- Do final evaluation of clean-up activities.

A trained SCAT team will be deployed by the Planning Section of the IMT at the time of shoreline stranding (informed by surveillance and tracking) to provide feedback on best methods for clean-up.

Shoreline clean-up

Shoreline clean-up consists of different manual and mechanical recovery techniques to remove oil and contaminated debris from the shoreline to reduce ongoing environmental contamination and impact. It may include the following techniques:

- Natural recovery – allowing the shoreline to self-clean (no intervention undertaken);
- Manual collection of oil and debris – the use of people power to collect oil from the shoreline;

- Mechanical collection – use of machinery to collect and remove stranded oil and contaminated material;
- Sorbents – use of sorbent padding to absorb oil;
- Vacuum recovery, flushing, washing – the use of high volumes of low-pressure water, pumping and/or vacuuming to remove floating oil accumulated at the shoreline;
- Sediment reworking – move sediment to the surf to allow oil to be removed from the sediment and move sand by heavy machinery;
- Vegetation cutting – removing oiled vegetation; and
- Cleaning agents – application of chemicals such as dispersants to remove oil.
- As predicted by the OSTM, there is a 48% probability that any shoreline will be contacted at the low threshold (10 g/m^2) in the event of a 155 m^3 release of MDO.

All these shorelines are sandy beaches. Manual and mechanical collection are the most suitable clean-up options.

Protection Priorities

The key environmental receptor along the stretch of coastline potentially impacted by oil is hooded plovers (and their nests).

Availability

Through its agreement with ORCA, GB Energy maintains shoreline clean-up capabilities for Level 2 or 3 vessel-based incidents. The resources available for SCAT and shoreline clean-up are outlined in Table 8.72.

Table 8.72. Resources available for SCAT and shoreline clean-up

Resource required	Resources	Provider
SCAT Team Leaders	1 x trained shoreline team leader (one team)	ORCA
Shoreline clean-up personnel	6 people (one team)	ORCA
Waste management services	See Section 5.6 of the OPEP	Cleanaway/SETIA
Beach clean-up kit	Seaford	DJPR EMB
Beach clean-up trailer	Seaford	DJPR EMB
Decontamination kit	Seaford	DJPR EMB

Hazards

The hazards associated with SCAT and shoreline clean-up are:

- Additional personnel activity on beaches;
- Mechanical access to and activity on beaches;
- Loss of shoreline sediment; and
- Waste collection and transport.

Risks of the Response Activity

The impacts and risks associated with SCAT and shoreline clean-up are:

- Damage to foreshore and backshore environments from vehicle, machinery and/or foot access and associated land use (e.g., waste storage);
- Disturbance to Aboriginal cultural heritage (e.g., shell middens);
- Temporary exclusion of the public from amenity beaches;
- Increased demand for what may be limited resources in small coastal towns (such as accommodation, fuel, hire vehicles in towns such as Golden Beach and Loch Sport);
- Deeper mixing of hydrocarbons within beach sediments; and
- Secondary contamination of foreshore and backshore areas from personnel and equipment movement.

Evaluation of Environmental Risks

Damage to foreshore and backshore environments

Damage to habitat is likely to be caused by high-pressure washing, whereby site-attached fauna such as limpets, mussels and lichen (on rocky substrates) will become detached from their habitat and may die. High-pressure washing may also damage the substrate itself. In both circumstances, the substrate is likely to be recolonised in a matter of weeks or months depending on site-specific conditions.

The mechanical collection of oil from sandy beaches will also result in significant volumes of clean sand lost from beaches, resulting in a temporary loss of shoreline habitat and associated macrofauna and meiofauna. The reduced profile of sandy beaches may also make them more vulnerable to damage (such as additional sand loss, erosion of dunes and loss of dune vegetation) created by spring tides and storm surges. However, this risk will be temporary as tides eventually replenish the lost sand over the following weeks and months.

The noise, light and general disturbance created by shoreline clean-up activities are likely to disturb the feeding, breeding, nesting or resting activities of resident and migratory fauna species that may be present. This is particularly the case for beach-nesting shorebirds such as hooded plovers, which are known to occur along the Gippsland coast. As an example, the eggs of hooded plovers (that nest only on sandy beaches) have small eggs that are very well camouflaged, so they are easily trodden on by accident. If the incubating adult is scared off the nest by passers-by, the eggs may literally bake in the sun, or become too cold in the cool weather. Either way, it kills the chick developing in the egg, and the egg will not hatch. Similarly, when people disturb a chick, it quickly runs into the sand dunes and hides. While it is running, the chick uses up valuable energy, and while it is hiding it is unable to feed (they usually forage at the water's edge), so that a chick that is forced to run and hide throughout the day could easily starve (Birdlife Australia, 2016). Any erosion caused by responder access to sandy beaches, or the removal of sand, may also bury nests. In isolated instances, this is unlikely to have impacts at the population level.

Secondary contamination of the shoreline

Untreated, secondary contamination of the environment (e.g., oil released into sand dunes, oil spilled along roadsides during transport) may cause chronic toxicity impacts to any flora and fauna directly contacted. Habitat degradation or loss may occur as a result of soil pollution (that may result in temporary or permanent soil sterilisation, thereby inhibiting or reducing plant growth). The degree to which these impacts occur is a function of the volume of oil spilled and how long it remains in the environment before being cleaned (if at all).

Disturbance to Aboriginal cultural heritage

The movement of people, vehicles and equipment through sand dunes may disturb cultural heritage artefacts that occur at the surface or are buried. The most likely cultural heritage artefacts to be present are Aboriginal shell middens, especially where freshwater and brackish water sources occur nearby, such as the Gippsland Lakes.

Infiltration of oil into beach sediments

The vertical infiltration of oil into shoreline sediments caused by heavy machinery and equipment can expose fauna to oil that would not otherwise have been exposed. This exposes the base of the food web to contamination that may bioaccumulate up through the food chain. It also results in the need for the increased removal of contaminated substrate, exacerbating risks such as beach erosion.

Temporary exclusion of the public from amenity beaches

The very presence of stranded MDO and clean-up operations may necessitate temporary beach closures (likely to be days to weeks, depending on the degree of oiling and nature of the shoreline). This means recreational activities (such as swimming, walking, fishing) in affected areas will be excluded until access is again granted by local authorities. Given the prevalence of sandy beaches along the coastline and the sparse nature and small population of coastal towns, the predicted rapid weathering of MDO, and the generally short-lived nature of clean-up activities, this is unlikely to represent a significant drawback to residents or tourists.

Increased demand for limited resources

The influx of shoreline clean-up personnel to a given region will place increased demand on the resources of small coastal towns such as Golden Beach, Paradise Beach and Seaspray, such as accommodation, meals, vehicle hire, fuel, groceries and other day-to-day consumables. While this will provide increased cash flow to local economies, sudden influxes of workers to small Australian towns is often fraught with social unrest as the demand for goods and services can negatively impact on the provision of limited goods and services to residents and tourists. As with most of the risks associated with clean-up operations, this is likely to be temporary and localised.

Environmental Risk Assessment

Table 8.73 presents the risk assessment for SCAT and shoreline clean-up activities.

Table 8.73. Risk assessment for SCAT and shoreline clean-up

Summary	
Summary of risks	Disturbance to coastal fauna and habitats, Aboriginal cultural heritage, temporary exclusion of the public from amenity beaches, secondary contamination.
Extent of risk	Localised (shoreline clean-up limited to areas where shoreline hydrocarbon loadings may have ecological effects).
Duration of risk	Short-term (days to weeks).
Level of certainty of risks	MEDIUM. The impacts associated with SCAT and shoreline clean-up are well understood, however an operational NEBA undertaken at the time of a spill will confirm the suitability of activities with respect the particular receptors at risk of stranded MDO.
Initial mitigation measures	

Performance outcome	Performance standard (control)	Measurement criteria
Minimise *Preparedness*		
GB Energy maintains capability to implement SCAT and shoreline clean-up in a Level 2 or 3 spill event.	As per 'surveillance and tracking.'	As per 'surveillance and tracking.'
Restore *Response*		
As requested by the IMT Leader, SCAT and shoreline clean-up resources appropriate to the nature and scale of predicted or observed shoreline impacts are deployed in a timely fashion.	SCAT teams mobilised to site within 6-24 hours of the notification of the spill (daylight hours permitting).	Incident management records verify that SCAT teams are deployed to site within the designated timeframe.
	SCAT information is provided to the IMT Leader for inclusion into the NEBA. An operational NEBA is undertaken to determine net benefits.	Operational NEBA is available, approved and was undertaken prior to shoreline clean-up.
	If an operational NEBA identifies that shoreline clean-up is required, the IAP includes this information to guide the response, with personnel and equipment deployed to relevant locations.	IAP is available and daily reports verify its implementation.
	Shoreline clean-up resources are deployed to site within timeframes identified in the IAP.	Incident records verify that IAP timelines were met.
Activity controls		
Response crews are made aware of coastal sensitivities prior to commencing work.	Environmental briefings are conducted prior to clean-up commencing in order to identify risks and suitable controls.	Briefing records are available.
Impacts to fauna, native vegetation and habitats are prevented.	Access to shoreline is via established tracks (with track edges fenced with bunting if required). Access outside of existing tracks and pathways is determined in consultation with local DELWP representatives.	Incident records verify consultation has occurred and controls implemented.
	Mobile equipment to be driven as close to the water's edge as possible to prevent impacts to shoreline birds. Clean-up will keep to the inter-tidal zone as far as possible.	Photos verify activity is restricted to the intertidal area as far as practicable.
Aboriginal cultural heritage is protected.	In consultation with local DELWP representatives, known occurrences of Aboriginal cultural heritage are flagged for avoidance.	Photos verify that Aboriginal cultural heritage sites were flagged for avoidance.

<table>
<tr><th colspan="4">Risk assessment (initial)</th></tr>
<tr><td>Receptor</td><td>Consequence</td><td>Likelihood</td><td>Risk rating</td></tr>
<tr><td>Shoreline habitat (ecosystem function)</td><td>Minor</td><td>Likely</td><td>Medium</td></tr>
<tr><th colspan="4">Additional mitigation measures</th></tr>
<tr><td>Performance outcome</td><td colspan="2">Performance standard (control)</td><td>Measurement criteria</td></tr>
<tr><td rowspan="3">Oil contamination spread through shoreline clean-up activities is prevented.</td><td colspan="2">Waste storage is located within a contained, impervious area.
Area is under supervision and secured from the public.</td><td>Photos verify waste storage facility has been appropriately set-up, secured and supervised.</td></tr>
<tr><td colspan="2">Oiled waste is transported in accordance with EPA waste disposal requirements.</td><td>EPA Waste Transport Certificates.</td></tr>
<tr><td colspan="2">All access points (personnel and equipment) will be controlled via designated access points through decontamination facilities.</td><td>Photos verify that access points were clearly delineated.</td></tr>
<tr><th colspan="4">Risk assessment (residual)</th></tr>
<tr><td>Receptor</td><td>Consequence</td><td>Likelihood</td><td>Risk rating</td></tr>
<tr><td>Shoreline habitat (ecosystem function)</td><td>Minor</td><td>Possible</td><td>Low</td></tr>
<tr><th colspan="4">Environmental Monitoring</th></tr>
<tr><td colspan="4">• As per the OPEP.</td></tr>
<tr><th colspan="4">Record Keeping</th></tr>
<tr><td colspan="4">• Agreement with ORCA.
• IAP.
• Operational NEBA.
• Briefing records.
• Photos.
• Daily operations reports.
• Incident reports.
• EPA Waste Transport Certificates.</td></tr>
</table>

8.17.5. Oiled Wildlife Response

Scope of the Activity

Oiled wildlife response (OWR) may form a key component of the response to an MDO release, both at sea (especially nearshore) and along the shore because of the known presence of seabirds (e.g., albatross and petrels) and nesting shorebirds (e.g., fairy terns, hooded plovers and little penguins).

Broadly, oiled wildlife response involves the following three-tiered approach:

1. Primary response – involves undertaking surveillance to determine the location and extent of wildlife injuries or death and deflecting oil away from areas of high sensitivity where practicable.

1. Secondary response – involves deterring or displacement strategies, by hazing (scaring animals through auditory bird scarers, visual flags or balloons, barricade fences, or pre-emptive capture).
2. Tertiary response – involves capture and stabilisation of oiled wildlife (on vessels or the beach), transport to treatment facilities, treatment of affected animals and rehabilitation and release of affected animals.

Oiled wildlife response equipment owned and maintained by DELWP, AMSA and AMOSC is available at various locations along the Victorian coastline and can be deployed to affected areas on an as-required basis (as units transportable by road or air). These will be called on through the SMEP, NatPlan (and AMOSPlan, if required), with DELWP taking the lead in any activities involving OWR with support from other agencies as requested.

Protection Priorities

The area of coastline predicted to have the highest areas of MDO loading (>1,000 g/m^2), where ecological impacts will occur, is entirely sandy beach. Several access points for machinery are available along this section of coastline using access tracks through the dunes at Seaspray, Golden Beach and Paradise Beach.
The key environmental receptor along this stretch of coastline is hooded plovers (and their nests).

Availability

DELWP is the responsible agency for responding to wildlife affected by a marine pollution incident in the Victorian jurisdiction. DELWP manages the rescue and rehabilitation with assistance from Parks Victoria (a DELWP agency) and Phillip Island Nature Park. DELWP's wildlife response is undertaken in accordance with the Wildlife Response Plan (a sub-plan of the Maritime Emergencies NSR Plan (EMV, 2016)) by trained DELWP officers. The resources available for OWR are outlined in Table 8.74. DEWLP resources include OWR kits stored at Lakes Entrance and Port Welshpool (with additional resources at Long Island Point, Melbourne, Geelong, Warrnambool and Portland). If the NatPlan is activated, additional AMSA and AMOSC resources can be sourced from Geelong.

Table 8.74. Resources available for OWR

Resource	Availability	Provider
Specialist OWR capability	Wildlife Response Commander.	DELWP
Oiled wildlife recovery team supervisor	One per team.	DELWP
OWR personnel	Trained group of first response personnel.	DELWP
OWR kit	Bairnsdale, Port Phillip, Colac, and Warrnambool with one kit each, and one State-wide trailer.	DELWP (approx. 50 units per day)
	Geelong (2 kits).	AMOSC (approx. 100 units per day)

Hazards

The hazards associated with OWR are:

- Hazing of target fauna may deter non-target species from their normal activities (resting, feeding, breeding, etc.);
- Distress, injury or death of target fauna from inappropriate handling and treatment;
- Euthanasia of target individual animals that cannot be treated or have no chance of rehabilitation; and
- Damage to shoreline environmental sensitivities from the establishment of OWR response centres.

Impacts and Risks of the Response Activity

The impacts and risks associated with OWR are:

- Disturbance, injury or death of fauna.

Evaluation of Environmental Impacts and Risks

It is preferable to have oil-affected animals that have no prospect of surviving or being successfully rehabilitated and released to the environment humanely euthanised than to allow prolonged suffering. The removal of these individuals from the environment has additional benefits in so far as they are not consumed by predators/scavengers, avoiding secondary contamination of the food web.

Hazing and exclusion of wildlife from known congregation, resting, feeding, breeding or nesting areas may have a short- or long-term impacts on the survival of that group if cannot access preferred resources. These effects may be experienced by target and non-target species. For example, shoreline booming or ditches dug to contain oil may prevent penguins from reaching their burrows after they've exited the water and low helicopter passes flown regularly over an beach to deter coastal birds from feeding in an oil-affected area may also deter penguins from leaving their burrows to feed at sea, which may impact on their health.

Onshore, the establishment of OWR centres will preferentially avoid locating infrastructure on or in close proximity to native habitat, thereby avoiding impacts associated with vegetation clearing (such as loss of habitat, reduction in local native species diversity and abundance). Facilities such as portable toilets and decontamination showers may be established to deal with day-to- day requirements of first responders so wastes are not discharged to the environment. Similarly, facilities will be supplied for the collection and/or treatment of oily water and detergents associated with the treatment of oiled wildlife, so these wastes are not inappropriately discharged to the environment. A licensed waste management contractor will coordinate the supply of waste facilities and regular removal of wastes (including animal carcasses) to licensed facilities for disposal and/or treatment.

Untrained resources capturing and handling native fauna may cause distress, injury and death of the fauna. To prevent these impacts, only DELWP-trained oiled wildlife responders will approach and handle fauna. This will eliminate any handling impacts to fauna from untrained personnel and reduce the potential for distress, injury or death of a species.

Environmental Risk Assessment

Table 8.75 presents the risk assessment for OWR.

Table 8.75. Impact and risk assessment for OWR

<table>
<tr><th colspan="3">Summary</th></tr>
<tr><td>Summary of risks</td><td colspan="2">Distress, injury or death of fauna through inappropriate handling and treatment.
Hazing of target fauna may result in disruption to feeding, resting, breeding activities of non-target species.</td></tr>
<tr><td>Extent of risk</td><td colspan="2">Localised – OWR limited to areas where shoreline hydrocarbon loadings may have ecological effects.</td></tr>
<tr><td>Duration of risk</td><td colspan="2">Short-term – days to weeks.</td></tr>
<tr><td>Level of certainty of risks</td><td colspan="2">HIGH – the impacts associated with OWR are well understood, with trained DELWP personnel in place to manage this activity.</td></tr>
<tr><th colspan="3">Initial mitigation measures</th></tr>
<tr><td>Performance outcome</td><td>Performance standard (control)</td><td>Measurement criteria</td></tr>
<tr><td colspan="3">Minimise
Preparedness</td></tr>
<tr><td>GB Energy maintains capability to undertake OWR in a Level 2 or 3 MDO spill event.</td><td>As per ‘surveillance and tracking’.</td><td>As per ‘surveillance and tracking’.</td></tr>
<tr><td colspan="3">Restore
Response</td></tr>
<tr><td rowspan="4">DELWP implements OWR resources appropriate to the nature and scale of predicted or observed shoreline impacts.</td><td>DELWP personnel are mobilised to site within 12 hours of the notification from the SCAT team that fauna are at risk.</td><td>Incident records verify that OWR personnel are deployed to site within the designated timeframe.</td></tr>
<tr><td>OWR kits are mobilised to site within 12 hours of the notification from the SCAT team that fauna are at risk.</td><td>Incident records verify that OWR kits are deployed to site within the designated timeframe.</td></tr>
<tr><td>An operational NEBA is undertaken to determine net benefits of undertaking OWR.</td><td>Operational NEBA is available, approved and was undertaken prior to OWR commencing.</td></tr>
<tr><td>If an operational NEBA identifies that OWR is required, the IAP includes measures to guide the response, with personnel and equipment deployed to relevant locations.</td><td>The IAP is available and daily reports verify it is implemented.</td></tr>
<tr><td colspan="3">Activity controls</td></tr>
<tr><td>Impacts to native vegetation, habitats and non-target wildlife are prevented.</td><td>Access to shoreline is via established tracks (with track edges fenced with bunting if required). Access outside of existing tracks and pathways is determined in consultation with local DELWP representatives.</td><td>Incident records verify consultation has occurred and controls implemented.</td></tr>
</table>

	Mobile equipment to be driven as close to the water's edge as possible to prevent impacts to shoreline birds.	Photos verify activity is restricted to the intertidal area as far as practicable.
Impacts to affected fauna are minimised.	Wildlife is only handled and treated by DELWP-trained or Phillip Island Nature Park wildlife clinic oiled wildlife responders.	Incident records and photos verify that wildlife is handled and treated only by trained oiled wildlife responders.

Risk assessment (initial)			
Receptor	Consequence	Likelihood	Risk rating
Fauna injury (impact on threatened and migratory species)	Negligible	Possible	Low
Fauna death (impact on threatened and migratory species)	Negligible	Possible	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Response crews are made aware of coastal sensitivities prior to commencing work.	Environmental briefings are conducted prior to clean-up commencing in order to identify risks and suitable controls.	Briefing records are available.

Risk assessment (residual)			
Receptor	Consequence	Likelihood	Risk rating
Fauna injury (impact on threatened and migratory species)	Negligible	Unlikely	Very low
Fauna death (impact on threatened and migratory species)	Negligible	Unlikely	Very low

Environmental Monitoring
• As per the OPEP.

Record Keeping
• Contracts and agreements with third parties. • IAP. • Operational NEBA. • Briefing records. • Photos. • Daily operations reports. • Incident reports.

9. Risk Assessment – Pipeline Installation

This section describes the risks identified for the pipeline installation phase of the Project using the methodology described in Chapter 7 of this report.

The EIA presented in this section follows the same structure as that for Chapter 8 (drilling and wellhead installation) and presents the latest information on the pipeline installation program, noting that more detail will be included in the Pipeline Installation EP (for submission to the DJPR ERR Branch under the OPGGS Regulations) as more detailed engineering design becomes available.

The exact pipeline installation method is yet to be determined (see Section 2.3). The risks described in the section, along with control measures, reflect the options currently available for this phase of the project. These options are summarised below.

- Pipelay vessel, using either a:
  - Pipe reel-lay vessel;
  - Pipelay barge (supported by two anchor handling vessels); or
  - Tow vessel if the pipeline is launched over the sand dunes.
- Pipeline installation method, via either;
  - Burial – using either water jetting, plough, water jet-assisted plough or water jetting sled (and allowing for natural backfill);
  - Bolting (anchoring) to the seabed; or
  - Resting on the seabed (using concrete coating).

While the pipeline installation options include either a single 24” pipeline or dual 18” pipelines, for simplicity, a single pipeline is referenced in this chapter (other otherwise noted). A summary of the risk ratings for each risk identified and assessed in this chapter is presented in Table 9.1.

Table 9.1. Pipeline installation environmental risk rating summaries

Risk		Initial risk	Residual risk
1	Seabed disturbance (ecosystem function)	Low	Low
2	Generation of underwater sound – (threatening processes)	Low	Low
	– (threatened and migratory species)	Medium	Low
	– (ecosystem function)	Low	Low
3	Atmospheric emissions (threatening processes)	Low	Very low
4	Light emissions – (ecosystem function)	Low	Very low
	– (threatening processes)	Medium	Low
	– (threatened and migratory species)	Medium	Low
5	Discharge of sewage and grey water (ecosystem function)	Low	Very low
6	Discharge of cooling and brine water (ecosystem function)	Low	Very low

Risk		Initial risk	Residual risk
7	Discharge of bilge water and deck drainage (ecosystem function)	Low	Low
8	Accidental overboard release of waste (threatening processes)	Low	Very low
9	Introduction of IMS – environmental (ecosystem function)	High	Medium
	– business (commercial fisheries)	Medium	Medium
10	Displacement of or interference with third-party vessels – displacement	Low	Very low
	– interference	Low	Low
11	Vessel strike with megafauna – individuals (threatening process)	Low	Low
	– population (threatening process)	Low	Low
12	Accidental bulk discharge of chemicals or hydrocarbons (threatening process)	Low	Very low
13	Diesel spill – Benthic fauna	Low	Low
	– Macroalgal communities	Low	Low
	– Plankton	Low	Low
	– Pelagic fish	Low	Low
	– Cetaceans	Low	Low
	– Pinnipeds	Low	Low
	– Marine reptiles	Low	Very low
	– Seabirds	Low	Low
	– Shorebirds	Low	Low
	– Sandy beaches	Low	Low
	– Commercial fisheries	Low	Very low
Hydrocarbon spill response activities		Initial risk	Residual risk
14	Surveillance and tracking (ecosystem function)	Very low	Very low
	Protection and deflection (ecosystem function) – nearshore habitat	Low	Very low
	– shoreline habitat	Low	Very low
	– fauna disturbance	Low	Very low
	Shoreline assessment and clean-up (ecosystem function) – shoreline habitat	Medium	Low
	Oiled wildlife response (threatened and migratory species) – fauna injury	Low	Very low
	– fauna death	Low	Very low

9.1. Seabed Disturbance

9.1.1. Risk Pathway

The following activities will result in seabed disturbance:

- Pipe laying – jetting, bolting (anchoring) or laying of pipeline on or in the seabed, disturbing and displacing sediments along a narrow corridor (about 20 m wide).
- Installation of PLEM, spools, HFL and EFL.
- Vessel movements:
  - Pipe reel-lay or tow vessel – thrusters will stir up sediments, particularly in the shallower waters, over a width of about 50-100 m.
  - Pipelay barge - anchors used by the lay barge and placed by anchor handling tugs, will continuously disturb seabed sediments (chains and wire movement on the seabed and anchors penetrating the seabed). Once in place, the anchor lines will move up and down depending on the sea state and due to the vessel movement along the lay corridor. The area of disturbance is dependent on the anchor pattern, the length of line laid out for each anchor (which can be up to 1,000 m long), and the number of anchor settings. Assuming a disturbance footprint of 8,000 m per anchor setting for an eight-point mooring and 3 anchor settings required to install the pipeline, then a potential disturbance of 24,000 m is assumed. Anchor placement and removal can result in localised short-term impacts to benthic habitat and substrate. Each anchoring event is likely to disturb an area of about 30 m^2 (equating to an area of 720 m^3 based on 8 point mooring and 3 anchor settings).

- Drill cuttings and drill muds – emerging from the HDD exit point (about 800 m from the shoreline) at the time of HDD breakthrough of the seabed. The drilling operation is controlled to minimise the fluid discharge to the environment. Bentonite (a naturally occurring material) is typically mixed with fresh water to form the drilling mud. Drilling mud losses will be expected during the break through at the HDD exit point.

The pipelay installation will proceed at around 40 m per hour, and once laid, will not be disturbed again.

9.1.2. Known and Potential Environmental Risks

Seabed disturbance will impact marine receptors because of:

- Physical removal or disturbance of seabed sediments;
- Increase in turbidity of the water column near the seabed; and
- Physical injury or death of benthic fauna.

These impacts will be localised (hundreds of metres in width [length of anchor wires and chains] along the 2.4 km long pipeline corridor) and temporary (hours to days in any one location).

The geophysical survey did not identify any shipwrecks within the Project area, so impacts to shipwrecks are not discussed here. Similarly, no rocky reef has been identified within the Project area (see Section 6.1.2), so there will be no damage to these sensitive ecosystems.

9.1.3. EMBA

The EMBA for seabed disturbance created by pipelay installation (including the HDD exit) activities is restricted to tens to hundreds of metres from the pipeline, depending on the installation method.

Receptors that are known to occur or may occur within this EMBA are:

- Plankton;
- Benthic species;
- Demersal fish species; and
- Pelagic species (fish, cetaceans, pinnipeds).

9.1.4. Evaluation of Environmental Risks

This impact assessment broadly considers two options; these being burial of the pipeline in the seabed and resting the weighted pipeline on the seabed.

Burial

Burial of the pipeline will disturb the unconsolidated seabed sediments and benthic organisms living in or on it. Benthic fauna are generally accustomed to temporary disturbances, such as those created by storms and trawling. For the most part, this will be a temporary impact, with benthic fauna recolonising once the sediments settle back to the seabed.

For example, post-construction monitoring of nearshore Victorian cable laying sites for the Basslink Project (approximately 41 km to the southwest of the Project area) found that within two years of cable trenching there was no surface trace of the cable on the seabed (Sherwood *et al*., 2016). It was found that the seabed at both nearshore locations, which is largely consistent with the conditions present in the Project area, had returned to the natural condition of medium grained sand (Sherwood *et al*., 2016). Twenty-two (22) months following installation of the Basslink cable, post-construction monitoring observed sparse epibiota, including the soft coral *Pseudogorgia godffreyi* and the starfish *Luida australiae*, had colonised the sediments covering the cable trench (Sherwood *et al*., 2016). It was concluded by Sherwood et al (2016) that the ecological effects of the cable installation on epibiota had been transient and minor for soft sediments where the cable is buried.

This indicates that natural backfill over the pipeline in soft sediments is possible and this would reinstate habitat that is temporarily lost that will likely be recolonised by benthic fauna

Non-burial

Laying the 2.6 km-long single 24" pipeline on the surface of the seabed will result in about 780 m^2 (0.078 ha) of seabed displacement over the length of the pipeline (this is based on a 60 cm diameter pipe, with less than half of this diameter (<30 cm) resting on the seabed). This is equal to 0.025% of the Project area.

For the dual 18" (460 mm) pipelines, the seabed displacement is about 598 m^2 for each pipeline (a total of 0.12 ha), equal to 0.038% of the Project area.

This, in addition to pipeline appurtenances including the umbilical, PLEM, Pipeline End Termination (PLET), SUTA and associated equipment, will cover sessile benthic organisms (such as sponges). In the context of the small area of impact and the large area of similar habitat in the region, this is a negligible impact.

The surface of the pipeline itself will provide new hard substrate, which may be subsequently be colonised by species such as sponges, molluscs, hydrozoans, bryozoans and algae, in turn providing fish habitat. Over time, this colonisation leads to the development of a fouling community (similar to that on shipwrecks), which provides predator and prey refuges. This phenomenon was observed during post construction monitoring of the Basslink Interconnector at nearshore locations in Tasmania. In April 2009, with the armoured cable having been in place for 3.5 years, epibiota were well established along the cable route (Sherwood *et al*., 2016). The cast-iron conduit provided a stable substrate for growth of marine organisms as demonstrated by the heavy encrustation by algal and invertebrate species (Sherwood *et al*., 2016). Algae including turfing species and red, brown and green algae were all common on the conduit's upper surface, with other organisms (such as lace-bryozoans, ascidians and sponges) present on the underside of the cable (Sherwood *et al*., 2016). The presence of the pipeline on the seabed surface may impede movement of sediments and create a barrier to movement of some benthic species (such as scallops). These issues are addressed in Chapter 10.

General

In a uniform substrate composed of sand, anchor chains and cables can result in localised disturbance of the top-most portion of the benthic habitat as the chain and cable can swing across the top of the sediments and periodically touch bottom in some cases. These episodes of anchor chain and cable contact with the sediments can result in localised displacement, physical injury or mortality of epibenthic fauna (e.g., molluscs and crustaceans) and infauna (such as polychaetes). These impacts would generally be short-term and localised, with conditions quickly returning to baseline following removal of the anchor, chain, and cables.

Fish and other mobile species are expected to avoid areas of physical disturbance, though there is some anecdotal evidence of fish being attracted to physical disturbance of the seabed because food items become agitated and therefore become available as food. Other than relatively sedentary fish species such as gobies, there is expected to be no direct impact to fish, which are expected to move back into the impacted area soon after pipe laying and HDD exit point push through. There will be no long-term physical change to the characteristics of the seabed and benthic fauna will recolonise disturbed areas rapidly.

A turbidity study completed by Chevron as part of the Wheatstone Project in northern Western Australia showed that a turbidity plume from trenching associated with pipeline installation may be evident up to 70 m from the trench area depending on environmental conditions (Chevron, 2014). The results of the survey found that turbidity levels may exceed 80 Formazin Turbidity Units (FTU) (compared to the maximum background turbidity level of 5 FTU) up to 50 m from the trenched area. However, the average turbidity level 50 m from the trench area was recorded at approximately 15 FTU. Within two hours of ceasing trenching operations, the turbidity level had returned to background or very close to background levels (Chevron, 2014).

Surveys of seabed disturbance from anchoring activities indicate that recovery of benthic fauna in soft sediment substrates (such as the sandy seabed) occurs between 6 to 12 months after the disturbance was created (URS, 2001). The anchor depression acts as a trap for marine detritus and sand, which will quickly fill and be recolonised by benthic organisms (Currie and Isaac, 2005).

Under both the burial and non-burial pipe lay methods, turbidity of the water column will occur when seabed sediments are mobilised into the water column. Any turbidity is likely to be within the limits of natural variability when considering the turbidity created by tides and storm events in the shallow waters of the activity area. For example, CSIRO monitoring undertaken in the Project area indicates that even under calm weather conditions, turbidity levels can be quite high (Photo 9.1 and Photo 9.2). This turbidity would limit light penetration into the water column but given its temporary nature, it would be unlikely to inhibit primary production.

In the context of the small area of impact and the vast area of similar habitat in the region that is continuously subject to disturbance through natural and anthropogenic processes (currents, shifting sands and trawling), pipeline installation will have a negligible impact in terms of changes to seabed character and benthic habitats.

Photo 9.1. Example of clear water conditions at site 8 (8 April 2018, water depth of 20 m, 5.2 km from shore, calm weather conditions)

Photo 9.2. Example of turbid water conditions at site 9 (8 April 2018, water depth of 15 m, 1.1 km from shore, calm weather conditions)

9.1.5. Risks to MNES

Seabed disturbance will not have a significant risk to any MNES, as outlined in Table 9.2.

Table 9.2. Risks to MNES from seabed disturbance

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	There are no benthic species listed as threatened or migratory in the project area. Threatened fish, cetacean and bird species are likely to temporarily avoid the disturbance caused by pipelay activities, which will not result in significant impacts given the small area and temporary nature of impact.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.1.6. Risk Assessment

Table 9.3 presents the risk assessment for seabed disturbance.

Table 9.3. Risk assessment for seabed disturbance

Summary		
Summary of impacts	Removal/disturbance of seabed sediments. Turbidity of the water column at the seabed.	
Extent of impact	Localised – around individual points of disturbance.	
Duration of impact	Temporary – returning to pre-impact condition soon after impact.	
Level of certainty of impacts	HIGH – the impacts of seabed disturbance are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid		

Avoid physical damage to nearby rocky reef.	The results of the G&G investigations will be used to inform the final pipeline alignment and ensure it avoids rocky reef.	G&G investigations report verifies the absence of rocky reef along the pipeline route.
	GB Energy provides pipeline alignment and rocky reef data to vessel contractors to enter into their GPS.	Photos of navigation screens verify that information is uploaded.
	Vessel Masters use bathymetric mapping and GPS to avoid mapped rocky reef to the immediate west of the pipeline corridor so as to: • Ensure there is clearance at all times between the vessel, rocky reef and seabed obstacles; and • No anchor or anchor chain placement on or drag over the reef.	
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Seabed disturbance from anchoring and/or thrusters is kept to the minimum area necessary for safe operations.	Offshore installation procedures specific to the type of method use will be developed. This will take account of moorings, anchor sizing and weights and so forth.	The procedure is reviewed and approved by GB Energy.
	Vessel audit is undertaken ahead of mobilisation.	Audit report is available and witnessed by a GB Energy representative.
Restore Large objects dropped overboard will be retrieved wherever possible.	An ROV or diverse are deployed to search for (and retrieve, where possible), non-buoyant dropped objects so that there are no obstacles on the seabed at the completion of construction activities.	ROV/diving operator logs verify that a survey took place following a non-buoyant dropped object incident.
	Dropped objects left behind at the end of construction (that cannot be retrieved) will be reported to DJPR (ERR).	Incident report/s verify that the report was issued to DJPR ERR.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Environmental Monitoring		
• Post-activity ROV survey for dropped objects.		

Record Keeping
• G&G investigations report. • Photos (navigation screens). • GPS records of rocky reef. • Equipment pre-deployment inspections. • Handling and transfer procedure. • Completed handling and transfer checklists. • Crane operator qualification and training records. • PMS records. • PTW records. • Load ratings and load test certificates. • ROV survey/diver camera footage and operator logs. • Incident reports.

9.2. Generation of Underwater Sound

9.2.1. Risk Pathway

The following activities will generate underwater sound:

- Vessels - engine noise transmitted through the hull and propellers;
- Pipeline installation – noise from water jetting, ploughing or sledding through the seabed.

Vessel sound

The description of underwater sound from vessels is as per Section 8.2.1.

Jasco (2013) report the typical sound levels for the following vessels and equipment used in offshore pipelay installation activities:

- Pipe lay vessel (shallow water, anchored) – 169 dB re 1 μPa at 1 m (*Tog Mor*);
- Pipe lay vessel (deep water, DP) – 192 dB re 1 μPa at 1 m (*Castorone*);
- Anchor handling tug – 189 dB re 1 μPa at 1 m (*Katun*); and

Pipeline installation

Water jetting, ploughing or sledding through a sandy seabed (will generate underwater sound. ISCPC (2018) indicates a sound source level of 178 dB re 1μP for cable trenching operations and a comparable sound source level for cable jetting operations, focused in the frequency range of 1 kHz to 15 kHz. The sounds of burial were attributed to cavitation bubbles as the water jets passed through the leading edge of the burial plough. Jasco (2013) report the typical sound levels for a trenching dredge used in offshore pipelay installation activities as 183 dB re 1 μPa at 1 m (*Calamity Jane*).

Shore crossing

The shore crossing exit point is approximately 800 m from the shoreline and the drill profile is typically 30 m (or greater) below the surface of the seabed (except at the seabed exit ‘punch through’ point). The HDD (or micro-tunnelling) penetrates the substrate by rotating the drill head and jetting with high-pressure fluid, which results in minimal vibration because of the rotational movement (rather than pulsed movement, such as pile driving).

The geotechnical investigations at the shore crossing identified only sands and clays, which can reasonably be considered to be similar for the 800 m section to the seabed exit point. In the absence of hard rock, the potential for significant vibration and noise from the shore crossing activity under the seabed is low.

As such, noise and vibration impacts to the marine environment from the shore crossing activity is not considered a credible impact for inclusion in this EIA.

9.2.2. Known and Potential Environmental Risks

The risks resulting from underwater sound are the same as those described in Section 8.2.2.

9.2.3. EMBA

The EMBA for underwater sound varies from tens of metres to several hundred metres from the sound source, dependent on the species, as described in Section 8.2.4.

Receptors that are known to occur or may occur within the underwater sound EMBA, either as residents or migrants, are:

- Benthic species;
- Pelagic species (plankton, fin fish);
- Marine reptiles;
- Seabirds;
- Cetaceans; and
- Pinnipeds.

9.2.4. Evaluation of Environmental Risks

The evaluation of impacts and risks resulting from underwater sound from pipeline installation activities are largely the same as those described in Section 8.2.4 in terms of the impacts of sound on the most sensitive species, generally considered to be cetaceans. This section focuses on any differences noted from the limited research specifically regarding offshore pipeline installation.

The Jasco (2013) modelling study indicates that the behavioural threshold recognised for cetaceans (120 dB re 1 μPa) extended from between 1.2 km to 24.9 km for the various vessels and equipment used in summer and winter in shallow water (23 m water depth). The 75 dB re 1 μPa behavioural threshold for bottlenose dolphins did not exceed 1.0 km from the sound source, and the same threshold used for various fish species (e.g., anchovy, herring) was only triggered by the anchor handling vessel (with the behavioural range extending to 260 m from the sound source).

Nedwell et al (2012) undertook underwater sound modelling for the installation of export power cables at the Beatrice offshore wind farm in Scotland, with the modelling results indicating that for trenching, the avoidance and behavioural impact range for fish (cod, dab, herring and salmon) was <1 m up to 27 m and the range for dolphins (bottlenose, striped, killer whale) was 81 to 570 m.

Monitoring of underwater sound from offshore pipelay activities in the Baltic Sea, reported in FOI (2012), found that compared to background ambient levels of underwater noise, the sound levels resulting from the pipelay vessel were 3.5 dB higher at site A1 (in 28 m water depth) and 19.6 dB higher at site B1 (in 40 m water depth). For trenching activity, the sound level at site A1 (in 28 m water depth) was 0.9 dB higher than background levels and 15.1 dB higher than background at site B1 (in 40 m water depth).

Given the short term nature of the pipeline installation activities (about 20 days), literature suggesting that distance thresholds relating to fish and cetacean avoidance behaviour are small, and that sound-sensitive species such as whales are only a temporary presence in the region while they migrate, means that impacts from underwater sound during pipeline installation activities are considered negligible.

9.2.5. Risks to MNES

The generation of underwater sound during pipeline installation will not have significant risks to MNES, as outlined in Table 9.4.

Table 9.4. Impacts to MNES from seabed disturbance

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	There are no benthic species listed as threatened or migratory in the project area. Threatened fish, cetacean and bird species are likely to temporarily avoid the disturbance caused by pipelay activities, which will not result in significant impacts given the small area and temporary nature of impact.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas:		
- AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.2.6. Risk Assessment

Table 9.5 presents the risk assessment for underwater sound impacts to marine fauna and avifauna.

Table 9.5. Risk assessment for underwater sound – biological receptors

Summary	
Summary of impacts	Physiological or pathological impacts to local populations of marine fauna and avifauna.
Extent of Impact	Up to several hundred metres, depending on the receptor and the source of sound.
Duration of Impact	Short-term (duration of pipelay).
Level of certainty of impacts	Moderate to high.

Initial mitigation measures			
Performance outcome	Performance standard (control)		Measurement criteria
Minimise			
Vessel power generation and propulsion systems are well maintained.	Engines and thrusters are maintained in accordance with the vessel-specific PMS to ensure they are operating efficiently.		PMS records verify that engines and thrusters are maintained to schedule.
Risk assessment (initial)			
Consequence type	Consequence	Likelihood	Risk rating
Threatening processes	Negligible - all fauna groups	Almost certain	Low
Threatened and migratory species	Minor - all fauna groups	Almost certain	Medium
Ecosystem function	Negligible - all fauna groups	Almost certain	Low
Additional mitigation measures			
Performance outcome	Performance standard (control)		Measurement criteria
Avoid Avoid injury or behavioural impacts to whales.	Support vessel crews will implement The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) for sea-faring activities, which means: • Caution zone (300 m either side of observed whales and 150 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone. • No approach zone (100 m either side of observed whales and 50 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone and should not enter this zone and should not wait in front of the direction of travel or an animal or pod/group. • Do not encourage bow riding. • If animals are bow riding, do not change course or speed suddenly. • If there is a need to stop, reduce speed gradually.		Observation logs and/or Daily Operations Reports (DORs) note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision.
	Selected crew have completed an environmental induction covering the above-listed requirements.		Induction records verify that selected crew have completed an environmental induction.
Risk assessment (residual)			
Consequence type	Consequence	Likelihood	Risk rating

Threatening processes	Negligible – all fauna groups	Almost certain	Low
Threatened and migratory species	Negligible – all fauna groups	Almost certain	Low
Ecosystem function	Negligible – all fauna groups	Almost certain	Low
Environmental Monitoring			
• Cetacean observations.			
Record Keeping			
• DORs. • Environmental induction presentation and attendance records. • Engine and thruster PMS records. • Incident reports.			

9.3. Atmospheric Emissions

9.3.1. Risk Pathway

The following activities will generate atmospheric emissions from the pipelay and support vessels:

- Combustion of MDO from vessel engines, generators and deck equipment.

The description of atmospheric emissions is as per Section 8.5.1. The volume of fuel used by the anchor handling tugs (if used) and pipeline lay vessels is likely to be similar to the volumes outlined in Section 8.5.1.

9.3.2. Known and Potential Environmental Risks

The known and potential environmental risks of atmospheric emissions are:

- Localised and temporary decrease in air quality due to gaseous emissions and particulates from diesel combustion; and
- Incremental build-up of GHG in the atmosphere (influencing climate change).

9.3.3. EMBA

The EMBA for atmospheric emissions associated with vessel activities is the local air shed – likely to be within hundreds of metres of the vessels, both horizontally and vertically. Receptors that may occur within this EMBA, either as residents or migrants, are seabirds. It is also likely that emissions will be incorporated into the airshed over local towns such as Golden Beach and Paradise Beach.

9.3.4. Evaluation of Environmental Risks

The evaluation of impacts and risks resulting from atmospheric emissions are the same as those described in Section 8.2.4. Note that the GHG risks associated with pipeline installation are addressed in Technical Report H and EES chapter 14.

9.3.5. Risks to MNES

Atmospheric emissions will not have significant risks to MNES, as outlined in Table 9.6.

Table 9.6. Risks to MNES from atmospheric emissions

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species flying overhead will not be significant given the temporary nature of emissions, the seasonality of presence of most threatened and migratory bird species, their temporary presence flying through the area and their ability to fly away from plumes. There is no habitat critical to any threatened or migratory bird species restricted to the air space around the construction location.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.3.6. Risk Assessment

Table 9.7 presents the risk assessment for atmospheric emissions.

Table 9.7. Risk assessment for atmospheric emissions

Summary		
Summary of impacts	Decrease in air quality due to gaseous emissions and particulates from MDO combustion and contribution to the incremental build-up of GHG in the atmosphere (influencing climate change).	
Extent of Impact	Localised (local air shed for air quality), widespread (for GHG).	
Duration of Impact	Temporary – duration of pipeline installation (emissions are rapidly dispersed and diluted).	
Level of certainty of impacts	HIGH – the impacts of atmospheric emissions are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		

Combustion systems on the pipelay and support vessels operate in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) requirements.	Only low-sulphur (<0.5% m/m) MDO will be used in order to minimise SOx emissions.	Bunker receipts verify the use of low-sulphur MDO.
	All combustion equipment is maintained in accordance with the PMS (or equivalent).	PMS records verify that combustion equipment is maintained to schedule.
	Vessels with gross tonnage >400 tonnes possess equipment, systems, fittings, arrangements and materials that comply with the applicable requirements of MARPOL Annex VI.	IAPP is current.
	Vessels >400 gross tonnes and involved in an international voyage implement their SEEMP to monitor and reduce air emissions.	SEEMP records verify energy efficiency records have been adopted.
	Vessels >400 gross tonnes must ensure that firefighting and refrigeration systems are managed to minimise ODS.	ODS record book is available and current.
The pipelay and support vessel HVAC systems will be maintained to minimise refrigerant gas leaks.	The HVAC system is maintained in accordance with the PMS (or equivalent).	PMS records verify that the HVAC systems are maintained to schedule.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid Solid combustible waste is not incinerated.	All solid combustible waste is returned to shore for appropriate disposal.	The Garbage Record Book verifies that waste is transferred to shore for disposal.
Minimise Fuel use will be measured, recorded and reported.	Fuel use will be measured, recorded and reported for abnormal consumption, and in the event of abnormal fuel use, corrective action is taken to minimise air pollution.	Fuel use is recorded in the daily operations reports.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Unlikely	Very low
Environmental Monitoring		
• Fuel consumption.		
Record Keeping		

- Fuel bunkering receipts.
- PMS records.
- IAPP certificates.
- SEEMPs.
- ODS record books.
- Fuel use records.
- Waste manifests.
- Garbage record books.

9.4. Light Emissions

9.4.1. Risk Pathway

The following activities will result in artificial lighting:

- Pipelay vessel or barge and anchor support vessel operation – deck and navigation lighting will be kept on 24 hours a day for maritime safety and crew safety purposes.
- ROV operations – when submerged to illuminate an area of interest (e.g., when connecting the offshore pipeline to the onshore pipeline at the HDD exit point).

9.4.2. Known and Potential Environmental Risks

The known and potential environmental and social risks of artificial lighting are the same as those outlined in Section 8.6.2.

9.4.3. EMBA

Pendoley Environmental (2020) undertook light modelling for the Barossa gas export pipeline installation (offshore Northern Territory) to predict the extent of biologically relevant light spill for vessels involved in pipelay activities. This modelling found that light emissions were reduced to ambient levels (that being a full moon) at 11.1 km from the pipelay vessel. Noting of course the difference in topography and atmospheric conditions in play between offshore Northern Territory and offshore Victoria, this can be considered the EMBA for artificial light for pipelay.

The intensity of artificial lighting diminishes with the square of the distance (i.e., light is reduced to 1% of the initial intensity after 10 m) (Apache Energy, 2008), so the received intensity of lighting will be very low from the shoreline (850 m from the HDD exit point) (for sensitive receptors such as nesting shorebirds).

Light-sensitive receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Cephalopods (e.g., squid);
- Marine reptiles;
- Fish; and
- Seabirds, shorebirds and migratory birds.

9.4.4. Evaluation of Environmental Risks

The evaluation of environmental risks of artificial lighting are essentially the same as those outlined in Section 8.6.4.

Pendoley Environmental's light modelling for the Barossa gas export pipeline installation modelled the extent of biologically relevant light spill at the closest point to the shoreline for two vessels located side by side (the *Auducia* pipelay vessel and the *Oceanic* construction vessel). These modelling results are presented in Table 9.8, which provides some indication for the possible extent of impacts to marine fauna (noting that turtles do not nest in Victoria and are vagrant visitors only, but provide a suitable proxy for other marine fauna), indicating that the combined light glow from the vessels may result in behavioural impacts up to 1 km away. Note that in the absence of any published or generally accepted units of measurement, or scale, for measuring the impact of artificial light at night on turtle hatchlings, moonlight is used as a proxy.

Photo 9.3 shows the extent of lighting on a typical pipeline vessel at dusk. Figure 9.1 (taken from Pendoley, 2020) presents results of the modelling when including both the pipelay and construction vessel located side by side. The red dotted line on the graph represents the distance between the HDD exit point and the shoreline (where light will appear the brightest from the coast). Noting the previously mentioned limitations of using this data, this graph indicates that the radiance level at the shoreline will be about 3 (equivalent to up to 3 times the radiance of one moon).

There are no actions within the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-16 (DSEWPC, 2011) or the National Light Pollution Guidelines for Wildlife (DoEE, 2020) that are compromised by light emissions during pipeline installation activities. There are no sensitive light receptors in the area of potential impact (e.g., turtle nesting beaches). Migratory seabirds and shorebirds are unlikely to interact with the vessels during pipeline installation given the low levels of light emissions and temporary nature of the activity. Any fauna attraction behaviour will be temporary and highly localised and therefore will not have impacts at the individual, population or ecosystem level.

Table 9.8. Distance of equivalent moon radiances for the pipelay and construction vessel

Proportion of radiance of a full moon	Distance from source (m)		
	Pipelay vessel	Construction vessel	Both vessels together
10	332	51	336
1	1,050	162	1,062
0.1	3,335	512	3,375
0.01 (ambient)	11,073	1,622	11,226

Key

Proportion of radiance of a full moon	Impact potential to marine turtles
10	Light or light glow visible and impact likely, represents a very bright light equivalence to up to 10 times the radiance of one moon. This light radiance will override the moderating influence of the ambient full moon at the time of exposure.
1	Light or light glow visible and behavioural impact possible, depending on ambient moon phase at the time of exposure, which will influence the visibility of the artificial light sources, equivalent to the light output. Artificial lights will be more visible to marine turtles under a first quarter moon than under a full moon.
0.1	Light or light glow visible but behavioural impact unlikely (i.e. not biologically

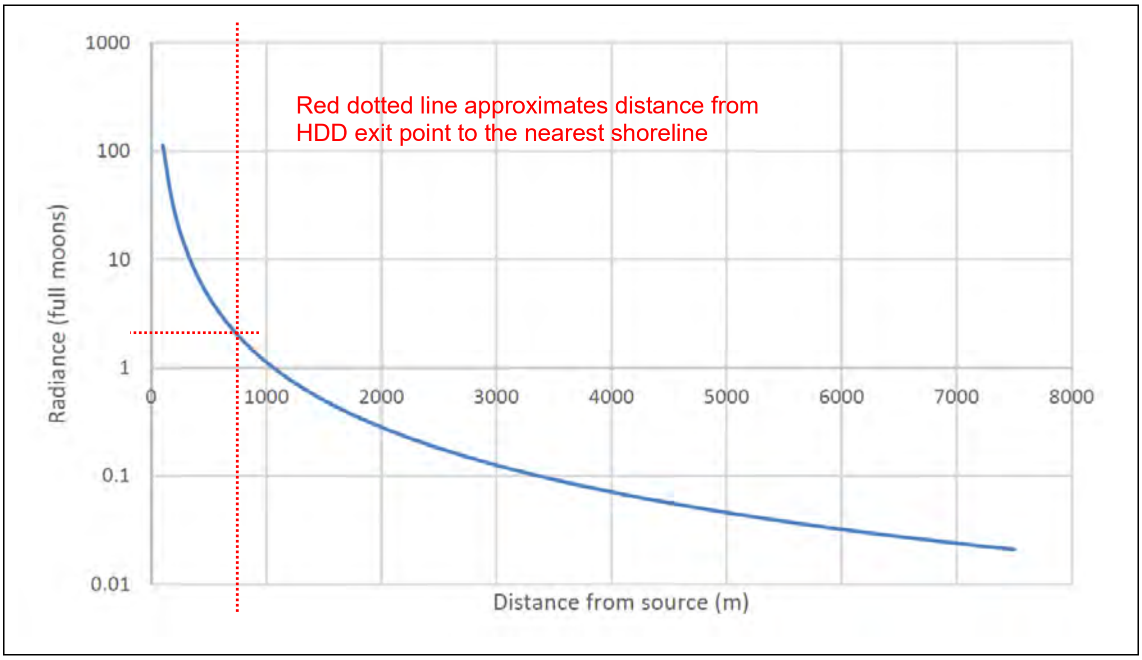
Proportion of radiance of a full moon	Impact potential to marine turtles
	relevant). Equivalent to the light output of the first quarter moon.
0.01	Light or light glow is considered ambient and no impact expected, equivalent to a new moon (100th the radiance of one full moon).

Lighting used during the pipeline installation will meet the requirements of the *Draft National Light Pollution Guidelines for Wildlife including marine turtles, seabirds and migratory shorebirds* (DAWE, 2020), which state that in terms of reducing impacts to seabirds, the following measures should be adopted in known seabird foraging areas:

- Reduce unnecessary outdoor and deck lighting on vessels;
- Extinguish outdoor/deck lights when not necessary for human safety;
- Restrict lighting at night to navigation lights; and
- Use block-out blinds on all portholes and windows.

Source: ConocoPhillips (2020).

Photo 9.3. Lighting levels at dusk of a typical pipelay vessel



Source: Pendoley (2020).

Figure 9.1. Radiance of light sources with distance from the pipelay vessel and construction vessels when side-by-side in the field

9.4.5. Risks to MNES

Light emissions will not have significant risks to MNES, as outlined in Table 9.9.

Table 9.9. Risks to MNES from light emissions

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species flying overhead will not be significant given the temporary nature of light emissions, the seasonality of presence of most threatened and migratory bird species, their temporary presence flying through the area and their ability to fly away from disturbance. There is no habitat critical to any threatened or migratory bird species restricted to the air space around the construction location.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate

MNES	Impact?	Notes
		Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.4.6. Risk Assessment

Table 9.10 presents the risk assessment for light emissions.

Table 9.10. Risk assessment for light emissions

Summary			
Summary of impacts	Light glow may act as an attractant to light-sensitive species (e.g., seabirds, fish, migratory and non-migratory birds, sea turtles and zooplankton), in turn affecting predator-prey and population dynamics (due to attraction to or disorientation from light).		
Extent of Impact	Localised – light glow/spill around the vessels and ROV.		
Duration of Impact	Temporary – duration of activity.		
Level of certainty of impacts	HIGH – the impacts of light glow on marine fauna are well known.		
Initial mitigation measures			
Performance outcome	Performance standard (control)	Measurement criteria	
Minimise External vessel lighting conforms to that required by maritime safety standards.	Light glow is minimised by managing external vessel lighting in accordance with: • AMSA Marine Orders Part 30 (Prevention of Collisions). • AMSA Marine Orders Part 59 (Offshore Support Vessel Operations).	Vessel class certifications are current.	
Risk assessment (initial)			
Consequence type	Consequence	Likelihood	Risk rating
Ecosystem function	Negligible – all fauna	Almost certain	Low
Threatening processes	Minor – all fauna	Almost certain	Medium
Threatened and migratory species	Minor – all fauna	Almost certain	Medium
Additional mitigation measures			
Performance outcome	Performance standard (control)	Measurement criteria	
Minimise Attraction to lights for birds and marine fauna is kept to a	Lighting is directed to working areas (rather than overboard) to minimise light spill to the ocean.	Completed vessel inspection checklists and photos verify that lights are	

minimum.	Lighting directed overboard can be manually over-ridden (with a local switch were possible) such that it is only switched on as required (e.g., man overboard).	directed inboard, and where this is not possible, lights are switched off when not in use.
	Pipe welding (if undertaken on the pipelay vessel) will be undertaken in an enclosed pipe welding area, where the intense light from this activity is not visible outside the vessel.	Completed daily environmental checklists and photos verify that welding is undertaken in an enclosed area.
	Blinds will be lowered on all portholes and windows at night.	Completed daily environmental checklists and photos verify that blinds are drawn each night.
	Light used to monitor pipelay activity on the stinger will only be used during active pipelay.	Completed daily environmental checklists and photos verify that lighting of the stinger is only used during active pipelay.

Risk assessment (residual)			
Consequence type	Consequence	Likelihood	Risk rating
Ecosystem function)	Negligible – all fauna	Unlikely	Very low
Threatening processes	Minor – all fauna	Likely	Low
Threatened and migratory species	Minor – all fauna	Likely	Low

Environmental Monitoring
• Daily inspections for deck lighting and drawn blinds at night.

Record Keeping
• Vessel class certification. • Completed environmental checklists. • Photos.

9.5. Discharge of Sewage and Grey Water

9.5.1. Risk Pathway

The use of ablution, laundry and galley facilities by the pipelay vessel and anchor handling vessel crews will result in the discharge of treated sewage and grey water. The impact pathways are the same as those described in Section 8.7.1.

Total volumes of sewage and grey water typically generated at offshore facilities range between 0.04 and 0.45 m^3 per person per day (NERA, 2017). Assuming 100 people working on the pipelay vessel and 12 people on each of the two anchor handling vessels (a total of 124 people), this equates to between 4.96 and 55.8 m^3 of sewage and grey water generated daily.

9.5.2. Known and Potential Environmental Risks

The known environmental risk of treated sewage and grey water discharges is:

- Temporary and localised increase in the nutrient content of surface waters around the vessels.

9.5.3. EMBA

The EMBA for sewage and grey water discharges is the same as that described in Section 8.7.3; the top 10 m of the water column and a 50 m radius from the discharge point.

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Marine reptiles;
- Pinnipeds; and
- Seabirds.

9.5.4. Evaluation of Environmental Risks

The evaluation of environmental risks for treated sewage and grey water discharges is the same as that described in Section 8.7.4.

9.5.5. Risks to MNES

Treated sewage and grey water discharges will not have significant risks to MNES, as outlined in Table 9.11.

Table 9.11. Risks to MNES from treated sewage and grey water discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges over a short-term pipeline installation program, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming or flying through the area. There is no habitat critical to any threatened or migratory marine species restricted to the EMBA for sewage and grey water discharges.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.

MNES	Impact?	Notes
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.5.6. Risk Assessment

Table 9.12 presents the risk assessment for the discharge of treated sewage and grey water.

Table 9.12. Risk assessment for the discharge of treated sewage and grey water

Summary		
Summary of impacts	Reduction in surface water quality around the discharge point.	
Extent of Impact	Localised – up to 50 m horizontally and 10 m vertically from the discharge point.	
Duration of Impact	Temporary – duration of pipeline installation activities.	
Level of certainty of impacts	HIGH – the impacts of sewage and grey water discharges water quality are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Sewage and grey water discharges comply with Section 23G of POWBONS.	Sewage and grey water are treated in a MARPOL-compliant STP prior to overboard discharge.	ISPP certificate is valid.
	The STP is maintained in accordance with the PMS.	PMS records confirm that the STP is maintained to schedule.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Sewage and grey water discharges comply with Section 23G of POWBONS.	In the event of a STP malfunction, untreated sewage will be managed such that: • Pipelay vessel/barge – stored in holding tanks until issue is rectified, or transferred to support/anchor handling vessels for discharge >12 nm from shore or discharged onshore.	Discharge records confirm discharge of untreated sewage in waters >12 nm from shore.

	• Anchor handling/support vessels - discharged when the vessel is >12 nm from shore.	
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Unlikely	Very low
Environmental Monitoring		
• None required.		
Record Keeping		
• ISPP certificates. • STP PMS records. • Discharge records.		

9.6. Discharge of Cooling and Brine Water

9.6.1. Risk Pathway

The risk pathways are the same as those described in Section 8.8.1.

9.6.2. Known and Potential Environmental Risks

The known and potential environmental risks of cooling water and brine discharges are:

- Temporary and localised increase in sea water temperature, causing thermal stress to marine biota;
- Temporary and localised increase in sea surface salinity, potentially causing harm to fauna unable to tolerate higher salinity; and
- Potential toxicity impacts to marine fauna from the ingestion of residual biocide and scale inhibitors.

9.6.3. EMBA

The EMBA for cooling water and brine discharges is the same as that described in Section 8.8.3; the top 10 m of the water column and a 100 m radius from the discharge point.

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds; and
- Avifauna.

9.6.4. Evaluation of Environmental Risks

The evaluation of environmental risks for cooling and brine water discharges will be the same as that described in Section 8.8.4.

9.6.5. Risks to MNES

Cooling and brine water discharges will not have significant risks to MNES, as outlined in Table 9.13.

Table 9.13. Risks to MNES from cooling and brine water discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges over a short-term pipeline installation program, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the EMBA for cooling and brine water discharges.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.6.6. Risk Assessment

Table 9.14 presents the risk assessment for the discharge of cooling and brine water.

Table 9.14. Risk assessment for the discharge of cooling and brine water

Summary	
Summary of impacts	Increased sea surface temperature and salinity around the discharge point. Potential toxicity impacts to marine fauna from residual biocide and scale inhibitors.
Extent of Impact	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.
Duration of Impact	Temporary – duration of pipeline installation activities.

Level of certainty of impacts	HIGH – the impacts of sea surface temperature and salinity increases on marine fauna are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Equipment that requires cooling by water, and the RO plant, is well maintained.	Engines and associated equipment that require cooling by water will be maintained in accordance with the PMS so that they are operating within accepted parameters.	PMS records verify that the equipment is maintained to schedule.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		
Only low-toxicity chemicals are used in the cooling and brine water systems.	Only ONCS 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM)-rated chemicals are used in the cooling and brine water systems.	Chemical inventory records verify that biocides and scale inhibitors are of low toxicity.
If an EMGPS is used, it is maintained in accordance with the PMS so it is operating within specified operating parameters.	The EMGPS is maintained in accordance with the PMS to ensure it is operating efficiently (without the use of chemicals).	PMS records verify that the EMGPS is maintained to schedule.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Unlikely	Very low
Environmental Monitoring		
• None required.		
Record Keeping		
• PMS records. • Chemical inventory.		

9.7. Discharge of Bilge Water and Deck Drainage

9.7.1. Risk Pathway

The risk pathways for bilge water and deck drainage discharges are the same as those described in Section 8.9.1.

9.7.2. Known and Potential Environmental Risks

The known and potential environmental risks of the discharge of bilge water and deck drainage are:

- Temporary and localised reduction of surface water quality (organics and toxins) around the discharge point; and
- Acute toxicity to marine fauna through ingestion of, or contact with, contaminated water in a localised mixing zone (in the event of malfunction of the OWS or an uncontrolled spill emanating from an open drainage area).

9.7.3. EMBA

The EMBA for bilge water and deck drainage discharges is the same as that described in Section 8.9.3; the top 10 m of the water column and a 100 m radius from the discharge point.

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds; and
- Avifauna.

9.7.4. Evaluation of Environmental Risks

The environmental risks for bilge water and deck drainage discharges during pipeline installation are the same as those described in Section 8.9.4.

9.7.5. Risks to MNES

The discharge of bilge water and deck drainage will not have significant risks to MNES, as outlined in Table 9.15.

Table 9.15. Risks to MNES from bilge water and deck drainage discharges

<table>
<tr><th>MNES</th><th>Impact?</th><th>Notes</th></tr>
<tr><td>World Heritage properties (see Section 6.4.2)</td><td>No</td><td>The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.</td></tr>
<tr><td>National Heritage properties (see Section 6.4.3)</td><td>No</td><td>The nearest National Heritage property (Australian Alps National Park) is located onshore.</td></tr>
<tr><td>Wetlands of international importance (see Section 6.4.4)</td><td>No</td><td>The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.</td></tr>
<tr><td>Listed threatened species (see Section 6.3)</td><td>No</td><td rowspan="2">Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges over a short-term pipeline installation program, the seasonality of presence of most threatened and migratory marine and bird species, and their temporary presence moving through the area. There is no habitat critical to any threatened or migratory marine species restricted to this discharge EMBA.</td></tr>
<tr><td>Listed migratory species (see Section 6.3)</td><td>No</td></tr>
</table>

MNES	Impact?	Notes
Commonwealth marine areas: - AMPs (see Section 6.4.1)	 No	 The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.7.6. Risk Assessment

Table 9.16 presents the risk assessment for the discharge of bilge water and deck drainage.

Table 9.16. Risk assessment for the discharge of bilge water and deck drainage

Summary		
Summary of impacts	Reduction of surface water quality around the discharge point. Acute toxicity to marine fauna through ingestion of, or contact with, heavily contaminated water (in the event of malfunction of the OWS or an uncontrolled spill on an un-bunded deck).	
Extent of Impact	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of Impact	Temporary – sporadically for the duration of pipeline installation.	
Level of certainty of impacts	HIGH – the impacts of oily water discharges on the marine environment are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Bilge water discharges comply with Section 8(4)(e) of POWBONS.	All bilge water passes through a MARPOL-compliant OWS set to limit OIW to <15 ppm prior to overboard discharge.	IOPP certificates are current.
	The OWS is maintained in accordance with each vessel's PMS.	PMS records verify that the OWS are maintained to schedule.
	The OWS is calibrated in accordance with the PMS to ensure the 15 ppm OIW limit is met.	PMS records verify that the OWS is calibrated to schedule.
	Residual oil from the OWS is pumped to tanks and disposed of onshore (no whole residual bilge oil is discharged overboard).	The Oil Record Books verify that waste oil is transferred to shore.

	In the event of OWS malfunction, all oily water is retained onboard for transfer to shore or discharged in waters >12 nm from the shore.	The Oil Record Book verifies that bilge water is transferred to shore or discharged in waters >12 nm from shore.
Hydrocarbon or chemical spills on the vessel are prevented from being discharged overboard.	Hydrocarbon and chemical storage areas (process areas) are bunded and drain to the bilge tank (or equivalent).	Vessel P&IDs verify that hydrocarbon and chemical storage areas are bunded and drain to the bilge tank.
	Portable bunds and/or drip trays are used to collect spills or leaks from equipment that is not contained within a permanently bunded area (non-process areas).	Site inspections (and associated completed checklists) verify that portable bunds and/or drip trays are used in non-process areas as required.
The marine crews are competent in spill response and have appropriate resources to respond to a spill.	The vessel crews are competent in spill response and have appropriate response resources in order to prevent or minimise hydrocarbon or chemical spills discharging overboard.	Training records verify that vessel crews receive spill response training.
	Fully stocked SMPEP response kits and scupper plugs or equivalent drainage control measures are readily available to the deck crews and used in the event of a spill to deck to prevent or minimise discharge overboard.	Site inspection verifies that fully stocked spill response kits and scupper plugs (or equivalent) are available on deck in high-risk locations.
		Review of incident reports indicate that the spills of hydrocarbons or chemicals to deck are cleaned up.
Level 1 spills (<10 m^3) of oil or oily water overboard are rapidly stopped.	The vessel-specific SMPEP is implemented in the event of a large spill of hydrocarbons or chemicals overboard.	Incident report verifies that the SMPEP was implemented.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Planned open deck discharges are non-toxic.	Deck cleaning detergents are biodegradable.	SDS verify that deck cleaning agents are biodegradable.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Possible	Low
Environmental Monitoring		
• Volume of bilge water discharge.		
Record Keeping		

- IOPP certificates.
- PMS records.
- Oil Record Books.
- Crew training records.
- Inspection and checklist records.
- P&IDs.
- SDS (for all hazardous materials, including deck cleaning agents).
- SMPEPs.
- Incident reports.

9.8. Accidental Overboard Release of Waste

9.8.1. Risk Pathway

The risk pathways for handling and storage of waste and hazardous and non-hazardous are the same as those described in Section 8.10.1.

In addition to the wastes listed in that section, those specific to the pipeline installation phase include welding butts, and steel and concrete shavings from the pipeline.

9.8.2. Potential Environmental Risks

The risks of the release or accidental overboard release of hazardous and non-hazardous materials and waste to the ocean, creating marine debris, are:

- Marine pollution (litter);
- Injury and entanglement of individual animals (such as seabirds and seals); and
- Localised (and normally temporary) smothering or pollution of benthic habitats.

9.8.3. EMBA

The EMBA for the accidental overboard release of hazardous and non-hazardous materials and waste is the same as that described in Section 8.10.3; likely to extend for kilometres from the release site (as buoyant waste drifts with currents) or localised for non-buoyant items that sink to the seabed.

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Benthic fauna;
- Benthic habitat (sand and reef substrates);
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles; and
- Avifauna.

In particular, the EPBC Act-listed species documented as being negatively impacted by the ingestion of, or entanglement in, harmful marine debris (and known to occur in the EMBA) are (according to DoEE, 2018):

- The five turtle species;
- Eight albatross species and three petrel species;

- Other birds (flesh-footed shearwater, southern fairy prion);
- Australian fur-seal; and
- The southern right, pygmy blue, humpback, sei, pygmy right and killer whales.

9.8.4. Evaluation of Environmental Risks

The environmental risks for the accidental overboard release of hazardous and non-hazardous materials and waste during pipeline installation are the same as those described in Section 8.10.4.

9.8.5. Risks to MNES

The accidental overboard release of hazardous and non-hazardous materials and waste will not have significant risks to MNES, as outlined in Table 9.17.

Table 9.17. Risks to MNES from the accidental release of hazardous and non-hazardous materials and waste

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the low risk of this release, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.8.6. Risk Assessment

Table 9.18 presents the risk assessment for the accidental overboard release of hazardous and non-hazardous materials and waste.

Table 9.18. Risk assessment for the accidental disposal of hazardous and non-hazardous materials and waste

Summary		
Summary of risks	Marine pollution (litter and a temporary and localised reduction in water quality), injury and entanglement of individual animals (such as seabirds and seals) and smothering or pollution of benthic habitats.	
Extent of risk	Non-buoyant waste may sink to the seabed near where it was lost. Buoyant waste may float long distances with ocean currents and winds.	
Duration of risk	Short-term to long-term, depending on the type of waste and location.	
Level of certainty of risks	HIGH – the effects of inappropriate waste discharges are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
The EPO, EPS and measurement criteria listed below are in addition to those for 'seabed disturbance'.		
Avoid Putrescible waste discharges comply with Section 23B of POWBONS.	No putrescible waste is discharged in the Project area (or state waters in general). All putrescible waste is transferred to shore for suitable disposal.	The Garbage Record Book verifies that putrescible waste was offloaded to support vessels for transfer to shore.
Minimise Comply with POWBONS (Part 2, Divisions 2, 2A & 2B) to ensuring there is no unplanned release of hazardous or non-hazardous solid wastes or materials.	A MARPOL Annex V-compliant GMP is in place for the vessels (i.e., for those >100 gross tonnes or certified to carry 15 persons or more) that sets out the procedures for minimising, collecting, storing, processing and discharging garbage.	GMPs are in place, readily available on board and kept current.
	Waste is stored, handled and disposed of in accordance with the GMP. This will include measures such as: • No overboard discharge of general operational or maintenance wastes or plastics or plastic products of any kind. • Waste containers are covered with secure lids to prevent solid wastes from blowing overboard. • All solid wastes are stored in designated areas before being sent ashore for recycling, disposal or treatment. • Any liquid waste storage on deck must have at least one barrier to minimise the risk of spills to deck	Garbage Record Books (along with the waste manifest) verify that the GMP is implemented.
		Visual inspections (and associated completed checklists) verify that waste is stored and handled according to its waste classification.
		Visual inspections (and associated completed checklists) verify that waste receptacles are properly located, sized, labelled, covered and secured for the waste they hold.

	entering the ocean. This can include containment lips on deck (primary bunding) and/or secondary containment measures (bunding, containment pallet, transport packs, absorbent pad barriers) in place. • Correct segregation of solid and hazardous wastes.	A licensed shore-based waste contract is in use for the management of onshore waste transport.
	Vessel crews are inducted into waste management procedures at the start of the activity to ensure they understand how to implement the GMP.	Induction and attendance records verify that all crew members have been inducted.
	Crane transfers are undertaken in accordance with the vessel-specific lifting procedures.	PTW (and associated JSA) is available for each shift.
	The cranes and lifting equipment are maintained fit for use at all times to minimise the risk of dropped objects.	PMS records and/or the sling register verifies that checks and maintenance are undertaken to schedule.
Grease and chemicals are stored in chemical storage lockers.	Chemical lockers are available, bunded and used for the storage of all greases and non-bulk chemicals (i.e., those not in tote tanks) so as to prevent discharge overboard.	Site inspection verifies that greases and chemicals are stored in a chemical locker.
Avoid objects being dropped overboard.	Large bulky items are securely fastened to or stored on the vessel deck/s to prevent loss to sea.	A sea-fastening plan is prepared ahead of mobilisation.
		A completed pre-departure inspection checklist verifies that bulky goods are securely sea-fastened.
	A crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects.	Completed handling and transfer procedure checklist, PTWs and/or risk assessments verify that the procedure is implemented prior to each transfer.
	The crane operators are trained to be competent in the handling and transfer procedure to prevent dropped objects.	Training records verify that crane operators are trained in the loading and unloading procedure.
	Visual inspection of lifting gear is undertaken every quarter by a qualified competent person (e.g., maritime officer) and lifting gear is tested regularly in line with the vessel specific PMS.	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.
	All lifting gear will be supplied with test certifications.	A completed pre-departure inspection checklist verifies that the rigging register is current.

Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor (threatening processes)	Unlikely	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Rehabilitate		
Comply with POWBONS (Part 2, Divisions 2, 2A & 2B) by ensuring there is no unplanned release of hazardous or non-hazardous solid wastes or materials.	Solid waste that is accidentally discharged overboard is recovered if reasonably practicable.	Incident records are available to verify that credible and realistic attempts to retrieve the materials lost overboard were made.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor (threatening processes)	Rare	Very low
Environmental Monitoring		
• Garbage Record Books. • Waste tracking in the activity-specific waste manifest.		
Record Keeping		
• GMPs. • Garbage Record Books. • Crew induction records. • Inspection records/checklists. • PMS records. • PTW/JSA records. • Shore-based waste contract. • Waste manifest. • Incident reports.		

9.9. Introduction and Establishment of Invasive Marine Species

9.9.1. Risk Pathway

The risk pathways for the introduction of IMS are the same as those described in Section 8.11.1 as they relate to vessels. As the pipelay vessel (and anchor support vessels, if required) are not contracted at this point, it is assumed that the vessels will be mobilised from interstate or international waters.

There is no risk of the pipeline and umbilicals introducing IMS as they will not have been submerged in seawater prior to installation.

9.9.2. Potential Environmental Risks

The risks of IMS introduction (assuming their survival, colonisation and spread) include:

- Reduction in native marine species diversity and abundance;

- Displacement of native marine species;
- Socio-economic impacts on commercial fisheries; and
- Changes to conservation values of protected areas.

9.9.3. EMBA

Receptors most at risk within this EMBA, either as residents or migrants, are:

- Benthic fauna (because of their limited ability to move to other suitable areas);
- Benthic habitat; and
- Pelagic and demersal fish.

9.9.4. Evaluation of Environmental Risks

The environmental risks relevant to the introduction of IMS are the same as those described in Section 8.11.4.

9.9.5. Risks to MNES

The introduction of IMS will not have significant risks to MNES, as outlined in Table 9.19.

Table 9.19. Risks to MNES from the introduction of IMS

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	There are no threatened benthic marine species (which are more susceptible to the effects of IMS) recorded in the Project area and surrounds. Impacts to threatened and migratory marine species will not be significant given their ability to find resources in other parts of the marine environment. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest. The long distance between the Beagle AMP (and its deeper, colder waters) and the Project area (with shallower, warmer waters) makes it unlikely that IMS introduced in the Project area would spread to and survive in the AMP.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.9.6. Risk Assessment

Table 9.20 presents the risk assessment for the introduction of IMS.

Table 9.20. Risk assessment for the introduction of IMS

Summary		
Summary of risks	Reduction in native marine species diversity and abundance, displacement of native marine species, socio-economic impacts on commercial fisheries and changes to conservation values of protected areas.	
Extent of risk	Localised (isolated locations if there is no spread) to widespread (if colonisation and spread occurs).	
Duration of risk	Short-term (IMS is detected and eradicated, or IMS does not survive long enough to colonise and spread) to long-term (IMS colonises and spreads).	
Level of certainty of risks	HIGH – the impacts associated with IMS introduction are well known and the vectors of introduction are known. Regulatory guidelines controlling these vectors have been established.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise *Biofouling*		
The vessels present a low biofouling risk.	The vessels are managed in accordance with the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (AQIS, 2009). This means: • Conducting in-water inspection by divers or inspection in drydock if deemed necessary. • Biofouling risk will be assessed, with cleaning of hull and internal seawater systems undertaken if deemed necessary. Anti-fouling coating status taken into account, with antifouling renewal undertaken if deemed necessary.	Biofouling assessment report prior to mobilising to site confirms acceptability of pipelay and support vessel entry into Commonwealth waters.
	Vessels >400 gross tonnes carry a current IAFS Certificate that is complaint with and Marine Order Part 98 (Anti-fouling Systems).	The IAFS Certificates are valid.
Ballast water		
The vessels discharge only low risk ballast water.	Vessels will fulfil the requirements of the Australian Ballast Water Management Requirements (DAWR, 2017, v7). This includes requirements to: • Carry a valid BWMP. • Submit a BWR through the MARS. o If intending to discharge	BWMP is available and current. BWR (or exemption) is submitted prior to entry to the activity area. A valid BWMC is in place.

	o internationally-sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival. o If intending to discharge Australian-sourced ballast water, seek a low-risk exemption through MARS. • Hold a BWMC. Ensure all ballast water exchange operations are recorded in a BWRS.	An up-to-date BWRS is in place. An ePAR is available and signed off by DAWR.

Risk assessment (initial)			
Risk focus	Consequence	Likelihood	Risk rating
Environmental (ecosystem function)	Major	Possible	High
Business (commercial fisheries)	Major	Unlikely	Medium

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise The vessels carry a low risk of IMS introduction.	A vessel contractor pre-qualification is undertaken to ensure biofouling and ballast water controls meet these EP requirements.	Vessel contractor pre-qualification report verifies the vessels meet the requirements outlined in this table.
Biofouling		
The vessels present a low biofouling risk.	An IMS evaluation takes place prior to the vessels mobilising to site based on the following: • Inspecting the IAFS certificates to ensure they are current. • Reviewing recent vessel inspection/audit reports to ensure that the risk of IMS introduction is low. • Determining recent ports of call to determine the IMS risk of those ports. • Determining the need for in-water cleaning and/or re-application of anti-fouling paint if neither has been done recently in line with Anti-fouling and in-water cleaning guidelines. • Implementing the biofouling guidance provided in part 5 of the Offshore Installations Biosecurity Guideline (v1.3, DAWR, Feb 2019).	An IMS evaluation report (or memo or similar) verifies that the evaluation took place and that the IMS risk is low.

Submersible equipment (e.g., ROV) carries a negligible risk of IMS introduction.	Submersible equipment will be cleaned (e.g., biofouling is removed) prior to initial use in the activity area.	Records are available to verify that towed equipment was cleaned prior to use in the activity area.
Ballast water		
No additional measures identified.		
Reporting		
Known or suspected non-compliance with biosecurity measures is reported to regulatory agencies.	Non-compliant discharges of domestic ballast water are reported to DELWP and DAWE immediately.	Incident report notes that contact was made with DELWP and DAWE regarding non-compliant ballast water discharges.

Risk assessment (residual)			
Risk focus	Consequence	Likelihood	Risk rating
Environmental (ecosystem function)	Major	Unlikely	Medium
Social (commercial fisheries)	Major	Rare	Medium

Environmental Monitoring

- Ballast water discharges.

Record Keeping

- Vessel contractor pre-qualification reports.
- Biofouling risk assessment reports.
- BWMP.
- BWR.
- BWMC.
- BWRS.
- IAFS Certificates.
- DAWR-signed ePARs.
- DAWR-signed ballast water exchange logs.
- Incident reports.

9.10. Displacement of or Interference with Third-party Vessels and Activities

9.10.1. Risk Pathway

The risk pathways for the displacement of or interference with third-party vessels and activities are the same as those described in Section 8.12.1. A temporary 500-m radius PSZ will be in place around the pipeline installation vessel for the duration of the campaign.

At the completion of pipeline installation, the pipeline will either rest on or in the seabed. In either scenario, no PSZ is declared around pipelines, but they are marked on navigation maps with a cautionary area.

Note that this section deals with displacement or interference in a socio-economic sense; collision hazard (and consequent diesel spill impacts) is addressed in Section 9.13.

9.10.2. Potential Environmental Risks

The risks of displacement of or interference with third-party vessels and activities are:

- Collisions between the pipelay and support vessels (resulting in vessel damage);
- Diversion from navigation paths (leading to increased travel times and fuel usage/costs);
- Vessel damage (resulting in financial loss); and
- Damage to or loss of fishing equipment and/or loss of commercial fish catches (resulting in financial loss).

9.10.3. EMBA

The EMBA for the displacement of or interference with third-party vessels and activities is the same as that described in Section 8.12.3; the PSZ around the pipelay vessel and wherever support vessel movements occur in the Project area (more specifically the immediate area around two intersecting vessels).

Receptors most at risk within this EMBA are:

- Commercial and recreational fishing vessels;
- Commercial fishing equipment (e.g., trawl nets, lobster pots); and
- Merchant vessels.

9.10.4. Evaluation of Environmental Risks

The environmental risks for the displacement of or interference with third-party vessels and activities are the same as those described in Section 8.12.4.

The pipeline and umbilical, PLEM, spools, HFLs and EFLs may present a risk to fishers after installation; this is addressed in Chapter 10 (operations).

9.10.5. Risks to MNES

The displacement of and interference with third-party vessels and activities will not have significant risks to MNES, as outlined in Table 9.21.

Table 9.21. Risks to MNES from the displacement of and interference with third-party vessels and activities

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species are not relevant to this risk.
Listed migratory species (see Section 6.3)	No	

MNES	Impact?	Notes
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.10.6. Risk Assessment

Table 9.22 presents the risk assessment for the displacement of or interference with third-party vessels and activities.

Table 9.22. Risk assessment for the displacement of or interference with third-party vessels and activities

Summary		
Summary of risks	Presence of vessel/s (and towed equipment), damage to or loss of fishing equipment and loss of commercial fish catches.	
Extent of risk	Highly localised – immediately around vessels.	
Duration of risk	Short-term (minutes for a third-party vessel detour) to long-term (vessel collision).	
Level of certainty of risk	HIGH – the impacts associated with vessel collisions are well known. The Bass Strait ATBA was established in acknowledgement of the risk posed by merchant vessels and petroleum infrastructure and smaller vessels.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid Collisions with the pipelay and support vessels are avoided by ensuring they are readily identifiable to, and their location communicated to third-party vessels.	GB Energy has undertaken thorough pre-activity consultation with fishing stakeholders to ensure that commercial fishers are aware of the pipe lay operations, timing and PSZ.	Consultation records verify that safety exclusion requirements were communicated to commercial fishing stakeholders.
	The AHO will be notified of the activity no less than four weeks prior to the activity commencing to enable the promulgation of Notice to Mariners and AusCoast navigational warnings.	Notice to Mariners is available, including pipelay and support vessel details, location and timing.

	The pipelay and support vessels are readily identifiable to third-party vessels.	Visual inspection (and associated completed checklists) verify that the anti-collision monitoring equipment (e.g., 24-hour radar watch, GMDSS and AIS) is functional and in use.
	The pipelay installation vessel will display the appropriate lights and day shapes for a vessel with restricted ability to manoeuvre during operations.	Visual confirmation (and associated completed checklists) verifies that these measures are in place during the investigations.
The risk of collision with the pipelay vessel is avoided by gazetting and enforcing a 500-m radius PSZ around it.	The temporary PSZ is gazetted in the Victorian Government Gazette, effective from the pipelay vessel's arrival on location.	The PSZ gazettal is issued to GB Energy and available on the Victorian Government website.
	Visual and radar watch is maintained on the bridge of the vessels at all times (except for a pipelay barge, which does not have its own propulsion). The Vessel Masters and deck officers have valid SCTW certificates in accordance with AMSA Marine Order 70 (seafarer certification) (or equivalent) to operate radio equipment to warn of potential third-party spatial conflicts (e.g. International Convention on Standards of Training, Certification and Watch-keeping for Sea-farers [STCW95], GDMSS proficiency).	Appropriate qualifications are available to verify the competence of the Vessel Masters and deck officers.
	Constant communications between the pipelay vessel and support vessels are maintained to ensure the vessels are patrolling the PSZ at all times.	Visual confirmation and interview with the pipelay vessel Watch Keeper and Control Room Operator verifies that the support vessels are patrolling the PSZ area at all times.
	The support Vessel Masters issue warnings (e.g., radio warning, flares, lights/horns) to third-party vessels approaching the PSZ in order to prevent a collision with the pipelay vessel.	Radio communications/ bridge log verifies that warnings to third-party vessels approaching the PSZ have been issued as necessary.
	One of the support vessels will remain with the pipelay vessel at all times and will intercept approaching vessels that have not heeded radio advice.	Bridge log verifies that a support vessel has intercepted a third-party vessel approaching the PSZ as necessary.

The pipelay and support vessels are authorised to operate within the Bass Strait ATBA.	GB Energy will apply to NOPSEMA and obtain permission for the pipelay and support vessels to operate within the Bass Strait ATBA.	An 'Area to be Avoided' authorisation from NOPSEMA is granted to GB Energy.
Vessel-to-vessel collisions are managed in accordance with vessel-specific emergency procedures.	The Vessel Master will sound the general alarm, manoeuvre the vessel to minimise the effects of the collision and implement all other measures as outlined in the vessel or structure collision procedure (or equivalent).	Incident report verifies that the relevant safety procedure was implemented.
	Vessel collisions will be reported to Transport Safety Victoria and AMSA if that collision has or is likely to affect the safety, operation or seaworthiness of the vessel or involves serious injury to personnel.	Incident report verifies that AMSA was notified of a vessel collision.

Risk assessment (initial)

Risk focus	Consequence	Likelihood	Risk rating
Displacement (shipping)	Negligible	Almost certain	Low
Interference (shipping)	Moderate	Unlikely	Low

Additional mitigation measures

Performance outcome	Performance standard (control)	Measurement criteria
Avoid Collisions with the pipelay and support vessels are avoided by ensuring they are readily identifiable to, and their location communicated to third-party vessels.	GB Energy will use SETFIA's SMS service to notify fishers of the pipelay activity, timing and PSZ at least 2 weeks prior to construction.	Consultation records verify the SMS service was used.
Prevent damage to commercial fishing equipment and the pipeline (and associated structures).	Within one week of completing pipeline installation, the location of the pipeline will be provided to commercial fisheries stakeholders via direct communications from GB Energy.	Stakeholder consultation records confirm that notification to commercial fisheries associations and the AHO was provided within a week of completing pipeline installation.
	Within one week of completing pipeline installation, the location of the pipeline will be provided to the AHO so that navigation charts can be updated.	

Risk assessment (residual)

Risk focus	Consequence	Likelihood	Risk rating
Displacement (shipping)	Negligible	Rare	Very low
Interference (shipping)	Moderate	Rare	Low

Environmental Monitoring

- Continuous bridge monitoring.

Record Keeping
• Stakeholder consultation communication records. • Notice to Mariners. • AusCoast warnings. • PSZ gazettal. • ATBA authorisation. • Bridge communication logs. • Crew qualifications. • Incident reports.

9.11. Vessel Strike with Megafauna

9.11.1. Risk Pathway

The movement of the pipelay and support vessels within the Project area has the potential to result in collision or entanglement with megafauna, this being cetaceans, pinnipeds and vagrant turtles.

9.11.2. Potential Environmental Risks

The risks of vessel strike with megafauna are:

- Injury; and
- Death.

9.11.3. EMBA

The EMBA for vessel strike with megafauna is the immediate area around the pipelay and support vessels.

Receptors most at risk within this EMBA are:

- Cetaceans (whales and dolphins);
- Pinnipeds (fur-seals and true seals); and
- Turtles.

9.11.4. Evaluation of Environmental Risks

The environmental risks for vessel strike with megafauna are the same as those described in Section 8.13.4; albeit the risk of colliding with a stationary MODU is replaced by the risk of collision with a very slow moving (<1 knot) pipelay vessel. As such, the pipelay vessel does not present a collision risk to megafauna as even slow-moving megafauna vulnerable to vessel strike (e.g., turtles) can avoid collisions at these speeds. As such, the only credible risks are those relating to support vessels given that they are able to move at faster speeds (noting that while fulfilling their role on location, they too will be moving very slowly).

9.11.5. Risks to MNES

Vessel strike with megafauna will not have significant risks to MNES, as outlined in Table 9.23.

Table 9.23. Risks to MNES from vessel strike with megafauna

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	The low likelihood of presence of southern right, pygmy blue and humpback whales outside of the migration period in the Project area, combined with the lack of a defined migration route for pygmy blue whales and preference for deeper water by humpbacks and pygmy blues in the Gippsland region, makes it unlikely that vessel strike with threatened whale species will occur. Vessel collisions are listed as a threat to cetaceans in the: • Conservation Management Plan for the Southern Right Whale (DSEWPC, 2012c); • Conservation Management Plan for the Blue Whale (DoE, 2015b); • Conservation advice for the sei whale (TSSC, 2015c); • Conservation advice for the fin whale (TSSC, 2015d); and • Conservation advice for the humpback whale (TSSC, 2015b). The EPS listed in this Table 9.24 aim to minimise the risk of vessel strike with megafauna, and do not breach the management actions of the above-listed whale conservation plans.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.11.6. Risk Assessment

Table 9.24 presents the risk assessment for megafauna vessel strike and entanglement.

Table 9.24. Risk assessment for megafauna vessel strike

Summary		
Summary of risks	Injury or death of cetaceans and/or pinnipeds.	
Extent of risk	Localised – limited to individuals coming into contact with the support vessels.	
Duration of risk	Temporary (if individual animal dies or has a minor injury) to long-term (if there is a serious injury).	
Level of certainty of risk	HIGH – injury may result in the reduced ability to swim and forage. Serious injury may result in death.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid No injury or death of megafauna as a result of vessel strike.	Support vessel crews will implement The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) for sea-faring activities, which means: • Caution zone (300 m either side of observed whales and 150 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone. • No approach zone (100 m either side of observed whales and 50 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone and should not enter this zone and should not wait in front of the direction of travel or an animal or pod/group. • Do not encourage bow riding. • If animals are bow riding, do not change course or speed suddenly. • If there is a need to stop, reduce speed gradually.	DORs note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision.
	Pipelay and support vessel crews have completed an environmental induction covering the above-listed requirements.	Induction and attendance records verify that support vessel crews have completed an environmental induction.
	Vessel crews, but most notably the vessel Masters and Mates, will keep watch for whales and dolphins at all times so that the guidelines can be implemented.	Whale and dolphin sighting records verify that watch was maintained at all times and that the guidelines were followed as required.

Rehabilitate Vessel strike is reported to regulatory authorities.	Injury to megafauna serious enough to require intervention/rescue is reported to the Whale and Dolphin Emergency Hotline on 1300 136 017 as soon as possible. No attempts to assist/rescue megafauna should be made by vessel crew.	Incident report verifies contact was made with the Whale and Dolphin Emergency Hotline.
	Vessel strike causing injury to or death of a cetacean is reported to the DAWE via the online National Ship Strike Database (https://data.marinemammals.gov.au/report/shipstrike) within 72 hours of the incident.	Electronic record of report submittal is available.

Risk assessment (initial)			
Risk	Consequence	Likelihood	Risk rating
Individual animal (threatening processes)	Minor	Possible	Low
Population level (threatening processes)	Minor	Unlikely	Low
Additional mitigation measures			
No additional mitigation measures identified.			
Risk assessment (residual)			
Risk	Consequence	Likelihood	Risk rating
Individual animal (threatening processes)	Minor	Possible	Low
Population level (threatening processes)	Minor	Unlikely	Low
Environmental Monitoring			
• Vessel crew induction presentation and attendance records. • Megafauna sightings by vessel crew.			
Record Keeping			
• DORs. • Induction and attendance records. • Megafauna sighting records. • Incident reports.			

9.12. Accidental Bulk Discharge of Chemicals or Hydrocarbons

9.12.1. Risk Pathway

The risk pathways that may result in accidental bulk discharges (spills) of chemicals and hydrocarbons are the same as those described in Section 8.10.1 and would apply to the pipelay and support vessel operations.

9.12.2. Potential Environmental Risks

The known and potential environmental risks of the bulk discharge of chemicals and hydrocarbons are:

- Temporary and localised reduction of water quality; and
- Acute toxicity to marine fauna through ingestion or absorption.

9.12.3. EMBA

The EMBA for the risk of bulk discharge of chemicals and hydrocarbons is likely to range from tens to hundreds of metres depending on the product and volume spilled, so a precise EMBA cannot be calculated.

Receptors most at risk within this EMBA are:

- Fish;
- Marine mammals; and
- Turtles.

9.12.4. Evaluation of Environmental Risks

The risks associated with the discharge of chemicals is addressed in Section 8.10.4. The risks of a bulk discharge of chemicals will be no different, though the increased release volume means it will take longer to dilute and disperse through the water column.

The risks associated with the discharge of MDO is addressed in Section 9.13.

9.12.5. Risks to MNES

Accidental bulk discharge of chemicals or hydrocarbons will not have significant risks to MNES, as outlined in Table 9.25.

Table 9.25. Risks to MNES from the accidental bulk discharges of chemicals or hydrocarbons

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the seasonality of presence of most threatened and migratory marine species, and their temporary presence moving through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

9.12.6. Risk Assessment

Table 9.26 presents the risk assessment for the accidental bulk discharge of chemicals and fuel.

Table 9.26. Risk assessment for the accidental bulk discharge of chemicals and fuels

Summary		
Summary of risks	Pollution of the water column. Toxicity to marine fauna.	
Extent of risk	Localised – a small mixing zone around the pipelay vessel.	
Duration of risk	Temporary (duration of the activity).	
Level of certainty of risk	HIGH – the impacts associated with drilling fluid, chemical and hydrocarbon spills at sea are well known and documented.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		
Hydrocarbons and chemicals stored on the vessels are stored in a manner that prevents bulk release.	All hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.	Visual inspection verifies that hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.
	Where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.	Visual inspection verifies that where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.
Planned maintenance will be undertaken on all chemical and hydrocarbon storage systems, hose fittings and so forth.	Planned maintenance is undertaken to the PMS schedule.	PMS records verify that maintenance work (and repairs where necessary) is undertaken.
Vessel crews are well prepared to respond to deck spills.	The Vessel Masters ensure that crew undertake spill response training every three months in accordance with the SMPEP and training matrix.	Training records show that relevant crew receive quarterly spill response training.
	In accordance with the SMPEP, oil spill response kits are available in relevant locations around the vessels, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for MDO spills to deck record that the spill is cleaned up using SMPEP resources.

Reporting		
A bulk spill of chemicals or hydrocarbons at surface will be promptly reported to regulatory agencies.	GB Energy will report to DJPR (EMB) within 2 hours of becoming aware of the spill.	Incident reports and logs confirm that regulatory authorities were notified within 2 hours of GB Energy becoming aware of the spill.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor (threatening process)	Unlikely	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise A pre-acceptance inspection of the vessels takes place.	GB Energy's pre-acceptance inspection of the vessels confirms that storage tanks, equipment, bunding and machinery spaces are free of defects.	Vessel pre-acceptance inspection records verify good condition of all equipment.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor (threatening process)	Rare	Very low
Environmental Monitoring		
• Not applicable.		
Record Keeping		
• Pre-acceptance vessel inspection records. • Inspection records. • Training records. • Daily fluids reports. • PMS records. • PTWs and JSAs. • Incident reports.		

9.13. Diesel Spill

9.13.1. Risk Pathway

The pipelay vessel (assuming it's not a barge) and support vessels carry large inventories of MDO. The fuel inventory is split between numerous tanks and some of this may be spilled in the event of an emergency. The following events may result in the loss of part of the inventory of one or more fuel tanks:

- Vessel grounding (e.g., in shallow waters on a rocky reef or sand bar).

DNV (2011) indicates that for the period 1982-2010, there were no spills over 1 tonne (1 m^3) for offshore vessels caused by collisions or fuel transfers. The Australian Transport Safety Bureau (ATSB) marine safety and investigates database indicates there have been no collisions for offshore industry vessels in Victoria.

Properties of MDO

The nature and behaviour of MDO is described in Section 8.15.

Weathering tests indicate that during constant winds, approximately 41% of the MDO is predicted to evaporate within 24 hours of release (Figure 9.2). Under calm conditions the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation of the residual compounds will slow significantly, and they will then be subject to more gradual decay through biological and photochemical processes.

Under variable winds (Figure 9.3), where the winds are of greater strength, entrainment into the water column is indicated to be significant. Approximately 48 hours after the spill, around 60% of the oil mass is forecast to have entrained and a further 40% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<1%). The increased level of entrainment in variable winds results in a higher percentage of biological and photochemical degradation, where the decay of the floating slicks and oil droplets in the water column occurs at an approximate rate of 0.43% per day with an accumulated total of ~4.3% after 10 days, in comparison to a rate of ~0.1% per day and an accumulated total of 1.3% after 10 days under constant winds.

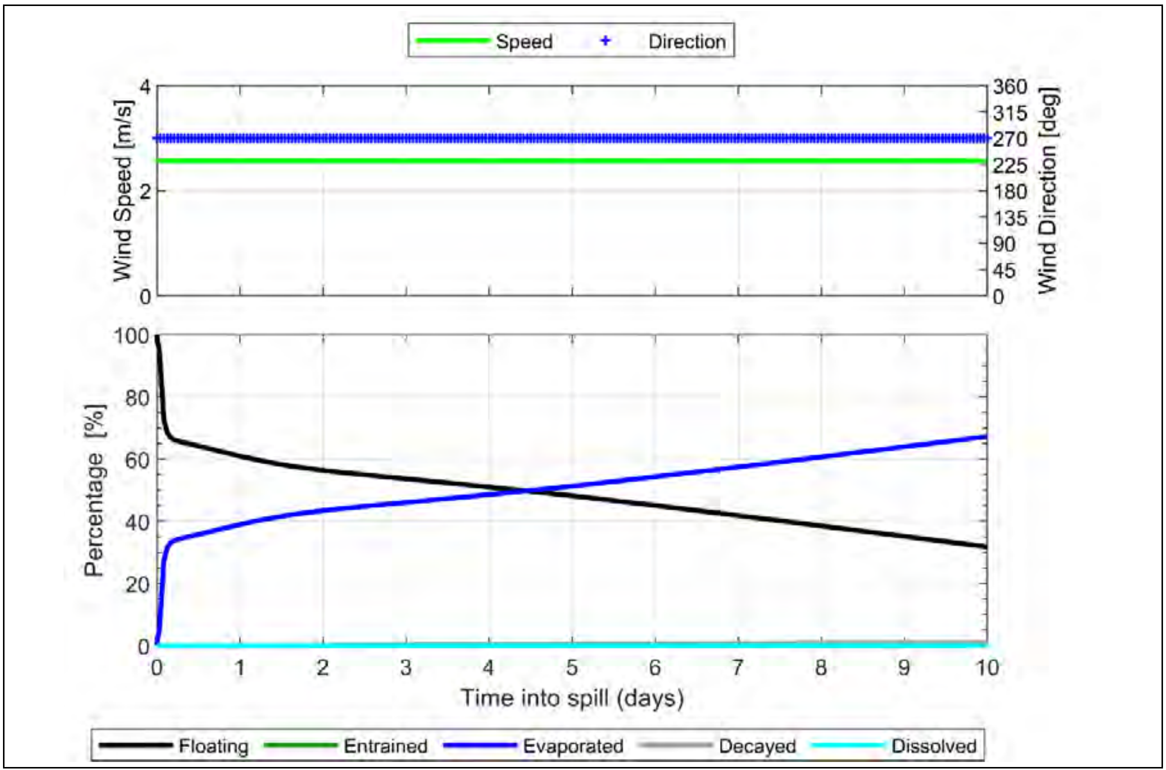


Figure 9.2. Proportional mass balance plot representing the weathering of MDO spilled onto the water surface as a one-off release (50 m^3 over 1 hour) and subject to a constant 5 knot (2.6 m/s) wind at 15°C water temperature and 25°C air temperature

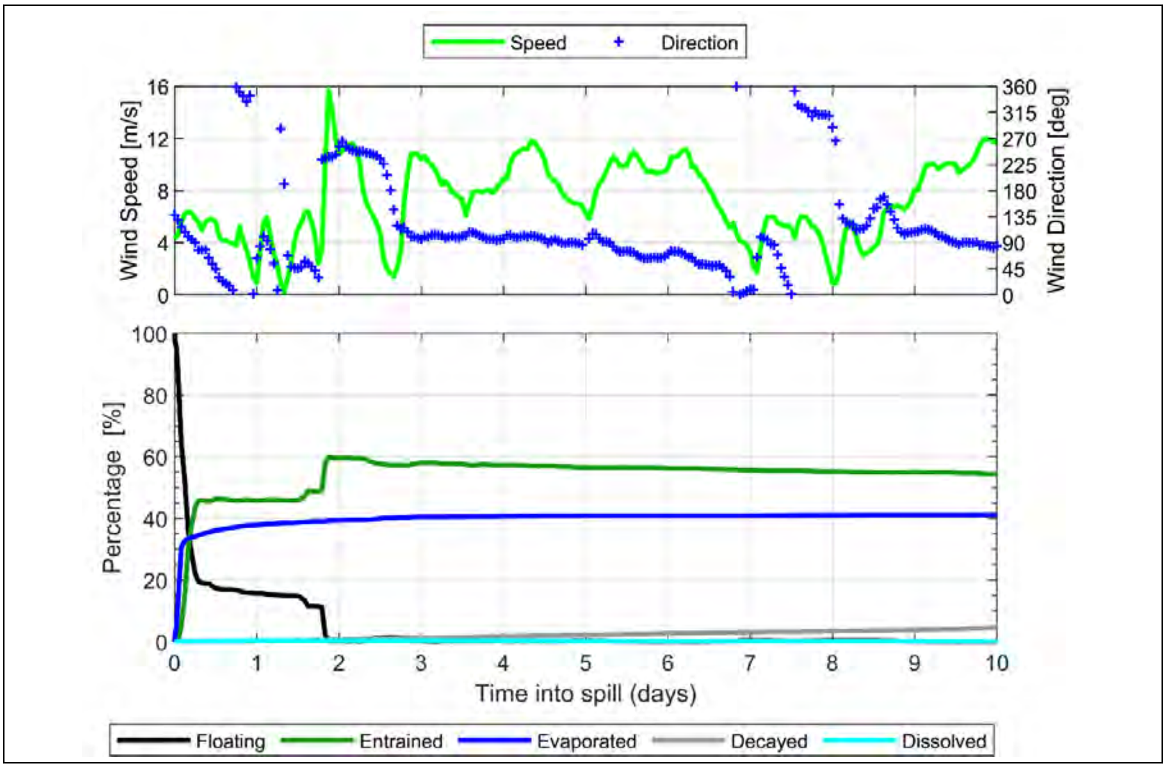


Figure 9.3. Proportional mass balance plot representing the weathering of MDO spilled onto the water surface as a one-off release (50 m³ over 1 hour) and subject to <u>variable</u> 5 knot (2.6 m/s) wind at 15°C water temperature and 25°C air temperature

Spill Modelling

RPS was commissioned to undertake OSTM specific to the location and design of this pipeline installation program (RPS, 2020a). This involved modelling the loss of 500 m^3 of MDO over 6 hrs (83 m^3/hr) from the pipelay vessel using an amalgamation of 100 random spill release sites within the activity area tracked for 20 days, using five years of wind and current data inputs (2009 to 2018 inclusive).

This modelling work meets and exceeds the *American Society for Testing and Material Standard F2067-13 (Standard Practice for Development and Use of Oil Spill Models).*

MDO spill modelling

MDO characteristics

The physical characteristics of the MDO are the same as those described for the drilling phase and are provided in Table 8.38, with the boiling ranges of the MDO provided in Table 8.39.

Determining Spill Scenario

The spill scenario subject to the OSTM is based on a vessel-to-vessel collision (e.g., between the pipelay vessel and support vessel) or the pipelay vessel (assuming a J-lay or S-lay vessel) grounding (e.g., on an unmapped sand bar). Other potential modelling scenarios were dismissed as having negligible risks or as non-credible, as discussed below:

- <u>Pipelay vessel and support vessel refuelling</u> will not be undertaken in the Project area.

- An errant vessel collision between a third-party vessel and the pipelay vessel that results in a significant loss of MDO from the vessel is dismissed as a non-credible risk because:
  - The pipeline installation location is located entirely within the Bass Strait ATBA, meaning large merchant vessels are unlikely to be in the Project area;
  - A temporary PSZ will be gazetted around the pipelay vessel;
  - One or more support vessels are present on location at all times to maintain guard and intercept any errant vessels; and
  - The MDO tanks are typically located inboard and double-skinned, further ensuring that piercing of the MDO tanks (and loss of fuel) is even more unlikely.

Spill Location

For this assessment, 100 randomly selected spill start times were run for the location closest to the known rocky reef.

Spill Volume

The *Technical Guidelines for preparing Contingency Plans for Marine and Coastal Facilities* (AMSA, 2015) specify that an appropriate spill size for a vessel collision (a non-oil tanker) should be based on the volume of the largest tank, while the volume for a non-major grounding should be based on the total fuel volume of one tank. GB Energy has used this guidance in determining the volume to be modelled for this study.

Given that vessels for this activity have yet to be contracted, the exact volume of MDO to be carried by the vessels cannot be provided. Therefore, the largest tank size for the *Seven Oceans* pipelay vessel (which would be the largest type of vessel used for this pipelay program) was selected as a suitably proxy, given that it installed the Sole Gas Pipeline in East Gippsland in 2019. It has 12 MDO tanks, with the largest tank holding a maximum volume of 504.7 m^3.

An outline of the spill thresholds used for the OSTM, together with the justification for their use, is provided in the drilling EIA chapter in Table 8.40.

A summary of the parameters used for the OSTM is provided below in Table 9.27.

Table 9.27. Summary of the OSTM settings

Parameter	Scenario inputs
Season	Annualised
Number of randomly selected spill locations	100
Spill volume	500 m^3
Spill volume justification	Based on the largest fuel tank on the *Seven Oceans* pipelay vessel
Release type	At sea surface
Release duration	6 hours
Release duration justification	A release of 500 m^3 would take several hours to be released from a hole of unknown diameter in a fuel tank

Parameter	Scenario inputs
Simulation length	30 days
Water temperature	Water temperatures used vary from 14-18°C across the year
Surface oil concentration thresholds	LOW exposure: 1 g/m^2 MODERATE exposure: 10 g/m^2 HIGH exposure: 50 g/m^2
Shoreline load threshold	LOW exposure: 10 g/m^2 MODERATE exposure: 100 g/m^2 HIGH exposure: 1,000 g/m^2
Dissolved aromatic dosage	LOW exposure: 10 ppb MODERATE exposure: 50 ppb HIGH exposure: 400 ppb
Entrained dosage	LOW exposure: 10 ppb HIGH exposure: 100 ppb

A summary of the stochastic OSTM results is provided in Table 9.28, with worst-case deterministic results presented for oil on the sea surface and at the shoreline. Further detail regarding the shoreline contact with certain sectors of the shore is provided in Table 9.29.

Table 9.28. Summary of the OSTM results

Threshold	Results
Sea surface contact (Figure 9.4)	
LOW exposure: 1-10 g/m^2 **(visual impact only)** (or 0.001 mm, or 1 µm, equivalent to a rainbow to metallic sheen)	The greatest distance travelled from the release location is 349 km, predominantly in an east-northeast direction. There is a 13% probably of incursion into the Ninety Mile Beach MNP (taking 0.9 days to reach the park), a 3% probability of reaching Point Hicks MNP, a 2% probability of reaching Cape How MNP and a 1% probability of reaching Wilsons Promontory Marine Park. There is a 40% probability of intersecting the Upwelling East of Eden KEF.
MODERATE exposure: 10-50 g/m^2 (or 0.01 mm, or 10 µm, equivalent to a metallic sheen)	The greatest distance travelled from the release location is 98 km, predominantly in an east-northeast direction. There is a 3% probably of incursion into the Ninety Mile Beach MNP (taking 1.1 days to reach the park), and zero probability of contact with other MNPs. There is a 4% probability of intersecting the Upwelling East of Eden KEF.
HIGH exposure: ≥50 g/m^2 (or 0.05 mm, equivalent to a metallic sheen to continuous true colour)	The greatest distance travelled from the release location is 33 km, predominantly in an east-northeast direction. No MNPs are predicted to be contacted at this threshold.
The deterministic trajectory that recorded the largest area of low (1-10 g/m^2) floating oil exposure commenced at 9:00 pm 16th May 2014. Figure 9.5 presents the potential zone of low exposure from floating oil (swept area), over the entire simulation. Zones of low and moderate (10-50 g/m^2) floating oil exposure were predicted	

to extend a maximum of ~69 km and ~43 km east from the release location, respectively. High exposure (≥50 g/m^2) extended ~10.5 km southwest from the release location. No shoreline oil was predicted for this trajectory.	
Shoreline (Figure 9.6)	
LOW exposure: 10 g/m^2 Equivalent to an oil stain/film (~2 tsp/m^2)	There is a 64% probability of shoreline contact. A maximum of 40.5 km of shoreline may be exposed to MDO at this threshold.
MODERATE exposure: 100 g/m^2 Equivalent to an oil coating (~½ cup/m^2)	A maximum of 20 km of shoreline may be exposed to MDO at this threshold.
HIGH exposure: 1,000 g/m^2 Equivalent to oil cover (~1 litre/m^2)	A maximum of 9.5 km of shoreline may be exposed to MDO at this threshold.
Maximum volume of hydrocarbons ashore – 297.3 m^3	
Average volume of hydrocarbons ashore – 112.6 m^3	
The deterministic trajectory that resulted in the longest length of shoreline contacted at or above actionable shoreline oil (≥100 g/m^2) commenced at 2 pm 15th November 2013. The longest length of shoreline predicted to be contacted by oil above 100 g/m^2 was 20 km. Figure 9.7 presents the potential zones of floating oil exposure (swept area) and shoreline loading, over the entire simulation. Oil exposure at the low threshold was predicted to extend a maximum distance of ~32 km (southwest) from the release site. Moderate (or actionable oil (≥10 g/m^2) exposure extended to a maximum distance of 10.5 km southwest. High (≥50 g/m^2) floating oil exposure was predicted within 5 km of the release site.	
Dissolved aromatic hydrocarbons (Figure 9.8)	
LOW exposure: 10 ppb	The greatest distance travelled from the release location is 359 km, predominantly in an east-northeast direction, in the 0-10 m water depth layer below the sea surface. No exposure was predicted below 10 m water depth. There is a 1% probably of contact with the East Gippsland AMP. There is a 3% probability of contact with the Point Hicks MNP, 1% probability with the the Cape Howe MNP and 2% probability with the Ninety Mile Beach MNP. There is a 3% probability of contact with the Upwelling East of Eden KEF.4 There is 1% probability of contact with the Nooramunga Marine and Coastal Park and with the Corner Inlet Ramsar wetland site.
MODERATE exposure: 50 ppb	No predicted exposure for dissolved or entrained hydrocarbons.
HIGH exposure: 400 ppb	No predicted exposure for dissolved or entrained hydrocarbons.
Entrained hydrocarbons (Figure 9.9)	
LOW exposure: 10 ppb	The greatest distance travelled from the release location is 914 km, predominantly in an east-northeast direction, in the 0-10 m water depth layer below the sea surface. No exposure was predicted below 10 m water depth. There is a 10% probably of contact with the Beagle AMP and 5% probability of contact with the East Gippsland AMP. There is a 68% probability of contact with the Point Hicks MNP, 47% probability with the the Cape Howe MNP and 29% probability with the Ninety Mile Beach MNP.

	There is a 72% probability of contact with the Upwelling East of Eden KEF, 13% probability of contact with the Big Horseshoe Canyon KEF and 10% probability of contact with the Canyons of the eastern continental slope. There is an 11% probability of contact with the Nooramunga Marine and Coastal Park and 5% probability of contact with the Wilsons Promontory MP. There is an 18% probability of contact with the Gippsland Lakes Ramsar wetland site and an 11% probability of contact with the Corner Inlet Ramsar wetland site.
HIGH exposure: 100 ppb	The greatest distance travelled from the release location is 449 km, predominantly in an east-northeast direction, in the 0-10 m water depth layer below the sea surface. No exposure was predicted below 10 m water depth. There is a 2% probably of contact with the Beagle AMP; no other AMPs are contacted. There is a 22% probability of contact with the Point Hicks MNP, 14% probability with the Ninety Mile Beach MNP and 13% probability with the Cape Howe MNP. There is a 26% probability of contact with the Upwelling East of Eden KEF. There is a 2% probability of contact with the Nooramunga Marine and Coastal Park and 1% probability of contact with the Wilsons Promontory MP. There is a 3% probability of contact with the Gippsland Lakes Ramsar wetland site and a 2% probability of contact with the Corner Inlet Ramsar wetland site.

Table 9.29 presents a summary of oil contact to all receptors and shorelines assessed.

Table 9.29. Summary of probability of contact (above each threshold) for specified shorelines under annualised conditions, for a 500 m^3 surface release of MDO over 6 hours and tracked for 30 days, calculated from 100 spill trajectories

Shoreline sector (moving west to east along the coast)	Probability of contact (%)			Minimum time before shoreline contact (days)			Load on shoreline (g/m^2)		Maximum length of shoreline contacted (km)			Average length of shoreline contacted (km)		
	L	M	H	L	M	H	Avg	Peak	L	M	H	L	M	H
McLoughlins Beach	1	1	-	0.9	0.9	-	820	820	0.5	0.5	-	0.5	0.5	-
Woodside Beach	6	5	4	0.9	0.9	0.9	429	3,066	12.5	8.0	4.0	5.9	4.4	1.9
Seaspray	22	21	14	0.3	0.4	0.5	433	6,368	22.0	13.0	6.0	10.6	6.3	2.3
Golden Beach	48	39	29	0.1	0.2	0.2	730	13,212	24.0	17.0	9.5	10.6	7.4	4.8
Lakes Entrance (West)	1	1	1	1.5	1.6	1.9	2,135	2,135	24.0	14.0	2.5	24.0	14.0	2.5
Lakes Entrance	1	1	-	1.6	1.8	-	356	356	11.0	4.5	-	11.0	4.5	-
Marlo	4	4	-	1.6	1.8	-	119	884	13.0	4.0	-	5.8	2.0	-
Cape Conran	1	1	-	8.3	8.5	-	170	170	4.0	0.5	-	4.0	0.5	-

Legend

L = low threshold exposure, M = moderate threshold exposure, H = high threshold exposure, Avg = average

Definitions

Probability of hydrocarbon contact to the shoreline:	Calculated by dividing the number of spill trajectories contacting shorelines (at the defined threshold) at a given location (single grid cell, shoreline receptor or all shorelines) by the total number of spill trajectories. For example, a reported probability of 47% for low shoreline contact for a given grid cell indicates that of the 100 individual spill trajectories, 47 made shoreline contact at the specific grid cell equal to or greater than the low contact threshold (10 g/m^2).
Probability of contact:	The maximum predicted probability of exposure for any grid cell along the boundary for the receptor calculated from the 100 spill trajectories.
Minimum time before shoreline contact:	Determined by ranking the elapsed time before shoreline contact to a given location/grid cell (at a given reporting threshold) for each of the 100 spill trajectories, with the minimum time from all spill trajectories being presented.
Average volume of oil ashore for a single spill:	Determined by calculating the average volume of all single spill trajectories predicted to make shoreline contact based on the minimum reporting threshold.
Maximum volume of oil ashore from a single spill trajectory:	Determined by identifying the single spill trajectory that recorded the maximum volume of oil to come ashore and presenting that value.

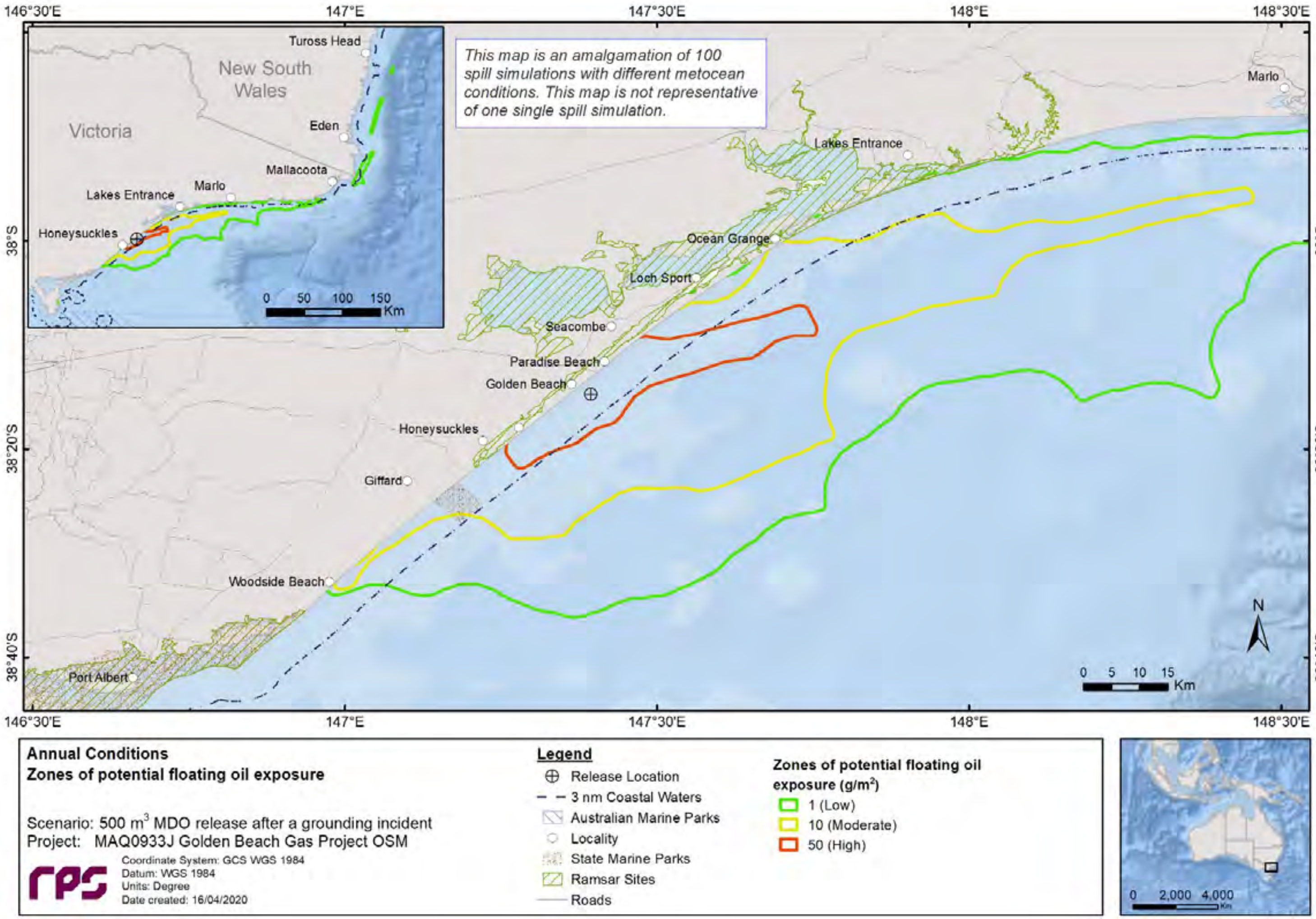


Figure 9.4. Predicted zones of potential floating oil exposure resulting from a 500 m^3 surface release of MDO over 6 hours, in the event of a pipelay vessel grounding incident during the pipeline installation phase

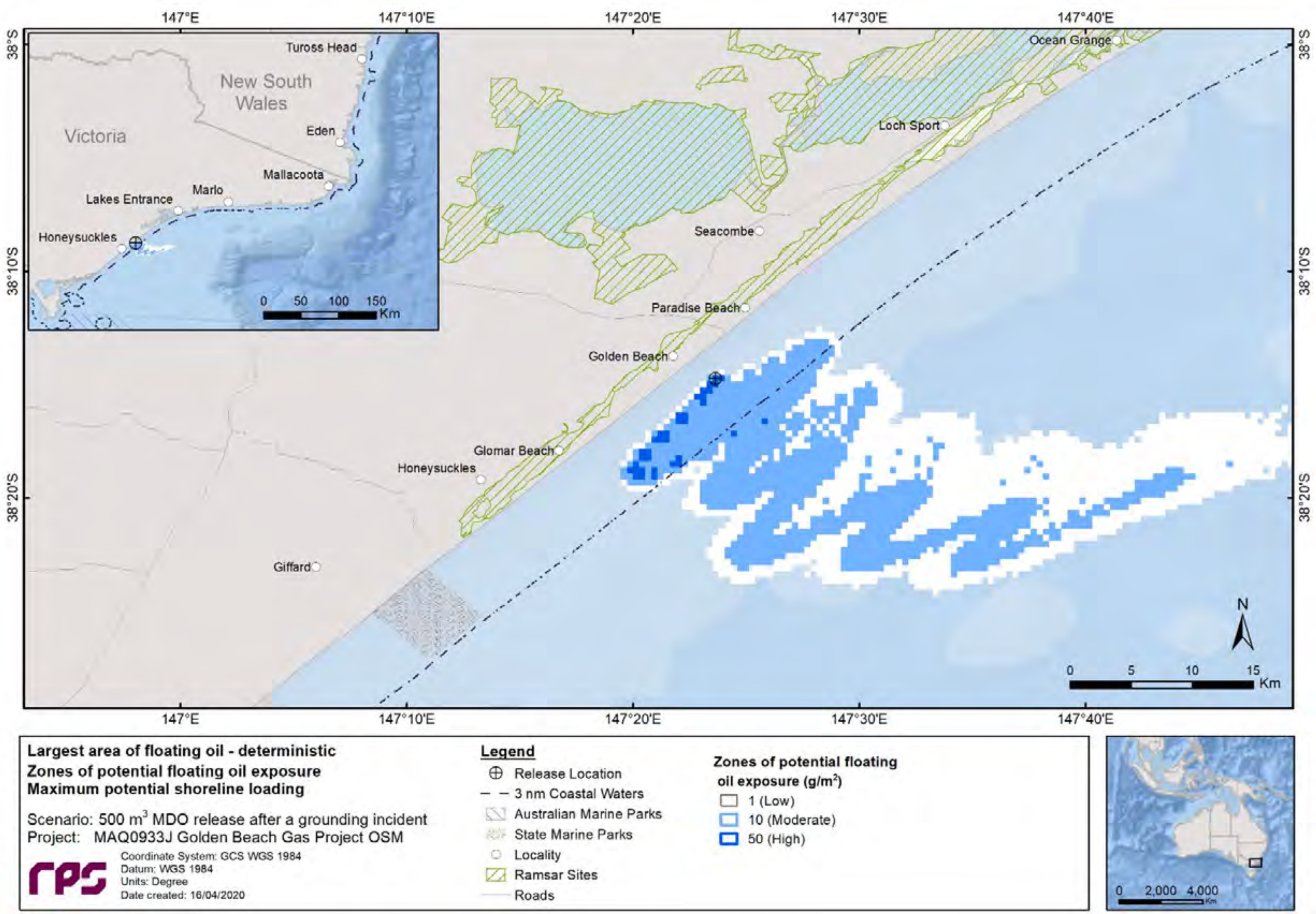


Figure 9.5. Predicted zones of potential floating oil exposure over the entire simulation for the identified deterministic trajectory from a 500 m^3 surface release of MDO over 6 hours, in the event of a pipelay vessel grounding incident, tracked for 30 days, starting 9 pm 16th May 2014

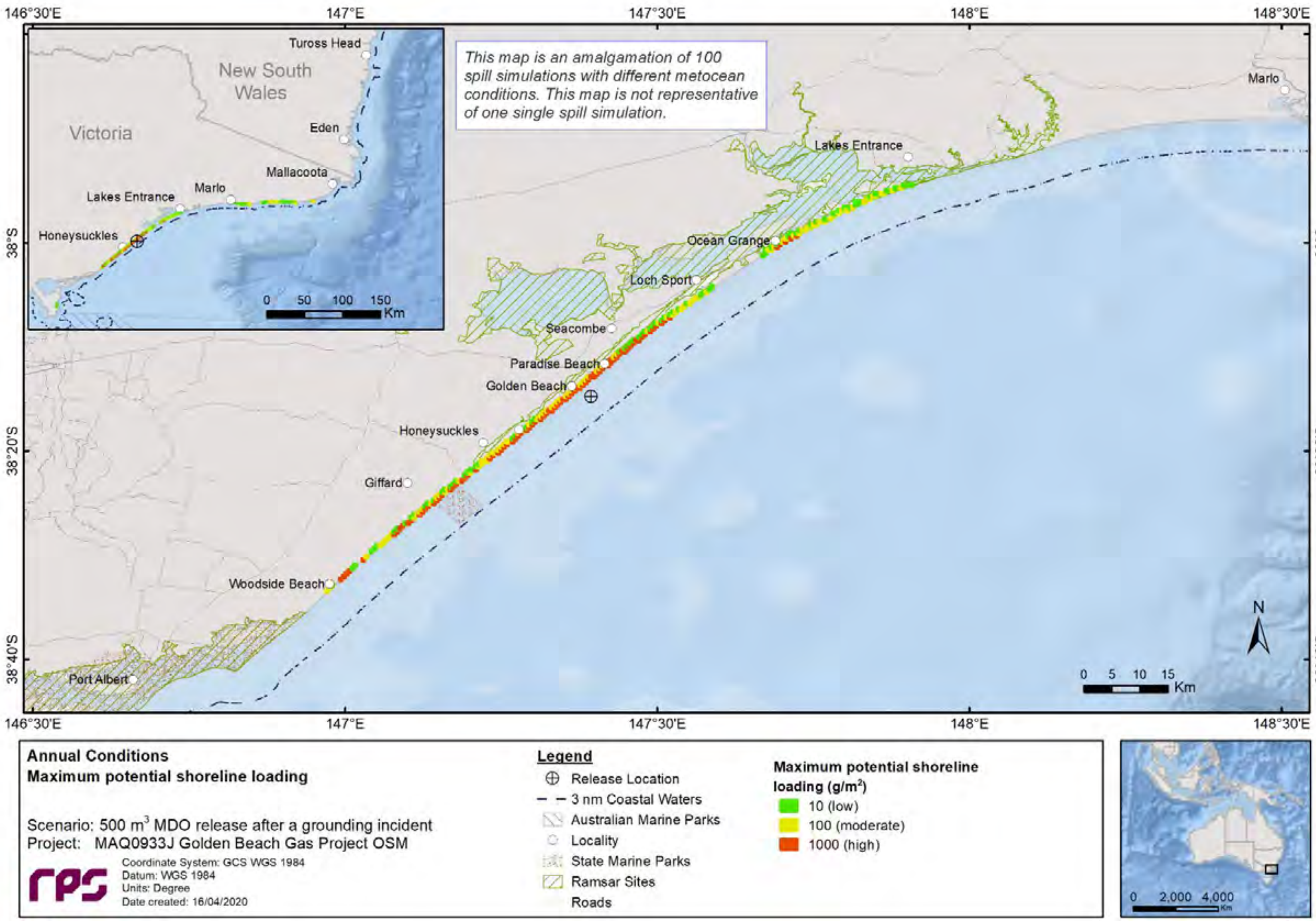


Figure 9.6. Predicted maximum shoreline loading resulting from a 500 m^3 surface release of MDO over 6 hours, in the event of a pipelay vessel grounding incident during the pipeline installation phase

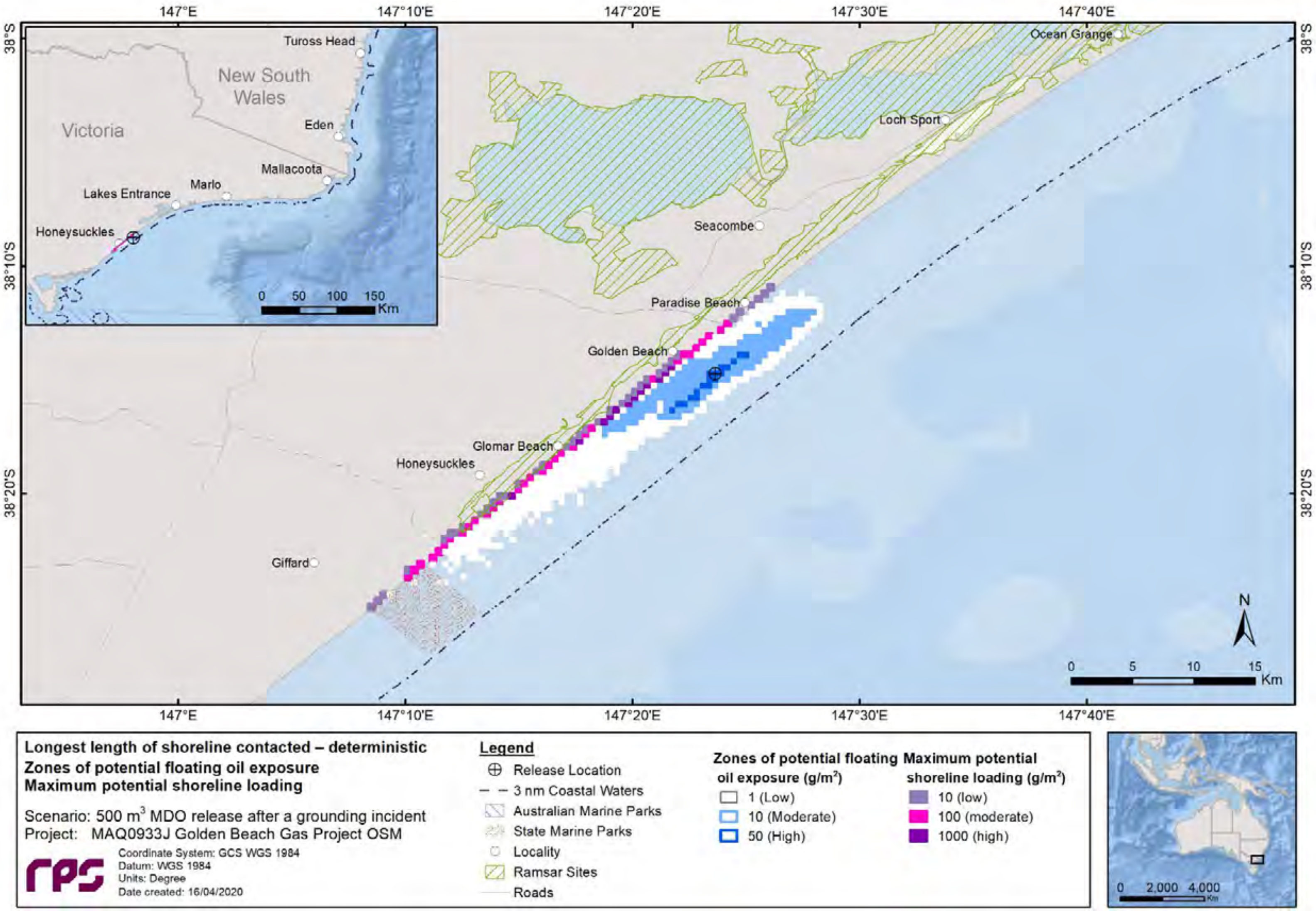


Figure 9.7. Predicted longest length of shoreline exposure over the entire simulation for the identified deterministic trajectory from a 500 m^3 surface release of MDO over 6 hours, in the event of a pipelay vessel grounding incident, tracked for 30 days, starting 2 pm 15th November 2013

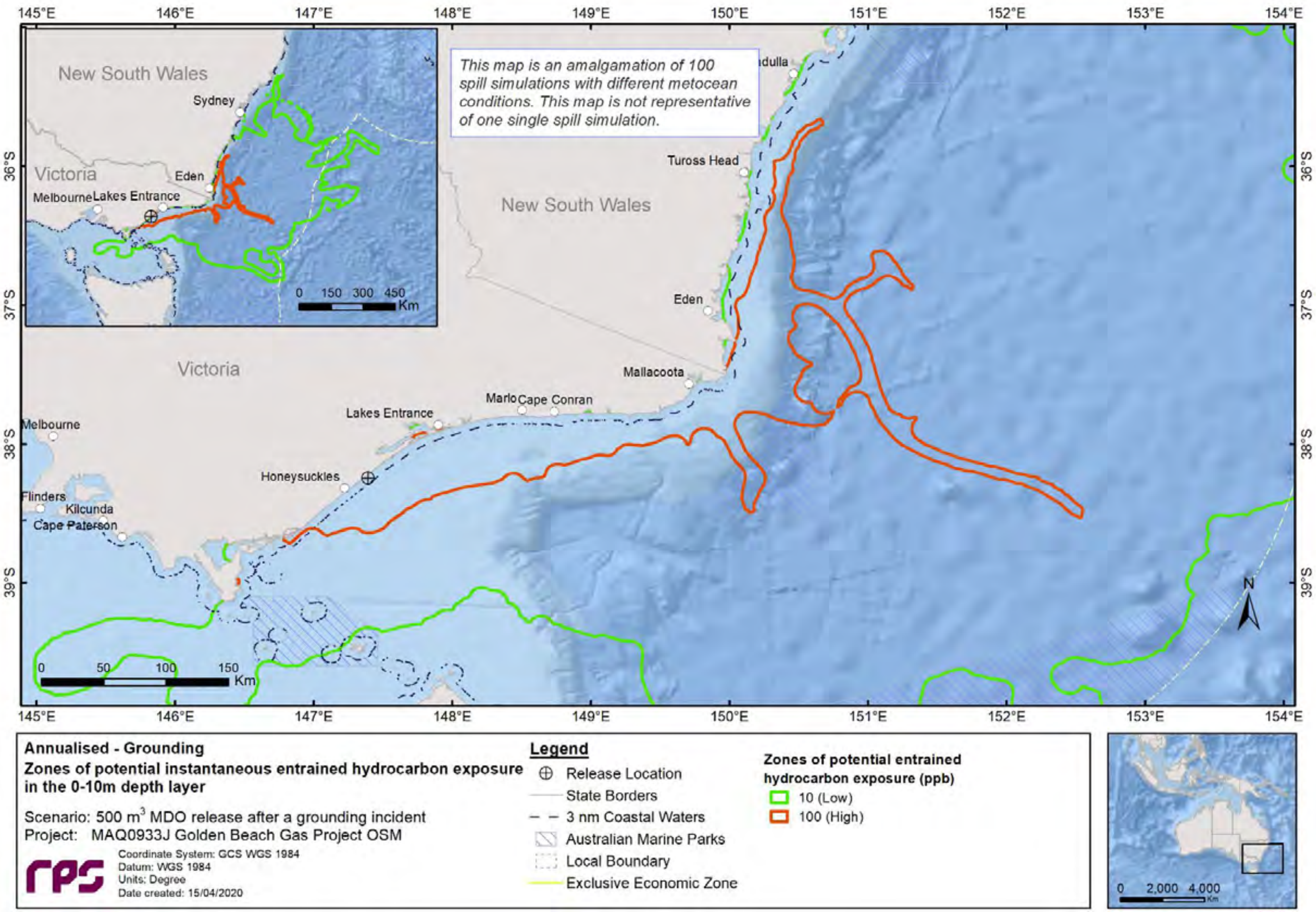


Figure 9.8. Predicted zones of potential entrained hydrocarbon exposure resulting from a 500 m³ surface release of MDO over 6 hours, in the event of a pipelay vessel grounding incident during the pipeline installation phase

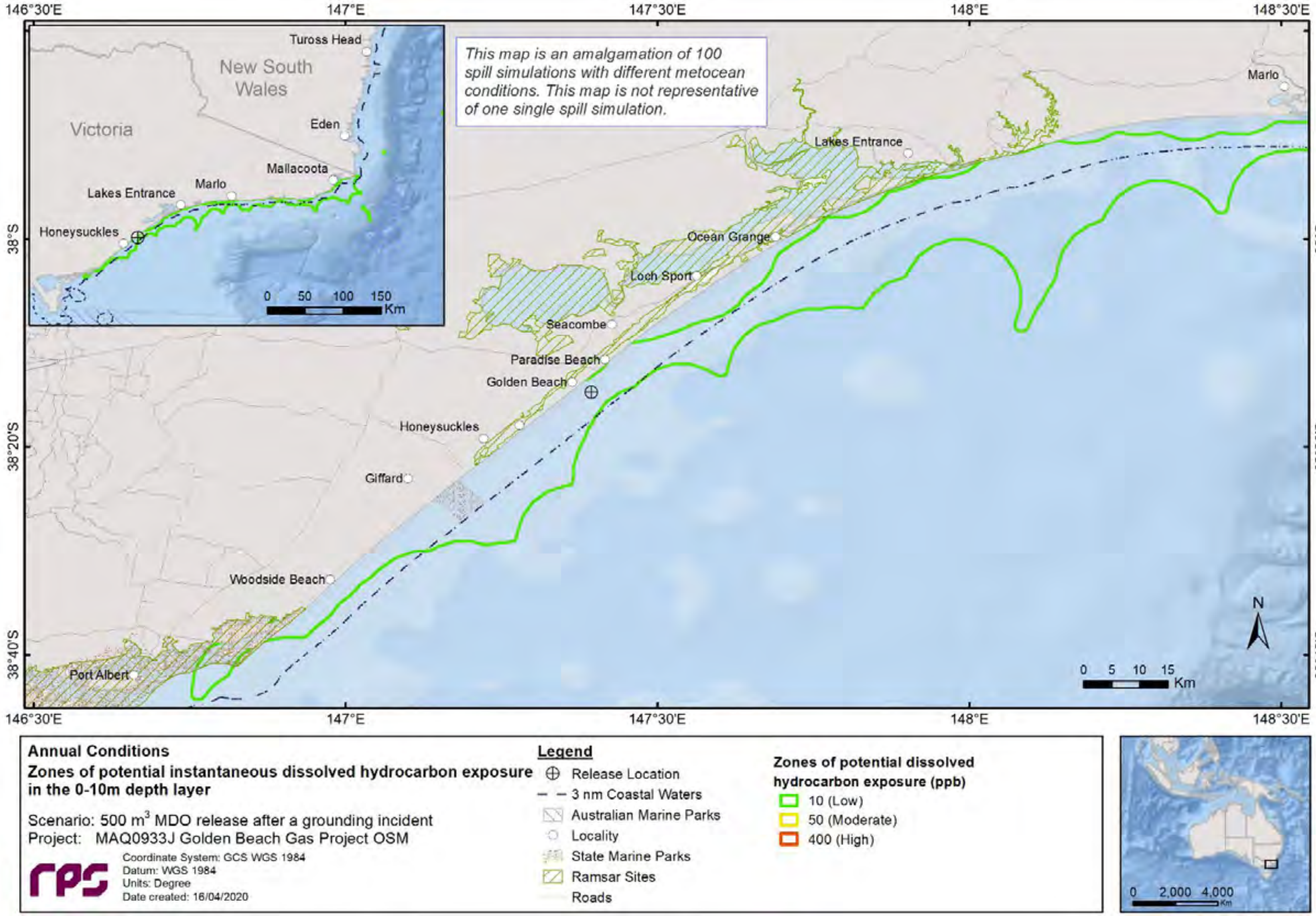


Figure 9.9. Predicted zones of potential dissolved hydrocarbon exposure resulting from a 500 m³ surface release of MDO over 6 hours, in the event of a pipelay vessel grounding incident during the pipeline installation phase

9.13.2. Potential Environmental Risks

The known and potential risks of an MDO spill are:

- A temporary and localised reduction in water quality;
- Injury or death of marine fauna and seabirds exposed to the MDO; and
- Habitat damage where the spill reaches shorelines.

9.13.3. EMBA

The EMBA for a 500 m^3 spill of MDO is illustrated in Figure 9.4 to Figure 9.9. Receptors most at risk within this EMBA, whether resident or migratory, are:

- Plankton;
- Fish;
- Turtles;
- Cetaceans;
- Pinnipeds;
- Avifauna; and
- Shoreline habitats.

9.13.4. Evaluation of Environmental Risks

The criteria used to determine the sensitivity of the receptors discussed in the risk assessments in this section is provided in Table 8.44 in the previous chapter (Section 8.15).

The effects of hydrocarbons to the receptors within the pipelay vessel spill EMBA are the same as those outlined in Table 8.45 to Table 8.54 in Section 8.15.

Table 9.30 to Table 9.39 in this section focus on the impacts to these receptors based on the OSTM results.

Table 9.30 Potential risks of hydrocarbons on benthic assemblages

General sensitivity to oiling – benthic assemblages		
The potential risks of hydrocarbons on benthic assemblages are the same as those described in Table 8.45.		
Potential risks from this scenario		
Sea surface	Water column	Shoreline
Not applicable.	No predicted exposure.	Shoreline oiling is predicted for a long section of the coastline between Woodside Beach and Lakes Entrance. Intertidal benthic species would be exposed to MDO (albeit weathered, dependent on the distance from the spill). Resident fauna such as worms, molluscs and crustaceans may suffer lethal impacts where high and moderate hydrocarbon loadings penetrate into the sediments and persist, especially in highly productive sheltered shorelines where hydrocarbon is more likely to be retained. As most of the shoreline of the EMBA is exposed coastline, these impacts are unlikely to occur except except at very isolated sections of the shoreline. Long-term depletion of intertidal fauna could have an adverse effect on birds or fish that use this habitat as feeding grounds. Where oiling is heavy, impacts on nearshore benthic fauna could be significant. While MDO penetrates porous sediments (such as sand) quickly, it is also washed off quickly (and weathered within sediments) by waves (NOAA, 2012), thus minimising impacts to intertidal fauna. The consequence of MDO stranding (ecosystem function) on benthic assemblages is **moderate**.

Table 9.31. Potential risks of hydrocarbons on macroalgal communities

General sensitivity to oiling – macroalgal communities		
The potential risks of hydrocarbons on macroalgal communities are the same as those described in Table 8.46.		
Potential risks from this scenario		
Sea surface	Water column	Shoreline
Emergent or floating vegetation in the intertidal and subtidal zone along the coast of eastern Victoria will be exposed to high concentrations of entrained hydrocarbon. Where concentrations of high exposure occur, macroalgal communities are likely to be impacted in the manner described in Table 8.46. There is a 13% and 22% probability of high exposure entrained hydrocarbons at the Cape Howe MNP and Point Hicks MNP, respectively, where there is a potential presence of the Giant Kelp Marine Forests TEC. There are no other areas of high threshold entrained hydrocarbon exposure in nearshore areas (i.e., <30 m deep) where the Giant Kelp Marine Forests potentially occur. Strong wave-action, an exposed coastline and the light characteristics of MDO all assist in the rapid dispersal and dilution of the MDO. The consequence to macroalgae communities is **moderate**.		Not applicable.
Because MDO will be highly weathered and in small volumes if it reached the sites of possible		

occurrence of the Giant Kelp Marine Forests TEC, a spill will not have a 'significant' impact on the Giant Kelp Marine Forests TEC (see Section 6.4.5) when assessed against the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013), as outlined in Table 8.46.

Table 9.32. Potential risks of hydrocarbons on plankton

General sensitivity to oiling - plankton		
The potential risks of hydrocarbons on plankton are the same as those described in Table 8.47.		
Potential risks from this scenario		
Sea surface	Water column	Shoreline
Plankton found in open waters of the EMBA is expected to be widely represented within waters of the wider Bass Strait region. Plankton in the upper water column is likely to be directly (e.g., through smothering and ingestion) and indirectly (e.g., toxicity from decrease in water quality and bioaccumulation) affected by dissolved and dispersed hydrocarbons. Once background water quality conditions are re-established, plankton populations are expected to recover rapidly due to the recruitment of plankton from surrounding waters and reproduction by survivors. The consequence (ecosystem function) of this MDO spill scenario to plankton is **moderate**.		Not applicable.

Table 9.33. Potential risks of hydrocarbons on pelagic fish

General sensitivity to oiling – pelagic fish	
The potential risks of hydrocarbons on pelagic fish are the same as those described in Table 8.48.	
Potential risks from this scenario	
Sea surface and water column	Shoreline
Because the majority of fish tend to remain in the mid-pelagic zone, they are not likely to come into contact with surface hydrocarbons. Some syngnathid species associated with nearshore reefs and rafts of floating seaweed may come into contact with surface oil. NOAA (2012) and ITOPF (2011a) state that MDO spills in open water are so rapidly diluted that fish kills are rarely observed. The predicted impact from surface oiling on fish is considered to be negligible at a population level. The area affected by dissolved hydrocarbons at the moderate threshold (where toxicity effects may be triggered) is absent. The area affected by the high threshold for entrained hydrocarbons is extensive. Fish exposed to hydrocarbons at this concentration for an extended period may experience sub-lethal or toxic effects. Given the highly mobile nature of fish and the well-mixed nature of Bass Strait waters, the consequence (ecosystem function, threatening process) of toxicity impacts to pelagic fish from entrained hydrocarbons is **moderate**.	Not applicable.

Table 9.34. Potential risks of hydrocarbons on cetaceans

General sensitivity to oiling - cetaceans		
The potential risks of hydrocarbons on cetaceans are the same as those described in Table 8.49.		
Potential risks from this scenario		
Sea surface	Water column	Shoreline
The OSTM shows that the moderate exposure zone for surface hydrocarbons will overlap the foraging BIAs for southern right whales and pygmy blue whales. This zone of exposure is very small compared to their overall migration and foraging grounds. The biological consequences of physical contact (when surfacing to breath) with very localised areas of moderate to high concentrations of hydrocarbons at the sea surface are unlikely to lead to any long-term impacts, with temporary skin irritation and very light fouling/matting of baleen plates likely to occur (it is unknown whether the latter would affect feeding ability). If large quantities of zooplankton (key prey) exposed to the spill were ingested, chronic toxicity impacts to baleen whales may occur. The consequence (impact on threatened and migratory species) is predicted to be **moderate**.	The area affected by dissolved hydrocarbons at the moderate threshold (where toxicity effects may be triggered) is absent. The area affected by the high threshold for entrained hydrocarbons is extensive. At this threshold, there may be sub-lethal toxicity effects to sensitive species, such as cetaceans. Highly mobile and transient species such as cetaceans moving through an area of hydrocarbons at this exposure concentration makes it unlikely that individual cetaceans would experience acute or chronic toxicity effects of the oil due to accumulation nor would population level impacts be likely. The area potentially impacted by entrained hydrocarbons at the high threshold represents a very small area of cetacean BIAs, so the consequence (impact on threatened and migratory species) to cetacean populations is **moderate**.	Not applicable.
This MDO spill scenario will not have a ‘significant’ impact on threatened cetacean species (see Section 6.3.5) when assessed against the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013), as presented in Table 8.49.		

Table 9.35. Potential risks of hydrocarbons on pinnipeds

General sensitivity to oiling - pinnipeds		
The potential risks of hydrocarbons on pinnipeds are the same as those described in Table 8.50.		
Potential risks from this scenario		
Sea surface	Water column	Shoreline
The foraging range for fur-seals may be temporarily exposed to MDO at the sea surface. As fur-seals forage for prey within the water column rather than at the sea surface, exposure to oil at the sea surface will only result when resting at surface or entering and exiting the water.	The area affected by dissolved hydrocarbons at the moderate threshold (where toxicity effects may be triggered) is absent. The area affected by the high threshold for entrained hydrocarbons is extensive. At this threshold, there may be sub-lethal toxicity effects to sensitive species,	There is no risk of MDO stranding along shorelines known to be used by fur-seals as breeding or haul-out sites. As such, it is unlikely that oiling of fur-seals will occur on shorelines.

Depending on the duration of time spent at the sea surface, exposure may result in irritation to mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, and anal and urogenital orifices. If seals inhale large volumes of volatile vapours within a fresh area of an MDO slick, acute or chronic toxicity impacts may eventuate. Given the generally brief time spent at the sea surface, permanent injury or mortality is unlikely to occur. The consequence (impact on threatened and migratory species) to individual animals and local populations is **minor**.	such as pinnipeds. Given that fur-seals forage for prey within the water column, exposure to hydrocarbons (either via ingestion of contaminated prey or direct contact with oil droplets) may occur, however the small amount of prey ingested by an individual in a spill-affected area would not be likely to impart permanent injury or mortality. There is also a low probability that pinnipeds would be feeding exclusively on prey found in these areas of higher hydrocarbon thresholds for long periods of time. The consequence (impact on threatened and migratory species) to individual animals and local populations is **moderate**.	Given the rocky nature of haul-out sites and their ability to self-clean, heavy oiling of pinnipeds at shorelines in general is not expected. The consequence (impact on threatened and migratory species) to individual animals and local populations is therefore **minor**.

Table 9.36. Potential risks of hydrocarbons on marine reptiles

General sensitivity to oiling – marine reptiles	
The potential risks of hydrocarbons on marine reptiles are the same as those described in Table 8.51.	
Potential risks from this scenario	
Sea surface and water column	Shoreline
Some individual vagrant marine reptiles may come into contact with localised areas of low to high hydrocarbon exposure on the sea surface and in the water column. This may result in irritation of skin or cavities. Due to the absence of turtle BIAs in Bass Strait and the low number of turtles migrating through Victorian waters in general, the consequence (impact on threatened and migratory species) to turtle populations is **minor**.	There are no turtle nesting beaches within the EMBA, so impacts to turtles from shoreline oiling will not occur.

Table 9.37. Potential risks of hydrocarbons on seabirds and shorebirds

General sensitivity to oiling – seabirds and shorebirds		
The potential risks of hydrocarbons on seabirds and shorebirds are the same as those described in Table 8.52.		
Potential risks from this scenario		
Sea surface	Water column	Shoreline
The threatened seabird species likely to occur in the EMBA, such as albatross and petrels, forage over an extensive area and are distributed over a wide geographic area. Seabirds rafting, resting,	The area affected by dissolved hydrocarbons at the moderate threshold (where toxicity effects may be triggered) is absent. The area affected by	The maximum length of shoreline predicted to be exposed to shoreline loading of hydrocarbons that may have biological impacts to birds (100 g/m^2) is 20 km. This section of coastline comprises mostly wide sandy beaches that provides habitat for shorebird species

diving or feeding at sea have the potential to come into contact with oil, ranging from low to high exposure. Given the extensive ocean foraging habitat available to species such as albatross and petrel and the small area and temporary nature of MDO on the sea surface at a threshold likely to result in toxicity impacts, makes it unlikely that a spill will limit their ability to forage for unaffected prey. The absence of breeding colonies or nesting areas in the EMBA for albatross and petrel further limits potential exposure to spilled MDO. The consequence (impact on threatened and migratory species) to seabirds is **moderate**.	the high threshold for entrained hydrocarbons is extensive. There is a low probability that seabirds or shorebirds would be feeding exclusively or predominantly on fish found in this area of higher hydrocarbon threshold, meaning there is low probability of seabirds themselves experiencing sublethal or toxic impacts as a result of consuming hydrocarbon-tainted fish. The consequence (impact on threatened and migratory species) to seabirds and shorebirds is **moderate**.	such as hooded plovers, terns and penguins, and nesting habitat for seabird species. MDO is unlikely to persist on the surface of sandy beaches because it quickly penetrates porous sediments (NOAA, 2012). This behaviour limits the duration of exposure to fauna on the shoreline. Shorebirds foraging for food in intertidal areas or along the splash zone may ingest weathered hydrocarbons that may be brought back to nests. Hydrocarbon entering the sandy nests of hooded plovers, terns or other bird species is likely to percolate through the sand and not accumulate in the feathers of adults or young. Toxicity effects from ingestion of contaminated prey caught in the intertidal zone or from direct exposure or transport back to are unlikely, as only very short sections of coastline may be impacted by fresh (rather than weathered oil). The seabird and shorebird species likely to occur within the EMBA have a wide geographic range, meaning that impacts to individuals or a local population at one location will not necessarily extend to populations at other un-affected locations. The consequence (impact on threatened and migratory species) to seabirds and shorebirds is **moderate**.
This MDO spill scenario will not have a ‘significant’ impact on migratory shorebird species (see Section 6.3.8) when assessed against the *EPBC Act Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act-listed migratory shorebird species Policy Statement 3.21* (DoEE, 2017), as presented in Table 8.52. Similarly, this MDO spill scenario will not have a ‘significant’ impact on threatened seabird species (see Section 6.3.8) when assessed against the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013), as presented in Table 8.52.		

Table 9.38. Potential risks of hydrocarbons on sandy beaches

General sensitivity to oiling – sandy beaches
The potential risks of hydrocarbons on sandy beaches are the same as those described in Table 8.53.
Potential risks from this scenario
Shoreline
The maximum length of shoreline predicted to be exposed to shoreline loading of hydrocarbons that may have biological impacts (100 g/m^2) is 20 km. This coastline is dominated by wide sandy beaches. With the shortest time to shoreline accumulation being 3 hours, the hydrocarbons will have only partially weathered by the time they strand. The area of shoreline subject to moderate and high loadings would likely result in acute toxicity, and death, of many invertebrate communities, especially as the MDO will easily penetrate into sandy sediments. However, tidal action is expected to lead to rapid weathering of any hydrocarbons in the intertidal area and the populations of these communities would be likely to rapidly recover. The consequence to sandy beaches is **moderate**. Short-term impacts to tourism and other human uses of the beach may occur as a result of temporary beach closures to protect human health or due to perceptions of a polluted environment.

Table 9.39. Potential risks of hydrocarbons to commercial fishing

General sensitivity to oiling – commercial fishing			
The potential risks of hydrocarbons on commercial fishing are the same as those described in Table 8.54.			
Potential risks from this scenario			
Fishery	Surface waters	Water column	Shoreline
General	A short-term fishing exclusion zone may be implemented by the VFA and/or AFMA. Given the temporary nature of any surface slick and the low fishing intensity in the EMBA, there are unlikely to be any significant impacts on fisheries in terms of lost catches (and associated income). The consequence (business) to fisheries in terms of lost catches (and associated income) is **minor.**	As illustrated in Figures 9.4 to 9.9, there is the probability of exposure to dissolved (low exposure only) and entrained (low and high) hydrocarbons in the water column. In general, depuration of hydrocarbons from fish tissue is rapid and thus the consequence (business) to fisheries (in terms of reduced catch or tainted catch) from hydrocarbon exposure in the water column is **minor**. However, a~~A~~ short-term fishing exclusion zone and taint monitoring program may be implemented by fishery management authorities, which may have **moderate** consequences for fishing operators.	Vessels use local ports, which are not included within the EMBA. As such, there should be no impacts to vessels while moored in port.
Victorian fisheries within the 500 m^3 MDO spill EMBA			
Scallop	No impacts due to their benthic habitat.	Hydrocarbons are not expected to accumulate among benthic sediments in areas fished for scallops. Therefore, the consequence to this fishery and its catch species is **negligible.**	As per 'general.'
Abalone	No impacts due to their benthic habitat.	The most heavily fished areas of the fishery are located off the east coast of Victoria, which is exposed to areas of low exposure entrained and dissolved hydrocarbons. A temporary closure of the area affected by hydrocarbons may be implemented. This is	As per 'general'.

		expected to be of **minor** consequence (business) to the overall function and long-term viability of the fishery or its catch species.	
Wrasse	No impacts due to their pelagic habitat.	The EMBA by entrained and dissolved MDO intersects large areas of the wrasse fishery. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence (business) to the overall function of the fishery or its catch species.	As per 'general'.
Rock lobster	No impacts due to their benthic habitat. There is potential for lobster pot buoys to accumulate hydrocarbons if they are set at the time of a spill. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	No predicted exposure at the seabed.	As per 'general.'
Ocean access	No impacts to fish due to their pelagic habitat. Longlines may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	The most heavily fished areas of the fishery are located off Lakes Entrance, which is exposed to a large area of entrained hydrocarbons and may result in sub-lethal or toxicity impacts to target species. A temporary closure of the area affected by hydrocarbons may be implemented. This may have a small impact on the overall function of the fishery or its catch species and is therefore considered to have a **minor** consequence (business).	As per 'general.'
Ocean purse seine	No impacts to fish due to their pelagic habitat. Surface buoys marking gillnet locations may accumulate hydrocarbons if they are set at the time of a spill. Vessel	The most heavily fished areas of the fishery are located off Lakes Entrance and fished by one licence holder. This area is exposed	As per 'general.'

	hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	to a large area of entrained hydrocarbons and may result in sub-lethal or toxicity impacts to target species. A temporary closure of the area affected by hydrocarbons may be implemented. This may have an impact on the function of the single-licence fishery or its catch species and is therefore considered to have a **minor** consequence (business).	
Inshore trawl	No impacts to fish due to their benthic habitat. Warp wires may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	This fishery has access to the entire Victorian coastline (except for bays and reserves), so only a part of the available fishing grounds are exposed to high exposure entrained and dissolved MDO. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence (business) to the overall function and long-term viability of the fishery or its catch species.	As per ‘general.’
Commonwealth fisheries within the 500 m^3 MDO spill EMBA			
Southern squid jig	The key fishing area of southwest Victoria makes it highly unlikely that the fishery operates in the EMBA.	The most heavily fished areas of the fishery within the EMBA are located off the east coast of Victoria, which is exposed to a large area of entrained hydrocarbons and may result in sub-lethal or toxicity impacts to squid. A temporary closure of the area affected by hydrocarbons may be implemented. This may have a small impact on the overall function of the fishery or its catch species and is therefore considered to have a **minor**	As per ‘general.’

		consequence (business).	
SESS - gillnet & shark hook	Surface buoys marking gillnet locations may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	The most heavily fished areas of the fishery are located off the east coast of Victoria, which is exposed to a large area of entrained hydrocarbons, though this is unlikely to result in sub-lethal or toxicity impacts to sharks given their high mobility (i.e., they are unlikely to remain in an area of high hydrocarbon exposure for long enough to experience toxicity effects). A temporary closure of the area affected by hydrocarbons may be implemented. This may have a small impact on the overall function of the fishery or its catch species and is therefore considered to have a **minor** consequence (business).	As per ‘general.’
SESS - Commonwealth trawl sector	Warp wires may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned.	The most heavily fished areas of the fishery are located off the far east coast of Victoria, which is exposed to a large area of entrained hydrocarbons, though this is unlikely to result in sub-lethal or toxicity impacts to target species given their high mobility (i.e., they are unlikely to remain in an area of high hydrocarbon exposure for long enough to experience toxicity effects). A temporary closure of the area affected by hydrocarbons may be implemented. This may have a small impact on the overall function of the fishery or its catch species and is therefore considered to have a **minor** consequence (business).	As per ‘general.’

9.13.5. Risks to MNES

A 500 m^3 MDO spill during pipeline installation will not have significant risks to MNES, as outlined in Table 9.40.

Table 9.40. Risks to MNES from an MDO release

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore. It is unlikely that MDO of high enough concentration will enter the lakes system (through the Lakes Entrance channel) to result in significant impacts. Any oil reaching the entrance will be highly weathered.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the seasonality of presence of most threatened and migratory marine species, their temporary presence swimming through the area and the rapid weathering of MDO. Impacts to migratory shorebirds, in accordance with EPBC Act Policy Statement 3.21, will not be significant. There is no habitat critical to any threatened or migratory marine species restricted to this spill EMBA. This is detailed in Table 9.30 to Table 9.38.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The East Gippsland and Beagle AMPs are intersected by entrained hydrocarbons. The minimum time in which they are contacted is 6 days, meaning the MDO will be weathered and non-toxic. Impacts will therefore not be significant.
- TECs (see Section 6.4.5)	No	Areas of the subtropical and temperate coastal saltmarsh TEC are intersected by the EMBA. However, this TEC is distributed along much of the central and eastern Victorian coast and into NSW. Therefore, no significant impact on the TEC is expected. Potential occurrence of the Giant Kelp Marine Forests of South east Australia TEC is also intersected by the EMBA at Point Hicks and Mallacoota. However, this TEC is distributed along much of the Tasmanian and western Victorian coast. Therefore, no significant impact, in accordance with the Significant Impact Guidelines 1.1, is expected on the TEC (see

MNES	Impact?	Notes
		Table 9.31). Due to the well-mixed nature of the waters of the EMBA (and therefore short exposure time to MDO) and the low concentrations of MDO in this part of the EMBA, coating of macroalgae by hydrocarbons is considered highly unlikely, and therefore significant impacts are not likely.
- KEFs (see Section 6.4.7)	No	The Upwelling East of Eden KEF is intersected by entrained and dissolved hydrocarbons. This would not impact on its values, but if the spill occurs at the time of an upwelling, there is the potential for more plankton to be exposed to hydrocarbons (as they 'bloom' in response to the cold water upwelling).

9.13.6. Risk Assessment

Table 9.41 presents the risk assessment for an MDO spill during pipeline installation.

Table 9.41. Risk assessment for an MDO spill

Summary		
Summary of risks	Water pollution. Pollution of marine and shoreline habitats. . Injury or death of marine fauna and seabirds through ingestion or contact. Disruption to fisheries operations.	
Extent of risk	As illustrated in Figure 9.4 to Figure 9.9. Up to: • 349 km for MDO on the sea surface; • 40.5 km of shoreline contact (maximum of 297 m^3); • 914 km for entrained MDO; and • 359 km for dissolved MDO.	
Duration of risk	Short-term (days to weeks, depending on level of contact, location and receptor).	
Level of certainty of risks	HIGH. Spill source volumes are limited in size, the environmental impact of MDO is well understood, a credible spill volume has been modelled and a very conservative threshold has been selected to define the EMBA.	
Initial management measures		
Performance outcome	Performance standard (control)	Measurement criteria
Preventative controls as per 'Interference with Third-party vessels' and avoidance measures for 'Seabed disturbance.' Additional controls are provided here.		
Minimise *Preparedness*		

Vessel crews are prepared to respond to a spill.	The vessels have approved SMPEPs (or equivalent appropriate to class) that is implemented in the event of a large MDO spill.	Current SMPEPs are available.
	Vessel crews are trained in spill response techniques in accordance with their SMPEP.	Training records verify that all marine crew are trained in spill response.
	In accordance with the SMPEP, oil spill response kits are available in relevant locations around the vessels, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for MDO spills to deck record that the spill is cleaned up using SMPEP resources.
Reporting		
Reporting and monitoring of an MDO spill will take place in accordance with the EP and OPEP.	GB Energy will report the spill to regulatory authorities within 2 hours of becoming aware of the spill.	Incident reports verify that contact with regulatory agencies was made within 2 hours of GB Energy becoming aware of the spill.
Response		
Vessel Master will initiate action to reduce fuel loss in the event of a tank rupture.	The Vessel Master will authorise actions in accordance with the vessel-specific SMPEP (or equivalent according to class) and the activity-specific OPEP to limit the release of MDO.	Daily operations reports verify that the SMPEP and OPEP were implemented.

Risk assessment (initial)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Moderate	Unlikely	Low
Macroalgal communities	Moderate	Unlikely	Low
Plankton	Moderate	Unlikely	Low
Pelagic fish	Moderate	Unlikely	Low
Cetaceans	Moderate	Unlikely	Low
Pinnipeds	Moderate	Unlikely	Low
Marine reptiles	Minor	Unlikely	Low
Seabirds	Moderate	Unlikely	Low
Shorebirds	Moderate	Unlikely	Low
Sandy beaches	Moderate	Unlikely	Low
Commercial fisheries	Minor	Unlikely	Low

Additional management measures		
Performance outcome	Performance standard (control)	Measurement criteria
Preventative controls as per 'Interference with Third-party vessels' and avoidance measures for 'Seabed disturbance.' Additional controls are provided here.		

Prevent No MDO is spilled to sea.	No pipelay or support vessel refuelling will be undertaken at sea (this will be done in port).	Bunker log verifies that refuelling was undertaken in port.
Minimise *Preparedness*		
Vessel crews are prepared to respond to a spill.	Within 4 weeks of the vessels mobilising to site, a desktop oil spill response exercise will be conducted to test interfaces between the SMPEPs, OPEP, NatPlan and VicPlan.	OPEP Exercise Report records verify oil spill response exercise has been undertaken.

Risk assessment (residual)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Moderate	Rare	Low
Macroalgal communities	Moderate	Rare	Low
Plankton	Moderate	Rare	Low
Pelagic fish	Moderate	Rare	Low
Cetaceans	Moderate	Rare	Low
Pinnipeds	Moderate	Rare	Low
Marine reptiles	Minor	Rare	Very low
Seabirds	Moderate	Rare	Low
Shorebirds	Moderate	Rare	Low
Sandy beaches	Moderate	Rare	Low
Commercial fisheries	Minor	Rare	Very low

Environmental Monitoring

- As per the OPEP.

Record Keeping

- Vessel crew induction presentation.
- Vessel crew training records.
- Oil spill response exercise records.
- SMPEPs.
- Incident reports.
- OPEP daily operations reports.
- OSMP daily operations reports/overall study reports.

9.14. Oil Spill Response Activities

Section 8.17 in the drilling EIA chapter details the MDO spill response strategies that may be applied in the event of a 155 m^3 MDO spill. The same response strategies are relevant to the 500 m^3 MDO spill scenario, because although the extent of the dissolved and entrained hydrocarbons is larger in the 500 m^3 MDO spill scenario, responses can only be put in place for MDO at the sea surface or stranded on the shoreline, and the extent of impacts for both spill scenarios in this regard is similar.

10. Risk Assessment – Gas Extraction and Injection (Operations)

This section describes the risks identified for the operations phase of the Project using the methodology described in Chapter 7 of this report.

The EIA presented in this section follows the same structure as that for Chapter 8 (drilling and wellhead installation) and Chapter 9 (pipeline installation) and presents the latest information on the Project's proposed operations, noting that more detail will be included in the operations phase EP (for submission to the DJPR ERR Branch under the OPGGS Regulations) as more detailed engineering design becomes available.

GB Energy will determine the inspection and maintenance intervals as part of the development of the final inspection plans, which will be outlined in the Operations EP.

The primary activity associated with this phase of the Project (other than the extraction, injection and storage of hydrocarbons) are the activities of ISVs. As noted in Section 3.7, ISVs will be required to undertake a range of IMMR activities on the water in accordance with the IMMR schedule. The exact frequency and duration of IMMR activities is currently indicative only.

A summary of the impact and risk ratings for each impact identified and assessed in this chapter is presented in Table 10.1.

Table 10.1. Operations phase environmental risk rating summaries

Risk		Initial risk	Residual risk
1	Seabed disturbance (ecosystem function)	Low	Low
2	Generation of underwater sound – (threatening processes)	Low	Low
	– (threatened and migratory species)	Medium	Low
	– (ecosystem function)	Low	Low
3	Atmospheric emissions (threatening processes)	Low	Very low
4	Light emissions – (ecosystem function)	Low	Very low
	– (threatening processes)	Low	Low
	– (threatened and migratory species)	Low	Low
5	Discharge of sewage and grey water (ecosystem function)	Low	Very low
6	Discharge of cooling and brine water (ecosystem function)	Low	Very low
7	Discharge of bilge water and deck drainage (ecosystem function)	Low	Low
8	Discharge of control fluids (threatening processes)	Low	Low
9	Accidental overboard release of waste (threatening processes)	Low	Very low

Risk		Initial risk	Residual risk
10	Introduction of IMS – environmental (ecosystem function)	High	Medium
	– business (commercial fisheries)	Medium	Medium
11	Displacement of or interference with third-party vessels – displacement	Low	Very low
	– interference	Low	Low
12	Vessel strike with megafauna – individuals (threatening process)	Low	Low
	– population (threatening process)	Low	Low
13	Accidental bulk discharge of chemicals or hydrocarbons (threatening process)	Low	Very low
14	Diesel spill – Benthic fauna	Low	Low
	– Macroalgal communities	Low	Very low
	– Plankton	Low	Low
	– Pelagic fish	Low	Very low
	– Cetaceans	Low	Low
	– Pinnipeds	Low	Low
	– Marine reptiles	Low	Very low
	– Seabirds	Low	Low
	– Shorebirds	Low	Low
	– Sandy beaches	Low	Low
	– Commercial fisheries	Low	Very low
15	Dry gas release from a subsea pipeline rupture (ecosystem function)	Very low	Very low
16	Dry gas release from a well blowout (ecosystem function)	Very low	Very low
Hydrocarbon spill response activities		Initial risk	Residual risk
17	Surveillance and tracking (ecosystem function)	Very low	Very low
	Protection and deflection (ecosystem function) – nearshore habitat	Low	Very low
	– shoreline habitat	Low	Very low
	– fauna disturbance	Low	Very low
	Shoreline assessment and clean-up (ecosystem function) – shoreline habitat	Medium	Low
	Oiled wildlife response (threatened and migratory species) – fauna injury	Low	Very low
	– fauna death	Low	Very low

10.1. Seabed Disturbance

10.1.1. Risk Pathway

The following subsea maintenance activities (if required) would result in seabed disturbance:

- Pipeline span rectification;
- Pipeline sandbag/concrete mattress repositioning;
- Blasting (sand or water jet) to removal scale and marine growth from subsea infrastructure;
- Vessel thrusters that stir up sediments, particularly in shallower waters; and
- Vessel anchoring (if required)

10.1.2. Known and Potential Environmental Risks

Seabed disturbance will impact marine receptors because of:

- Physical removal or disturbance of seabed sediments;
- Increase in turbidity of the water column near the seabed; and
- Physical injury or death of benthic fauna (or fouling fauna on infrastructure).

These impacts will be localised (tens of metres along the 2.4 km pipeline corridor) and temporary in duration (hours to days in any one location per IMMR activity).

The geophysical survey undertaken in March 2020 did not identify any shipwrecks within the Project area, so impacts to shipwrecks are not discussed here.

Similarly, no rocky reef has been identified within the offshore Project area (see Section 6.3.1), so there will be no damage to these sensitive ecosystems.

10.1.3. EMBA

The EMBA for seabed disturbance created by the IMMR activities is restricted to tens of metres from the point of the works, depending on the exact activity being undertaken and the sea state in the Project area.

Receptors that are known to occur or may occur within this EMBA are:

- Plankton;
- Benthic species (including fouling species on the subsea infrastructure);
- Demersal fish species; and
- Pelagic species (fish, cetaceans, pinnipeds).

10.1.4. Evaluation of Environmental Risks

Removal or Disturbance of Seabed Sediments

As the shifting sands of the nearshore environment of the Project area move with the currents and tides over time, areas of free span and scour can develop where the pipeline is not adequately supported. This generates risk to pipeline integrity and may require intervention via divers or ROV. IMMR activities that support stabilisation or span rectification of the subsea pipeline, such as placement or repositioning of a concrete mattress or grout bags, are important maintenance activities during pipeline operation. This results in disturbance of the seabed as sediments are displaced or altered. Planned inspection of the pipeline and subsea equipment will be conducted infrequently (e.g., every few years).

As presented in Section 6.1.2, marine habitat assessments undertaken in the Project area indicate that the seabed in the pipeline corridor comprises sandy sediments, which is broadly represented in the region and is of low environmental sensitivity. IMMR activities on the subsea infrastructure will result in the temporary displacement of benthic organisms, with recolonization facilitated soon after the disturbed sediments settle.

In the case of an emergency while a ROV is in use, control of the ROV may be lost. This could result in damage to the seabed on contact with the ROV and could eventually result in the creation of artificial marine habitat if the ROV cannot be retrieved. Given that an emergency situation while a ROV is in use is highly unlikely and the lack of sensitive benthic habitats in the Project area, a significant impact caused by the loss of a ROV is not likely.

While most ISVs involved in IMMR activities will use DP during operation, anchoring may be required by some vessels, or in case of an emergency. Direct contact by anchors and anchor wires/chains can damage seabed habitats and anchoring is likely to be restricted to the shallower areas of the Project area. Any anchoring will follow specific procedures, and anchors will be designed to meet vessel holding criteria, to minimise excessive dragging of the anchor and subsequent disruption to the seabed. In shallower waters, engagement of vessel thrusters may result in the disturbance of seabed sediments.

Surveys of seabed disturbance from anchoring activities indicate that recovery of benthic fauna in soft sediment substrates (such as the sandy seabed) occurs between 6 to 12 months after the disturbance was created (URS, 2001). The anchor depression acts as a trap for marine detritus and sand, which will quickly fill and be recolonised by benthic organisms (Currie and Isaac, 2005).

Given the widespread habitat distribution of the seabed habitat present in the Project area, the localised disturbance that may result from anchoring and the subsequent rapid recovery/recolonisation that will occur, this temporary impact will be negligible.

Reduction in Water Quality

Grout bag installation will involve pumping grout (cement and water) through a hose from the vessel to fill grout bags underwater. Minor leakage of grout may occur during filling of the bags and when the hose is flushed with seawater at the completion of operations, dispersing residual grout into the marine environment. The volume of grout involved is expected to be very low (generally < 50 L).

The release of grout may create a localised increase in the turbidity of the water column, and a localised alteration to sediment composition and/or smothering of the benthos. Cement chemicals selected will be low toxicity, chemically inert and set rapidly in the marine environment.

The level of turbidity associated with this small volume is expected to be negligible given that the cement is designed to set in the marine environment and will therefore not disperse widely. The turbidity resulting from this activity would not be expected to exceed natural levels in the area.

Installation of grout bags is expected to be undertaken within a very short duration of time (less than 1 day) and relatively rapid recovery/recolonisation of any benthic biota disturbed by settling cement material is expected to occur from adjacent areas following sedimentation.

The frequency of release and volumes of grout that may be released to the marine environment are very low and the potential affects would be restricted to the immediate vicinity of the operation. Given the very small extent of effects, the widespread distribution of the habitats involved, and the non-toxic nature of the grout, the consequence is negligible.

Dislodgement of Marine Growth

As part of ongoing maintenance and to facilitate inspections, the removal of marine growth (biofouling) from infrastructure using a ROV and/or divers may be required. Marine growth will be removed with high pressure water blasting, grit blasting or by mechanical means such as a rotary brush or a combination of these, and will likely result in the mortality of the biofouling species. This is unlikely to affect benthic productivity in the Project area due to the limited contribution of the marine growth species on the subsea infrastructure to local productivity. Only beach sand will be used for grit blasting, and preference will be given to water blasting or mechanical removal when possible.

Marine growth removal may result in a localised increase in turbidity, due to the suspended marine growth and grit (if used). Grit and paint chips/flakes generated as a resulted of blasting activities that dislodge and settle on the seabed are not expected to form a physical or chemical impediment to biota settling on or in the seabed sediments. The area of impact will be small (localised around the platform or pipeline) and the dynamic nature of the seabed environment (rapid shifting/mixing of sands) means the impacts are minor.

Given the short duration of any marine growth removal activities, the low toxicity of the grit and the highly localised area that would potentially be impacted the risk of environmental impact is low.

Water Column Turbidity

During some IMMR activities, such as span rectification and abrasive blasting, there is expected to be a temporary increase in turbidity levels within the water column. Considering turbidity levels can be naturally high in this area, fauna are likely to be habituated to natural fluctuations in turbidity and therefore this is not likely to have a discernible impact on marine fauna. This turbidity would limit light penetration into the water column but given its temporary nature and shallow depth of the seabed, it would be unlikely to inhibit primary production. Fish and other mobile species are expected to avoid areas of physical disturbance, though there is some anecdotal evidence of fish being attracted to physical disturbance of the seabed because food items become agitated and therefore become available as food. There is expected to be no direct impact to fish, which are expected to move back into the impacted area soon after the IMR activity is complete.

A turbidity study completed by Chevron as part of the Wheatstone Project in northern Western Australia showed that a turbidity plume from trenching associated with pipeline installation may be evident up to 70 m from the trench area depending on environmental conditions (Chevron, 2014). The results of the survey found that turbidity levels may exceed 80 FTU (compared to the maximum background turbidity level of 5 FTU) up to 50 m from the trenched area. However, the average turbidity level 50 m from the trench area was recorded at approximately 15 FTU. Within two hours of ceasing trenching operations, the turbidity level had returned to background or very close to background levels (Chevron, 2014). Pipeline trenching activities, such as those assessed in this study, would result in a greater amount of disturbed seabed than is necessary to conduct the IMR activities assessed in this section. The 70 m plume identified in the study would likely be much less in the case of activities to be undertaken during the operations phase due to the lower volume of disturbed sediments. In addition, there are no sensitive receptors, such as rocky reef habitat, present within 500 m of the Project area.

There will be no long-term physical change to the characteristics of the seabed and benthic fauna will recolonise disturbed areas rapidly. In the context of the small area of impact to the seabed and the vast area of similar habitat in the region that is continuously subject to disturbance through natural and anthropogenic processes (currents, shifting sands and trawling), IMR activities will have a negligible impact in terms of changes to seabed character and benthic habitats.

10.1.5. Risks to MNES

Seabed disturbance will not have significant risks to any MNES, as outlined in Table 10.2.

Table 10.2. Risks to MNES from seabed disturbance

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	There are no benthic species listed as threatened or migratory in the project area. Threatened fish and cetacean species are likely to temporarily avoid the disturbance caused by IMR activities, which will not result in significant impacts given the small area and temporary nature of impact.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.1.6. Risk Assessment

Table 10.3 presents the risk assessment for seabed disturbance.

Table 10.3. Risk assessment for seabed disturbance

Summary		
Summary of impacts	Removal/disturbance of seabed sediments. Dislodgement/removal of marine growth. Turbidity of the water column at the seabed. Reduction in water quality.	
Extent of impact	Localised – around individual points of disturbance.	
Duration of impact	Temporary – returning to pre-impact condition soon after impact.	
Level of certainty of impacts	HIGH – the impacts of seabed disturbance are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid Avoid physical damage to rocky reef located outside the Project area.	GB Energy provides pipeline alignment data to vessel contractors to enter into their GPS.	Photos of navigation screens verify that information is uploaded.
	Vessel Masters use bathymetric mapping and GPS to avoid mapped rocky reef to the west of the Project area so as to ensure there is clearance at all times between the vessel and rocky reef.	
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Seabed disturbance is kept as local as possible during IMMR activities.	IMMR activities are limited to the immediate works area as per the activity-specific plan (i.e., no indiscriminate sand or water blasting).	Documentation describing the planning undertaken for inspection and maintenance activities demonstrates that work is limited to the immediate work area.
		ROV footage is available and reviewed to ensure disturbance is limited to infrastructure footprint.
	Water blasting or mechanical removal is given preference to grit blasting.	Maintenance activity reports verify that water blasting was considered.

Rehabilitate Large objects dropped overboard will be retrieved wherever possible.	Divers or ROV are deployed to search for (and retrieve, where possible), non-buoyant dropped objects so that there are no obstacles on the seabed at the completion of the activity.	Dive logs verify that a ROV/dive survey took place following a non-buoyant dropped object incident.
	Dropped objects left behind at the end of the activity (that cannot be retrieved) will be reported to DJPR ERR.	Incident report/s verify that the report was issued to DJPR ERR.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Environmental Monitoring		
• Post-activity ROV survey for dropped objects.		
Record Keeping		
• G&G investigations report. • Photos (navigation screens). • GPS records of rocky reef. • Equipment pre-deployment inspections. • Handling and transfer procedure. • Completed handling and transfer checklists. • Crane operator qualification and training records. • PMS records. • PTW records. • Load ratings and load test certificates. • ROV survey footage and operator logs. • Incident reports.		

10.2. Generation of Underwater Sound

10.2.1. Risk Pathway

The following activities will generate underwater sound:

- Vessel operations - engine noise transmitted through the hull, DP thrusters and/or propellers during inspection and maintenance activities;
- Maintenance activities described in Section 10.1;
- Geophysical inspections (e.g., SSS and MBES); and
- Gas flow through the RGP.

10.2.2. Known and Potential Environmental Risks

The known and potential environmental risks resulting from underwater sound are the same as those described in Section 8.2.2.

10.2.3. EMBA

The EMBA for underwater sound is unlikely to be beyond tens of metres (or several hundred metres at most) from the sound source depending on the receptor, as outlined in this section. Receptors that are known to occur or may occur within the underwater sound EMBA, either as residents or migrants, are:

- Benthic species;
- Pelagic species (plankton, fin fish);
- Turtles;
- Cetaceans; and
- Pinnipeds.

10.2.4. Evaluation of Environmental Risks

Activities that generate underwater sound can affect marine fauna by interfering with aural communication, eliciting changes in behaviour and, potentially, causing either acute or chronic physiological damage. For this phase of the Project, gas flow through the pipeline, vessel operations and use of geophysical survey equipment (e.g., SSS or MBES) are expected to generate underwater sound at varying levels over different durations. Each sound source is investigated separately in this section. The information box in Section 8.2.4 describes how underwater sound is measured and referenced.

Gas Flow through the RGP

Sound from the flow of gas through the RGP is expected to be negligible. A study conducted by Glaholt et al (2008) found that sound measurements made over a 25.4 cm (10") diameter subsea high-pressure gas pipeline indicate that the pipeline was not producing any noise. Methods for assessment of operational noise generated from the pipeline included a combination of field measurements, laboratory investigation and pipeline component analysis.

Given the low intensity of gas pipeline noise and the fact that species sensitive to underwater sound, primarily cetaceans, typically occupy ranges over many hundreds or thousands of square kilometres, impacts of sound through a 2.4 km long subsea pipeline on cetacean communication or foraging efficiency are expected to be negligible.

Vessel Sound

The vessels undertaking IMR activities will generate low levels of sound. This is generated from propeller cavitation (the dominant sound source), hydrodynamic flow around the hull and from onboard machinery (Popper *et al*., 2014). The size of the vessels undertaking the IMR activities will vary depending on the activity being undertaken, but will be no larger than a drilling support vessel. The sounds produced by the vessels during the activity will not be outside the range of other anthropogenic sound (see Table 6.8, Section 6.1.3) and ambient underwater sound of the Project area and surrounds.

The impact assessment for underwater sound from vessels is therefore the same as that in Section 8.2.4 (and no TTS or PTS is likely to occur in any marine species as a result of vessel operations).

The environmental significance of acoustic disturbances arising from the vessels during this phase is considered to be negligible because:

- The IMR activities will be of very short duration (hours to days);

- The IMR activities will be infrequent and highly localised;
- The presence of threatened cetaceans in the region is largely restricted to migration seasons;
- There are no sensitive ecosystems in the Project area, such as reefs or kelp forests;
- Benthic sensitivities in and around the Project area are sparse (i.e., there are no commercial scallop beds, southern rock lobster habitat and no extensive sponge gardens);
- Fish species are likely to experience only temporary displacement from habitat (thus avoiding physiological effects); and
- There is no spatially-limiting habitat for the fin fish and benthic species known to occur in the Project area (i.e., the sandy seabed habitats are widespread through the shallow waters of eastern Bass Strait).

Geophysical Surveys

Side Scan Sonar (SSS) surveys are used to create a large image of the seabed. The technology will be utilised when determining the location of the pipeline during operations to determine if there has been any movement or shift over time (as a result of currents and storms). The frequency and sound source level for SSS are presented in Table 10.4, along with other typical geophysical equipment for comparison. While there is a significant volume of published research regarding the effects of offshore seismic noise on marine fauna (mammals, fish, turtles), there is a paucity of equivalent information relating to the impacts of noise generated by non-seismic geophysical equipment, such as SSS. SSS and MBES are likely to be the only type of geophysical equipment planned to be used during the operations phase.

Table 10.4. Typical geophysical equipment frequency ranges and source levels

Geophysical investigation	Frequency range (kHz)	Source levels (dB re 1 µPa @ 1 m)
MBES	200–700	236–242
SSS	100-120 and up to 1,600	210–220
SBP	0.05–24 (depending on the exact equipment selected)	100–225 (depending on the exact equipment selected)

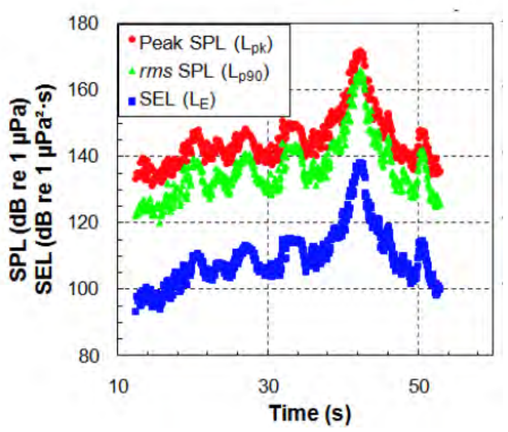
One particular paper (Reiser *et al.*, 2011) presents high quality data regarding the SPL and SEL of SSS based on measurements undertaken in the Chukchi and Beaufort Seas in 2010. Table 10.5 summarises this research using SPL metrics, while Figures 10.1, 10.2 and Figure 10.3 present the same results using SPL and SEL metrics.

This data illustrates that the sound levels generated by SSS rapidly attenuates within hundreds of metres of the sound source, and this sound is likely to be of a lower SEL that that of the measured ambient underwater sound in the Project area.

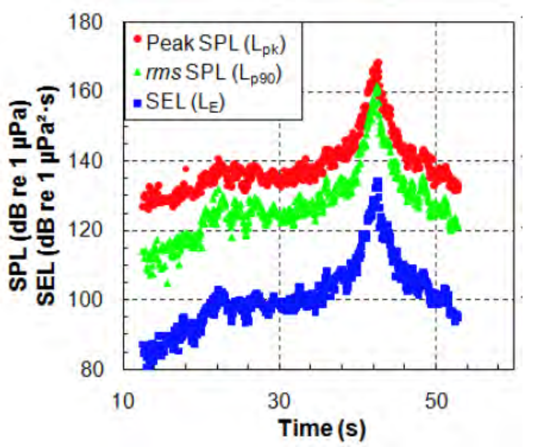
Table 10.5. Summary of SSS sounds from the Beaufort Sea investigation

Distance to sound level threshold (rms SPL dB re 1 µPa @ 1 m)	@ 120 kHz in-beam (90th percentile fit)	@ 400 kHz in-beam (90th percentile fit)
	Receiver depth	
	7 m	7 m
190	-	2
180	4	5
170	22	16
160	95	45
150	280	95
140	550	160
130	880	240
120	1,200	330
110	-	-
100	-	-
SL (dB re 1 µPA @1 m)	187.4	191.1

Source: Reiser et al (2011).



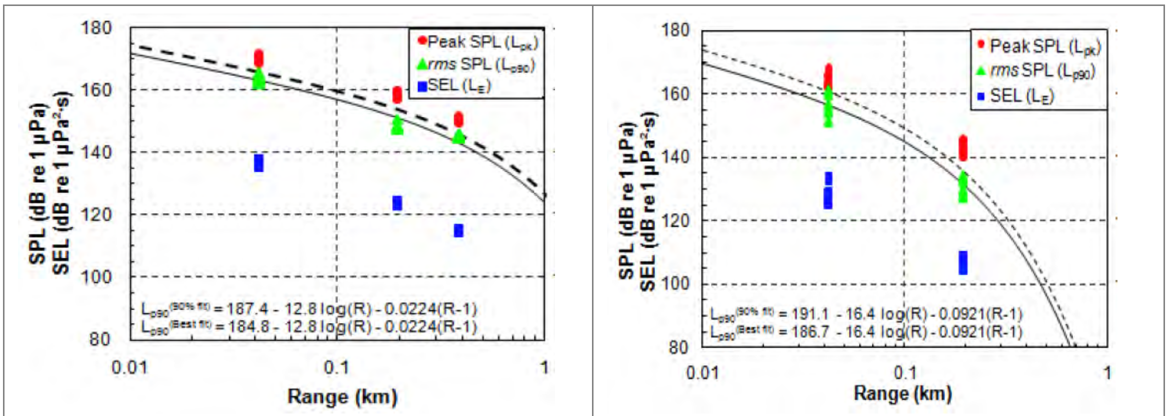
SSS 120-kHz pulse peak SPL, 90% rms SPL, and SEL over time for direct-path (left) and multi-path (right) arrivals along the 42-m CPA track line. In-beam measurement occurs at 46 s.



SSS 400-kHz pulse peak SPL, 90% rms SPL, and SEL over time for direct-path (left) and multi-path (right) arrivals along the 42-m CPA track line. In-beam measurement occurs at 46 s.

Source: Reiser et al (2011).

Figure 10.1. SSS measurements from the Chukchi Sea measured at 7 m receiver depth and 42 m range

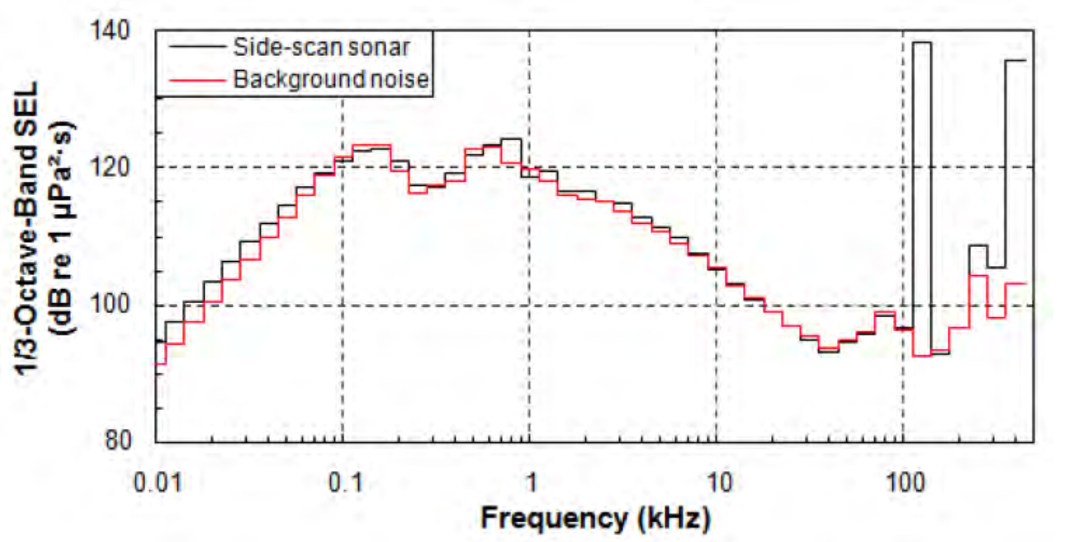


SSS 120-kHz pulse in-beam peak SPL, 90% rms SPL, and SEL versus range. Solid line is best fit of the empirical function to L_{p90} values. Dashed line is the best-fit shifted to exceed 90% of the L_{p90} values (90th percentile fit).

SSS 400-kHz pulse in-beam peak SPL, 90% rms SPL, and SEL versus range. Solid line is best fit of the empirical function to L_{p90} values. Dashed line is the best-fit shifted to exceed 90% of the L_{p90} values (90th percentile fit).

Source: Reiser et al (2011).

Figure 10.2. SSS measurements from the Chukchi Sea measured at 7 m receiver depth and 42 m range



SSS average 1/3-octave band in-beam SEL over 10 ms time windows from 10 pulses. The corresponding average band levels of background noise from the preceding 10 ms windows are shown in red.

Source: Reiser et al (2011).

Figure 10.3. SSS measurements from the Chukchi Sea measured at 7 m receiver depth and 42 m range

Impacts to Plankton

Plankton (described in Section 6.3.3) is very widely dispersed throughout the ocean and are transported by prevailing wind and tide- driven currents. They cannot take evasive behaviour to avoid anthropogenic sound sources. However, the potential for population-level noise effects is limited due to their widespread distribution and rapid population growth rates. This means that only a small percentage of a cohort will be exposed at any one time. Invertebrate plankton species that have gas-filled flotation organs (such as cephalopods) are more likely to be affected by underwater noise.

Impacts to plankton are likely to be negligible at both a local and population level or compared with natural variability and mortality rates for plankton organisms. Additional factors contributing to the negligible impacts to plankton are:

- The region has a high ambient underwater sound environment (see Section 6.1.3).
- The hydrodynamics of Bass Strait are conducive to continual mixing and replenishment of plankton.
- The Project area is located 53 km southwest of the 'Upwelling East of Eden' KEF, which becomes an important feeding whale feeding area during plankton blooms.
- Currents travelling from the east will act as a source of replenishment for plankton populations in and around the Project area.
- The results of CarbonNet's pre- and post-Pelican 3DMSS plankton monitoring (which took place within a few kilometres of the Project area) found that the abundance and diversity of zooplankton samples were typical of a healthy Bass Strait ecosystem (CarbonNet, 2018) before and after the MSS. As the sound sources for MSS are higher than for SSS, this indicates that impacts to plankton will be negligible when used in the operations phase.

<u>Impacts to Fish</u>

Fish species known to occur within the Project area and surrounds are listed and/or described in Section 6.3.4.

All fish studied to date are able to detect sound, with the main auditory organs in teleost (bony) fish being the otolithic organs of the inner ear (Carroll *et al*., 2017). Hearing in fish primarily involved the ability to sense acoustic particle motion via direct inertial stimulation of the otolithic organs or their equivalent. Many species also have the ability to sense sound pressure using an indirect path of sound stimulation involving gas-filled chambers such as the swim bladder (Carroll *et al*., 2017).

Underwater noise levels significantly higher than ambient levels can have a negative impact on fish, ranging from physical injury or mortality, to temporary effects on hearing and behavioural disturbance effects.

The effects of underwater sound on fish within the vicinity of a sound source will vary depending on the size, age, sex and condition of the receptor among other physiological aspects, and the topography of the benthos, water depth, sound intensity and sound duration. The effect of noise on a receptor may be either physiological (e.g., injury or mortality) or behavioural.

Site-attached fish species that exhibit a high degree of site fidelity are more likely to be affected by sound than larger more mobile roaming demersal species that have a greater ability to leave the affected area. Habitats for site-attached fish, such as rocky reef, do not occur in the Project area. There is limited rocky patch reef nearshore of the Project area (see Figure 6.7) where site-attached species may exhibit TTS. The nearest site of rocky reef is located 500 m to the southwest of the Project area.

There are substantial differences in auditory capabilities from one fish species to another, hence the use of anatomy to distinguish fish groups, as done by Popper et al (2014) (Table 10.6). Within these categories, two groups have an increased ability to hear. The first of those are fish with swim bladders close to, but not intimately connected to the ear, can hear up to about 500 Hz, and are sensitive to both particle motion and sound pressure. Fish with swim bladders mechanically linked to the ear are primarily sensitive to pressure, although they can still detect particle motion. These fishes have the widest hearing range, extending to several kilohertz, and are generally more sensitive to sound pressure than any of the other groups of fish (Hawkins and Popper, 2016).

The predominant frequency range of geophysical sound is below 500 Hz, which is within the detectable hearing range of most fish.

Table 10.6. Exposure criteria for sonar sources – fish

<table>
<tr><th rowspan="2">Type of fish</th><th rowspan="2">Mortality and potential mortal injury</th><th colspan="3">Impairment</th><th rowspan="2">Behaviour</th></tr>
<tr><th>Recoverable injury</th><th>TTS</th><th>Masking</th></tr>
<tr><td colspan="6">Low-frequency sonar</td></tr>
<tr><td rowspan="3">Fish with no swim bladder</td><td>(N) Low</td><td>(N) Low</td><td rowspan="3">>193 dB rms</td><td>(N) Low</td><td>(N) Low</td></tr>
<tr><td>(I) Low</td><td>(I) Low</td><td>(I) Low</td><td>(I) Low</td></tr>
<tr><td>(F) Low</td><td>(F) Low</td><td>(F) Low</td><td>(F) Low</td></tr>
<tr><td rowspan="3">Fish with swim bladder not involved in hearing</td><td rowspan="3">>193 dB rms</td><td rowspan="3">>193 dB rms</td><td rowspan="3">>193 dB rms</td><td>(N) Low</td><td>(N) Low</td></tr>
<tr><td>(I) Low</td><td>(I) Low</td></tr>
<tr><td>(F) Low</td><td>(F) Low</td></tr>
<tr><td rowspan="3">Fish with swim bladder involved in hearing</td><td rowspan="3">>193 dB rms</td><td rowspan="3">>193 dB rms</td><td rowspan="3">>193 dB rms</td><td>(N) Moderate</td><td rowspan="3">>197 dB rms</td></tr>
<tr><td>(I) Low</td></tr>
<tr><td>(F) Low</td></tr>
<tr><td colspan="6">High-frequency sonar</td></tr>
<tr><td rowspan="3">Fish with no swim bladder</td><td>(N) Low</td><td>(N) Low</td><td rowspan="3">N/A</td><td rowspan="3">N/A</td><td rowspan="3">N/A</td></tr>
<tr><td>(I) Low</td><td>(I) Low</td></tr>
<tr><td>(F) Low</td><td>(F) Low</td></tr>
<tr><td>Fish with swim bladder not involved in hearing</td><td>>210 dB rms</td><td>>210 dB rms</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="3">Fish with swim bladder involved in hearing</td><td rowspan="3">>210 dB rms</td><td rowspan="3">>210 dB rms</td><td rowspan="3">>210 dB rms</td><td>(N) Low</td><td rowspan="3">>209 dB rms</td></tr>
<tr><td>(I) Low</td></tr>
<tr><td>(F) Low</td></tr>
<tr><td colspan="6">Source: Popper et al (2014).
<u>Distance from the source</u>
(N) Near = tens of metres.
(I) Intermediate = within hundreds of metres.
(F) Far = thousands of metres.</td></tr>
</table>

Potential impacts

The data presented in Figures 10.1, 10.2 and Figure 10.3 (which reports results in SEL, the same unit of measurement used in Table 10.6) indicates that the sound levels from the SSS will not reach the thresholds outlined in Table 10.6 and therefore impacts from the activity are likely to be negligible to fish.

Fish, including sharks, are omnipresent throughout the Project area and surrounds and the South-east Marine Bioregion in general. They are likely to be more concentrated around the patchy low-profile reef where sponge and reef habitat provides more feeding opportunities and habitat compared to the areas of open sandy seabed.

The activity will not have a 'significant' impact on endangered or vulnerable fish species (see Section 6.3.4) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), which are:

- Lead to a long-term decrease in the size of a population – NO.
- Reduce the area of occupancy of the species – NO.
- Fragment an existing population into two or more populations – NO.
- Adversely affect habitat critical to the survival of a species – NO.
- Disrupt the breeding cycle of a population – NO.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline – NO.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat – NO.
- Introduce disease that may cause the species to decline – NO.
- Interfere with the recovery of the species - NO.

Threatened shark species that may migrate through, forage or breed within the Project area (e.g., great white shark) are not likely to experience effects that cause mortality or behavioural impacts (and thus impact on population dynamics) because of their biology; they lack a swim bladder, are generally transitory in nature, are known to avoid sudden sound increases and have wide ranging habitat with key breeding areas outside of the Project area.

Impacts to Cetaceans

Marine mammal species evolved from terrestrial mammals and share basic hearing anatomy and physiology with their terrestrial ancestors. Marine mammals, however, have broader hearing frequency ranges due to the much higher sound speed underwater compared to in air. Odontocetes (toothed whales and dolphins) hear best at higher frequencies, generally in the ultra-sonic range (>20,000 Hz), with no responsive hearing below 500 Hz (0.5 kHz). Mysticetes (baleen whales, such as humpbacks and southern right whales) hear better at lower frequencies (Wartzok & Ketten, 1999; Mooney *et al*., 2012), generally at infrasonic frequencies as low as 10-15 Hz (APPEA, 2004). The optimal hearing frequency range for baleen whales is between ~20 and 1,000 Hz (McCauley *et al*., 1994).

Sound is very important to whales and dolphins for effective hunting, navigation and communication. Mysticetes communicate at low frequencies (20 Hz to approximately 5 kHz) using predominantly tonal type calls. Odontocetes communicate using both tonal signals (up to approximately 30 kHz) and echolocation clicks (peak frequencies range from approximately 40 – 130 kHz), which they also use for hunting and navigation (Au *et al*., 2000).

The type and scale of the effect on cetaceans to underwater sound generated by geophysical equipment will depend on a number of factors including the level of exposure, the physical environment, the location of the animal in relation to the sound source, how long the animal is exposed to the sound, the exposure history, how often the sound repeats (repetition period) and the ambient sound level. The context of the exposure plays a critical and complex role in the way an animal might respond (Gomez *et al*., 2016; Southall *et al*., 2016).

High levels of anthropogenic underwater noise can have potential effects on cetaceans ranging from changes in their acoustic communication, behavioural disturbances and in more severe cases physical injury or mortality (Richardson *et al*., 1995), as described herein.

Physiological impacts

Physiological impacts such as physical damage to the auditory apparatus (e.g., loss of hair cells or permanently fatigued hair cell receptors), can occur in marine mammals when they are exposed to intense or moderately intense sound levels and could cause permanent or temporary loss of hearing sensitivity. While the loss of hearing sensitivity is usually strongest in the frequency range of the emitted noise, it is not limited to the frequency bands where the noise occurs but can affect a broader hearing range. This is because animals perceive sound structured by a set of auditory bandwidth filters that proportionately increase in width with frequency.

A TTS is hearing loss from which an animal recovers, usually within a day at most, whereas PTS is hearing loss from which an animal does not recover (permanent hair cell or receptor damage). The severity of TTS is expressed as the duration of hearing impairment and the magnitude of the shift in hearing sensitivity relative to pre-exposure sensitivity, in decibels (dB). TTS occurs at lower exposure levels than PTS. The cumulative effects of repeated TTS, especially if the animal receives another sound exposure near or above the TTS threshold before recovering from the previous sensitivity shift, could cause PTS. If the sound is intense enough, an animal could succumb to PTS without first experiencing TTS (Weilgart, 2007). Though the relationship between the onset of TTS and the onset of PTS is not fully understood, a specific amount of TTS can be used to predict sound levels that are likely to result in PTS. For example, in establishing PTS thresholds, Southall et al (2007) assume that PTS occurs with 40 decibels of TTS. While there are results from TTS and PTS studies on odontocetes exposed to impulsive sounds (Finneran, 2016), there is no data for mysticetes. There is no conclusive evidence of a link between sounds of seismic surveys and mortality of cetaceans (Gotz *et al*., 2009).

Behavioural impacts

A secondary concern arising from sound generation is the potential non-physiological effects on cetaceans including:

- Increased stress levels;
- Disruption to underwater acoustic cues;
- Masking;
- Behavioural changes; and
- Displacement.

These aspects are discussed further in this section.

Behavioural responses to underwater sound are difficult to determine because animals vary widely in their response type and strength, and the same species exposed to the same sound may react differently (Nowacek *et al*., 2004; Gomez *et al*., 2016; Southall *et al*., 2016). An individual's response to a stimulus is influenced by the context in which the animal receives the stimulus and how relevant the individual perceives the stimulus to be. A number of biological and environmental factors can affect an animal's response—behavioural state (e.g., foraging, travelling or socialising), reproductive state (e.g., female with or without calf, or single male), age (juvenile, sub-adult, adult), and motivational state (e.g., hunger, fear of predation, courtship) at the time of exposure as well as perceived proximity, motion and biological meaning of the sound and nature of the sound source.

Animals might temporarily avoid anthropogenic sounds, but could display other behaviours such as approaching novel sound sources, increasing vigilance, hiding and/or retreating, that might decrease their foraging time (Purser & Radford, 2011). Some cetaceans might also respond acoustically to seismic survey noise in a range of ways, including by increasing the amplitude of their calls (Lombard effect), changing their spectral (frequency content) or temporal vocalisation properties, and in some cases, cease vocalising (McDonald *et al*., 1995; 2007; Parks *et al*., 2007; Di Iorio & Clark, 2010; Castellote *et al*., 2012; Hotchkin & Parks, 2013; Blackwell *et al*., 2015). Masking can also occur (Erbe *et al*., 2015).

Thresholds

In August 2016, the National Marine Fisheries Service (NMFS) finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS, 2016). These are used to determine the possible ranges for injury from the use of geophysical equipment to species other than those protected through enactment of the exclusion zone determined through the application of EPBC Act Policy Statement 2.1. EPBC Act Policy Statement 2.1 determines suitable exclusion zones with an unweighted per-pulse SEL threshold of 160 dB re 1 μPa2·s (DEWHA, 2008).

There are two categories of auditory threshold shifts or hearing loss:

- PTS (a physical injury to an animal’s hearing organs); and
- TTS (a temporary reduction in an animal’s hearing sensitivity as the result of receptor hair cells in the cochlea becoming fatigued).

To assist in assessing the potential for injuries to marine mammals in addition to the application of EPBC Act Policy Statement 2.1, the criteria recommended by NMFS (2018) are considered here.

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. Considering this, and the complexity of information in the field, NMFS has historically used a relatively simple sound level criterion for potentially disturbing a marine mammal. For impulsive sounds (such as those generated during the use of SSS), this threshold is 160 dB re 1 μPa SPL cetaceans (NMFS, 2013).

A summary of the threshold criteria used to assess impacts of underwater sound for each of the cetacean functional hearing groups is presented in Table 10.7.

Table 10.7. The unweighted per-pulse SPL, SEL and SEL24h and PK thresholds for acoustic effects on cetaceans

Cetacean hearing group	NMFS (2013) & DEWHA (2008)	NFMS (2018)			
	Behaviour	Injury - TTS		Injury - PTS	
	SPL (dB re 1 µPa)	Weighted SEL_{24h} (dB re 1 µPa².s)	PK (dB re 1 µPa)	Weighted SEL_{24h} (dB re 1 µPa².s)	PK (dB re 1 µPa)
LFC	160	168	213	183	219
MFC		170	224	185	230
HFC		140	196	155	202

Cetacean functional hearing groups:

- *Low-frequency cetaceans (LFC) – mysticetes (baleen whales, including southern right, blue, humpback and fin whales);*
- *Mid-frequency cetaceans (MFC) – some odontocetes (toothed whales and dolphins); and*
- *High-frequency cetaceans (HFC) – odontocetes specialised for using high frequencies (e.g., harbour porpoise and Amazon river dolphin).*

Predicted Impacts

Cetaceans using low frequency communications (e.g., baleen species such as humpback and southern right whales) are more likely to be affected by lower frequency sources (i.e., SBP), which are not intended to be used during the operations phase. Cetaceans using mid-frequency communications (e.g., toothed species such as sperm whales) are more affected by the higher frequency sources (i.e., SSS).

Cetaceans are highly mobile and behavioural effects are expected to be limited to short-term avoidance of the Project area if sounds levels create disturbance.

The known temporal and spatial characteristics of cetaceans that may occur in and around the Project area make it unlikely that behavioural effects or TTS will occur because:

- For all whale species, using the threshold criteria in Table 10.7 and results illustrated in Figure 10.2, the distance to behavioural effects is likely to be limited to within 100 m of the sound source.
- For southern right whales:
    - If southern right whales were migrating along this part of the Gippsland coast during the use of SSS, based on the literature summarised above, it is possible that they will experience masking of their communications, and perhaps exhibit avoidance from a very localised area around the source.
    - Any localised avoidance of an active SSS when leaving the coastline could plausibly add a few kilometres to this migration. Such a marginal increase is not considered likely to significantly affect the metabolic demands of individuals whose migrations occur over thousands of kilometres.
    - The closest known calving/nursery grounds occurs 426 km to the west of the Project area. Southern right whales are therefore unlikely to be present in the BIA for migration/resting on migration at the time of the intermittent IMR activities.

  - All species of large whales, except Bryde's whale, are known to have populations that migrate from winter breeding grounds in the tropics to summer feeding grounds in the Antarctic (Kasamatsu & Joyce, 1995; Kasamatsu *et al.*, 2000). In common with other large whales that feed within Antarctic waters during the Austral summer, the southern right whale has evolved within, and annually enters, an environment with a ubiquitous natural source of low frequency sound.
- For pygmy blue whales:
  - They are unlikely to be present in the Project area (they are known to occur mainly in southwest Victoria, with a low possibility of occurrence in or around the Project area towards the tail end of summer). The risk of significantly reducing foraging habitat as a consequence of sound generated by the SSS is considered to be negligible.
  - It is unlikely that pygmy blue whales will be exposed to levels likely to cause physiological damage because of their ability to avoid the vessel and the sound source (McCauley, 1994).
  - It is unlikely that the sound source will create anything other than avoidance behavioural in a highly localised area for a very short amount of time.
- For humpback whales:
  - They may be encountered in the Project area during their southern migration from September to November, but this likelihood is considered low due to their preference for migrating along the edge of the continental shelf (in water depths of about 200 m).
- For sei whales:
  - This species is known to prefer deep offshore waters with no known mating or calving areas in Australian waters. As such, the generation of underwater sound from SSS and vessel movement is highly unlikely to impact on this species.
- For fin whales:
  - This species is known to prefer deep offshore waters and are considered rare in Australia. As such, the generation of underwater sound from SSS and vessel movement is highly unlikely to impact on this species.
- In the absence of BIAs in and around the Project area for cetacean breeding and calving, it is likely that cetaceans will only be migrating through waters of the region rather than milling around, so cumulative sound impacts will not be relevant.
- All species of large whales, except Bryde's whale, are known to have populations that migrate from winter breeding grounds in the tropics to summer feeding grounds in the Antarctic (Kasamatsu & Joyce, 1995; Kasamatsu *et al.*, 2000). In common with other large whales that feed within Antarctic waters during the Austral summer, the southern right whale has evolved within, and annually enters, an environment with a ubiquitous natural source of low frequency sound.
- Cetaceans have an observed ability to avoid vessels and acoustic sound sources.
- Any reduction in plankton biomass in and immediately around the Project area as a result of SSS sound is expected to have a negligible effect on the foraging habits of baleen whales because:

- o The reduced biomass is temporary;
- o The Project area is located well outside of plankton bloom areas (such as the Upwelling East of Eden KEF); and
- o They have vast foraging grounds, with the Project area representing a miniscule proportion of these foraging grounds. In Victoria, foraging grounds are concentrated on the southwest coast (associated with the Bonney Upwelling) rather than the west Gippsland coast.

The use of SSS or MBES will not have a ‘significant’ impact on threatened cetacean species when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), which are:

- Lead to a long-term decrease in the size of a population – NO.
- Reduce the area of occupancy of the species – NO.
- Fragment an existing population into two or more populations – NO.
- Adversely affect habitat critical to the survival of a species – NO.
- Disrupt the breeding cycle of a population – NO.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline – NO.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species’ habitat – NO.
- Introduce disease that may cause the species to decline – NO.
- Interfere with the recovery of the species - NO.

<u>Impacts to Pinnipeds</u>

The scientific literature that characterises the risk of underwater sound on pinnipeds is the same as that presented in Section 8.2.4.

Thresholds

The NOAA (2016) guidance suggests that seals are split into two groups based on functional hearing and PTS onset thresholds levels, as outlined in Table 10.8.

Table 10.8. The unweighted per-pulse SPL, SEL and SEL_{24h} and PK thresholds for acoustic effects on pinnipeds

Hearing group	NMFS (2013)	NMFS (2018)			
	Behaviour	Injury - TTS		Injury - PTS	
	SPL (dB re 1 µPa)	Weighted SEL_{24h} (dB re 1 µPa^2.s)	PK (dB re 1 µPa)	Weighted SEL_{24h} (dB re 1 µPa^2.s)	PK (dB re 1 µPa)
Phocid pinnipeds in water	160	170	212	185	218
Otariid pinnipeds in water		188	226	203	232

Predicted impacts

The results of measurements undertaken during geophysical investigations offshore Alaska (see Table 10.5) indicate that when compared against the thresholds for pinnipeds listed in Table 10.8, behavioural impacts are likely to be limited to an area of tens to hundreds of metres from the sound source, and that thresholds for injury will not be triggered.

Fish, being the key prey of pinnipeds, are not likely to be impacted in the long-term by the temporary and sporadic use of SSS over the operations phase of the Project. As such, there are not likely to be significant consequences to the foraging habits of fur-seals.

These results, combined with the fact that the Project area is located a significant distance from known breeding of the Australian fur-seal and New Zealand fur-seal, mean the use of SSS during the operations phase of the Project will have negligible impacts on pinnipeds.

<u>Impacts to Seabirds</u>

The Project area contains potential foraging habitat for a diverse array of seabirds. In the event that individual birds or flocks are present in the Project area during SSS usage, vessel movement is expected to temporarily deter them from foraging in the immediate vicinity of the vessel. The risk of underwater sound significantly impacting a population of any given species or even individuals (during plunge/dive feeding) is extremely low.

An indirect impact may occur if sound discharges cause changes to the abundance or behaviour of prey species (fish). However, the extent to which temporary ‘descending’ or ‘tightening’ responses of schooling prey fish such as pilchards (if it occurs) affects availability to avifaunal predators either positively or negatively, is not known. As described in the previous sub-section regarding fish, the effects to fish from the use of SSS will be very localised and transitory, and it is not likely that significant impacts to predatory avifauna will be experienced.

Seabird species that may forage in the Project area all have considerable foraging habitat present throughout Bass Strait. The small size of the Project area is not significant relative to their normal foraging environment. Any temporary dispersal of prey species (i.e., fish) due to the use of SSS would not result in any significant decrease in availability of prey species that is of biological significance for these populations.

Shorebird species such as the Australian fairy tern and hooded plover are not expected to be affected by SSS noise, as they would not be directly exposed to underwater sound (as they don't swim or plunge/dive) and given their preference for species of prey occurring within the intertidal part of the coastline.

Penguins communicate via calls (vocalisations) that allow partners to recognise each other and their chick. There is a lack of information on the auditory systems and communication of penguins, however the hearing range of most birds lies between 0.1 - 8 kHz (McCauley, 1994). It is therefore inferred that penguins have relatively poor hearing thresholds in the lower frequencies, which overlaps the frequencies of MBES, SSS and SBP (McCauley, 1994). Observations made by dedicated on-board MMO personnel of little penguins approaching seismic vessels during survey acquisition in eastern Bass Strait during 2001 and 2002 (Doodie, pers. comm., 2003; Pinzone, pers. obs., 2003) suggest that penguins are not negatively disturbed by the intense sound sources. It may be that the penguins are unaffected as they are in the seismic ‘shadow’ area, predominantly above the downward focus of the pulse.

A literature review on penguin hearing by SCAR Ad-hoc Work Group (2002) found that:

- Penguin hearing capacities can be partially alluded to by consideration of bird behaviour. For example, many penguin displays are based on voice recognition;
- On land, it is known that penguins use sounds extensively for intra-specific communication including mate and chick recognition; and
- The sound range used for this varies between about 0.3 and 3 kHz and that these contact calls may be heard up to 1 km from the originating bird(s).

During the 2014 Enterprise 3D transition zone seismic survey (2,500 cui source array), undertaken in Victorian coastal waters in depth ranges 20 to 65 m and located 1 km from the coast, breeding little penguin adults were equipped with GPS and depth recorders before and concomitantly with seismic survey activities in the vicinity of known colonies. The differences in behaviour characteristics of the little penguin, such as trip duration, maximum distance travelled during foraging, path length, dive frequency, dive time and average dive depth between survey and non-survey periods was not statistically significant, confirming little penguins do not appear to be disturbed by seismic sound sources (Pichegru *et al*., 2016). These results may also be applicable to similar sound sources, such as MBES, SSS and SBP.

As with other predatory avifauna, penguins may be indirectly affected if underwater sound alters the abundance or behaviour of prey (this is predicted to be localised, as assessed earlier in ‘Impacts to fish’). However, given this species routinely forages over distances of 15 – 50 km from their colonies and are highly mobile in the water, this is not expected to have any significant impact to the species. The nearest known breeding colony of penguins is located at Wilsons Promontory. Given that little penguins forage within 5-25 km of the coast during the breeding season, and up to 75 km from the coast at other times (SARDI, 2011), it is unlikely that high numbers of little penguins will be found in the Project area.

Predicted impacts

As most seabirds spend very little time under the water surface, and when they do it is for several seconds at a time, direct impacts to seabirds are predicted to be negligible to nil. The Project area does not contain spatially limiting food sources, with Bass Strait providing abundant foraging grounds and so indirect impacts from altered food availability are also predicted to be negligible.

10.2.5. Risks to MNES

The generation of underwater sound during the operations phase will not have significant risks to MNES, as outlined in Table 10.9.

Table 10.9. Risks to MNES from underwater sound

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.

MNES	Impact?	Notes
Listed threatened species (see Section 6.3)	No	There are no benthic species listed as threatened or migratory in the Project area. Threatened fish, cetacean and bird species are likely to temporarily avoid the disturbance caused by IMR activities, which will not result in significant impacts given the small area and temporary nature of impact.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.2.6. Risk Assessment

Table 10.10 presents the risk assessment for underwater sound impacts to marine fauna and seabirds.

Table 10.10. Risk assessment for underwater sound – biological receptors

Summary			
Summary of impacts	Physiological or pathological impacts to local populations of marine fauna and avifauna.		
Extent of Impact	Up to several hundred metres, depending on the receptor and the source of sound.		
Duration of Impact	Short-term (limited to the infrequent IMR activities).		
Level of certainty of impacts	Moderate to high.		
Initial mitigation measures			
Performance outcome	Performance standard (control)	Measurement criteria	
Minimise Vessel power generation and propulsion systems are well maintained.	Engines and thrusters are maintained in accordance with the vessel-specific PMS to ensure they are operating efficiently.	PMS records verify that engines and thrusters are maintained to schedule.	
Risk assessment (initial)			
Consequence type	Consequence	Likelihood	Risk rating
Threatening processes	Negligible – all fauna groups	Almost certain	Low
Threatened and migratory species	Minor – all fauna groups	Almost certain	Medium
Ecosystem function	Minor – all fauna groups	Almost certain	Low

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Avoid injury or behavioural impacts to whales.	Support vessel crews will implement The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) for sea-faring activities, which means: • Caution zone (300 m either side of observed whales and 150 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone. • No approach zone (100 m either side of observed whales and 50 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone and should not enter this zone and should not wait in front of the direction of travel or an animal or pod/group. • Do not encourage bow riding. • If animals are bow riding, do not change course or speed suddenly. • If there is a need to stop, reduce speed gradually.	Observation logs and/or Daily Operations Reports (DORs) note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision.
	Whale management strategy will be discussed with regard to SSS use. This information will be used to inform the operational strategy.	Daily operations reports indicate that sighting data has been used to inform daily operational planning.
	Vessel crews have completed an environmental induction including the above-listed requirements and the underwater sound impacts on whales.	Induction records verify that vessel crews have completed an environmental induction.
Whale sightings are reported to the DoEE.	GB Energy will report whale sightings online to the DoEE within 3 months of activity completion using the online Cetacean Sightings Application: http://www.marinemammals.gov.au/sorp/sightings.	Copies of sighting reports are maintained to verify reports were made.

Risk assessment (residual)			
Consequence type	Consequence	Likelihood	Risk rating
Threatening processes	Negligible – all fauna groups	Possible	Low
Threatened and migratory species	Negligible – all fauna groups	Possible	Low
Ecosystem function	Negligible – all fauna groups	Possible	Low

Environmental Monitoring
• Cetacean observations.
Record Keeping

- Vessel operations reports.
- Environmental induction presentation and attendance records.
- Engine and thruster PMS records.
- Incident reports.

10.3. Atmospheric Emissions

10.3.1. Risk Pathway

The following activity will generate atmospheric emissions from the IMMR vessels:

- Combustion of MDO from vessel engines, generators and deck equipment.

The description of atmospheric emissions is as per Section 8.5.1. The volume of fuel (per day) used by the vessels is likely to be similar to (if not less than) the volumes outlined in Section 8.5.1.

The risks of atmospheric emissions (methane) resulting from a pipeline rupture or well blowout during the operations phase are addressed in Section 10.15 and Section 10.16, respectively.

10.3.2. Known and Potential Environmental Risks

The known and potential environmental risks of atmospheric emissions are:

- Localised and temporary decrease in air quality due to gaseous emissions and particulates from diesel combustion; and
- Incremental build-up of GHG in the atmosphere (influencing climate change).

10.3.3. EMBA

The EMBA for atmospheric emissions associated with IMMR vessel activities is the local air shed – likely to be within hundreds of metres of the vessels, both horizontally and vertically. Receptors that may occur within this EMBA, either as residents or migrants, are seabirds. It is also likely that emissions will be incorporated into the airshed over local towns such as Golden Beach and Paradise Beach.

10.3.4. Evaluation of Environmental Risks

The evaluation of risks resulting from atmospheric emissions are the same as those described in Section 8.5.4. Note that the GHG risks associated with operations are addressed in Technical Report H and EES chapter 14.

10.3.5. Risks to MNES

Atmospheric emissions will not have significant risks to MNES, as outlined in Table 10.11.

Table 10.11. Risks to MNES from atmospheric emissions

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species flying overhead will not be significant given the temporary nature of emissions, the seasonality of presence of most threatened and migratory bird species, their temporary presence flying through the area and their ability to fly away from plumes. There is no habitat critical to any threatened or migratory bird species restricted to the air space around vessels.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas:		
- AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.3.6. Risk Assessment

Table 10.12 presents the risk assessment for atmospheric emissions from IMMR vessels.

Table 10.12. Risk assessment for atmospheric emissions

Summary		
Summary of impacts	Decrease in air quality due to gaseous emissions and particulates from MDO combustion and contribution to the incremental build-up of GHG in the atmosphere (influencing climate change).	
Extent of Impact	Localised (local air shed for air quality), widespread (for GHG).	
Duration of Impact	Temporary – duration of individual IMR activities over the operations phase (emissions are rapidly dispersed and diluted).	
Level of certainty of impacts	HIGH – the impacts of atmospheric emissions are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria

Minimise Combustion systems on the vessels operate in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) requirements.	Only low-sulphur (<0.5% m/m) MDO will be used in order to minimise Sox emissions.	Bunker receipts verify the use of low-sulphur MDO.
	All combustion equipment is maintained in accordance with the PMS (or equivalent).	PMS records verify that combustion equipment is maintained to schedule.
	Vessels with gross tonnage >400 tonnes possess equipment, systems, fittings, arrangements and materials that comply with the applicable requirements of MARPOL Annex VI.	IAPP is current.
	Vessels >400 gross tonnes and involved in an international voyage implement their SEEMP to monitor and reduce air emissions.	SEEMP records verify energy efficiency records have been adopted.
	Vessels >400 gross tonnes must ensure that firefighting and refrigeration systems are managed to minimise ODS.	ODS record book is available and current.
Vessel HVAC systems will be maintained to minimise refrigerant gas leaks.	The HVAC system is maintained in accordance with the PMS (or equivalent).	PMS records verify that the HVAC systems are maintained to schedule.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Almost certain	Low
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid Solid combustible waste is not incinerated.	All solid combustible waste is returned to shore for appropriate disposal.	The Garbage Record Book verifies that waste is transferred to shore for disposal.
Minimise Fuel use will be measured, recorded and reported.	Fuel use will be measured, recorded and reported for abnormal consumption, and in the event of abnormal fuel use, corrective action is taken to minimise air pollution.	Fuel use is recorded in the daily operations reports.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (threatening processes)	Unlikely	Very low
Environmental Monitoring		
• Fuel consumption.		
Record Keeping		

- Fuel bunkering receipts.
- PMS records.
- IAPP certificates.
- SEEMPs.
- ODS record books.
- Fuel use records.
- Waste manifests.
- Garbage record books.

10.4. Light Emissions

10.4.1. Risk Pathway

The following activities will result in artificial lighting during IMMR activities:

- Vessel operations – navigational and vessel deck lighting will be kept on 24 hours a day for maritime safety and crew safety purposes; and
- ROV operations – underwater light will be emitted when the ROV is submerged in order to illuminate an area of interest.

10.4.2. Known and Potential Environmental Risks

The known and potential environmental risks of artificial lighting are the same as those outlined in Section 8.6.2.

10.4.3. EMBA

The EMBA for light emissions is the same as that described in Section 9.4.3.

Light-sensitive receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Cephalopods (e.g., squid);
- Turtles;
- Fish; and
- Seabirds and shorebirds.

10.4.4. Evaluation of Environmental Risks

The evaluation of environmental risks of artificial lighting from IMMR vessels are essentially the same as those outlined in Section 8.6.4 and Section 9.4.4.

10.4.5. Risks to MNES

Light emissions will not have significant risks to MNES, as outlined in Table 10.13.

Table 10.13. Risks to MNES from light emissions

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory species flying overhead will not be significant given the temporary nature of light emissions, the seasonality of presence of most threatened and migratory bird species, their temporary presence flying through the area and their ability to fly away from disturbance. There is no habitat critical to any threatened or migratory bird species restricted to the air space around the drilling location.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.4.6. Risk Assessment

Table 10.14 presents the risk assessment for light emissions from IMMR vessels.

Table 10.14. Risk assessment for light emissions

Summary	
Summary of impacts	Light glow may act as an attractant to light-sensitive species (e.g., seabirds, fish, migratory and non-migratory birds, sea turtles and zooplankton), in turn affecting predator-prey and population dynamics (due to attraction to or disorientation from light).
Extent of Impact	Localised – light glow/spill around the vessels and ROV.
Duration of Impact	Temporary – sporadically for the duration of vessel activities over the operations phase.
Level of certainty of impacts	HIGH – the impacts of light glow on marine fauna are well known.

Initial mitigation measures			
Performance outcome	Performance standard (control)	Measurement criteria	
Minimise External vessel lighting conforms to that required by maritime safety standards.	Light glow is minimised by managing external vessel lighting in accordance with: • AMSA Marine Orders Part 30 (Prevention of Collisions). • AMSA Marine Orders Part 59 (Offshore Support Vessel Operations).	Vessel class certifications are current.	
Risk assessment (initial)			
Consequence type	Consequence	Likelihood	Risk rating
Threatening processes	Negligible – all fauna groups	Almost certain	Low
Threatened and migratory species	Negligible – all fauna groups	Almost certain	Low
Ecosystem function	Negligible – all fauna groups	Almost certain	Low
Environmental Controls and Performance Measurement			
Performance outcome	Performance standard (control)	Measurement criteria	
Minimise Attraction to lights for birds and marine fauna is kept to a minimum.	Lighting is directed to working areas (rather than overboard) to minimise light spill to the ocean.	Completed vessel inspection checklists and photos verify that lights are directed inboard, and where this is not possible, lights are switched off when not in use.	
	Lighting directed overboard can be manually over-ridden (with a local switch were possible) such that it is only switched on as required (e.g., man overboard).		
	Blinds will be lowered on all portholes and windows at night.	Completed daily environmental checklists and photos verify that blinds are drawn each night.	
Risk assessment (residual)			
Consequence type	Consequence	Likelihood	Risk rating
Threatening processes	Negligible – all fauna groups	Unlikely	Very low
Threatened and migratory species	Negligible – all fauna groups	Unlikely	Very low
Ecosystem function	Negligible – all fauna groups	Unlikely	Very low
Environmental Monitoring			
• Daily inspections for deck lighting and drawn blinds at night on vessels.			

Record Keeping
• Vessel class certification. • Completed environmental checklists. • Photos. • Injured fauna incident reports.

10.5. Discharge of Sewage and Grey Water

10.5.1. Risk Pathway

The use of ablution, laundry and galley facilities by the IMMR vessel crews will result in the discharge of sewage and grey water. The risk pathways are the same as those described in Section 8.7.1 with regard to vessels.

10.5.2. Known and Potential Environmental Risks

The known environmental risk of treated sewage and grey water discharges is:

- Temporary and localised increase in the nutrient content of surface waters around the IMMR vessels.

10.5.3. EMBA

The EMBA for sewage and grey water discharges will be the same as that described in Section 8.7.3; the top 10 m of the water column and a 50 m radius from the discharge point.

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Turtles;
- Pinnipeds; and
- Seabirds.

10.5.4. Evaluation of Environmental Risks

The evaluation of environmental risks for treated sewage and grey water discharges is the same as that described in Section 8.7.4.

10.5.5. Risks to MNES

Treated sewage and grey water discharges will not have significant risks to MNES, as outlined in Table 10.15.

Table 10.15. Risks to MNES from treated sewage and grey water discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges over a short-term IMR activity, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming or flying through the area. There is no habitat critical to any threatened or migratory marine species restricted to the EMBA for sewage and grey water discharges.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.5.6. Risk Assessment

Table 10.16 presents the risk assessment for the discharge of treated sewage and grey water from IMMR vessels.

Table 10.16. Risk assessment for the discharge of treated sewage and grey water

Summary		
Summary of impacts	Reduction in surface water quality around the discharge point.	
Extent of Impact	Localised – up to 50 m horizontally and 10 m vertically from the discharge point.	
Duration of Impact	Temporary – sporadically for the duration of individual IMR campaigns.	
Level of certainty of impacts	HIGH – the impacts of sewage and grey water discharges on water quality are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria

Minimise Sewage and grey water discharges comply with Section 23G of POWBONS.	Sewage and grey water are treated in a MARPOL-compliant STP prior to overboard discharge.	ISPP certificate is valid.
	The STP is maintained in accordance with the PMS.	PMS records confirm that the STP is maintained to schedule.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Environmental Controls and Performance Measurement		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Sewage and grey water discharges comply with Section 23G of POWBONS.	In the event of a STP malfunction, untreated sewage will be discharged only when >12 nm from shore or at a designated port transfer facility.	Discharge records confirm discharge of untreated sewage in waters >12 nm from shore.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Unlikely	Very low
Environmental Monitoring		
• None required.		
Record Keeping		
• ISPP certificates. • STP PMS records. • Discharge records.		

10.6. Discharge of Cooling and Brine Water

10.6.1. Risk Pathway

The risk pathways for the discharge of cooling and brine water from IMMR vessels are the same as those described in Section 8.8.1.

10.6.2. Known and Potential Environmental Impacts

The known and potential environmental risks of cooling water and brine discharges are:

- Temporary and localised increase in sea water temperature, causing thermal stress to marine biota;
- Temporary and localised increase in sea surface salinity, potentially causing harm to fauna unable to tolerate higher salinity; and
- Potential toxicity impacts to marine fauna from the ingestion of residual biocide and scale inhibitors.

10.6.3. EMBA

The EMBA for cooling water and brine discharges is the same as that described in Section 8.8.3; the top 10 m of the water column and a 100 m radius from the discharge point.

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds; and
- Avifauna.

10.6.4. Evaluation of Environmental Risks

The evaluation of environmental risks for cooling and brine water discharges from IMMR vessels is the same as that described in Section 8.8.4.

10.6.5. Risks to MNES

Cooling and brine water discharges will not have significant risks to MNES, as outlined in Table 10.17.

Table 10.17. Risks to MNES from cooling and brine water discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges during short-term IMMR campaigns, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the EMBA for cooling and brine water discharges.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal

MNES	Impact?	Notes
		Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.6.6. Risk Assessment

Table 10.18 presents the risk assessment for the discharge of cooling and brine water from IMMR vessels.

Table 10.18. Risk assessment for the discharge of cooling and brine water

Summary		
Summary of impacts	Increased sea surface temperature and salinity around the discharge point. Potential toxicity impacts to marine fauna from residual biocide and scale inhibitors.	
Extent of Impact	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of Impact	Temporary – sporadically for the duration of vessel activities over the operations phase.	
Level of certainty of impacts	HIGH – the impacts of sea surface temperature and salinity increases on marine fauna are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Equipment that requires cooling by water, and the RO plant, is well maintained.	Engines and associated equipment that require cooling by water will be maintained in accordance with the PMS so that they are operating within accepted parameters.	PMS records verify that the equipment is maintained to schedule.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		
Only low-toxicity chemicals are used in the cooling and brine water systems.	Only ONCS ‘Gold’/’Silver’ (CHARM) or ‘D’/’E’ (non-CHARM)-rated chemicals are used in the cooling and brine water systems.	Chemical inventory records verify that biocides and scale inhibitors are of low toxicity.

If an EMGPS is used, it is maintained in accordance with the PMS so it is operating within specified operating parameters.	The EMGPS is maintained in accordance with the PMS to ensure it is operating efficiently (without the use of chemicals).	PMS records verify that the EMGPS is maintained to schedule.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Unlikely	Very low
Environmental Monitoring		
• None required.		
Record Keeping		
• PMS records. • Chemical inventory.		

10.7. Discharge of Bilge Water and Deck Drainage

10.7.1. Risk Pathway

The risk pathways for bilge water and deck drainage discharges from IMMR vessels are the same as those described in Section 8.9.1.

10.7.2. Known and Potential Environmental Risks

The known and potential environmental risks of the discharge of bilge water and deck drainage are:

- Temporary and localised reduction of surface water quality (organics and toxins) around the discharge point; and
- Acute toxicity to marine fauna through ingestion of, or contact with, contaminated water in a localised mixing zone (in the event of malfunction of the OWS or an uncontrolled spill emanating from an open drainage area).

10.7.3. EMBA

The EMBA for bilge water and deck drainage discharges from IMMR vessels is the same as that described in Section 8.9.3; the top 10 m of the water column and a 100 m radius from the discharge point.

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles; and
- Avifauna.

10.7.4. Evaluation of Environmental Risks

The environmental risks for bilge water and deck drainage discharges from IMMR vessels during the operations phase are the same as that described in Section 8.9.4.

10.7.5. Risks to MNES

The discharge of bilge water and deck drainage will not have significant risks to MNES, as outlined in Table 10.19.

Table 10.19. Risks to MNES from bilge water and deck drainage discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the intermittent nature of discharges during short-term IMR campaigns, the seasonality of presence of most threatened and migratory marine and bird species, and their temporary presence moving through the area. There is no habitat critical to any threatened or migratory marine species restricted to this discharge EMBA.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.7.6. Risk Assessment

Table 10.20 presents the risk assessment for the discharge of bilge water and deck drainage.

Table 10.20. Risk assessment for the discharge of bilge water and deck drainage

Summary		
Summary of impacts	Reduction of surface water quality around the discharge point. Acute toxicity to marine fauna through ingestion of heavily contaminated water (in the event of malfunction of the OWS or an uncontrolled spill on an un-bunded deck).	
Extent of Impact	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of Impact	Temporary – sporadically for the duration of vessel activities over the operations phase.	
Level of certainty of impacts	HIGH – the impacts of oily water discharges on the marine environment are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Bilge water discharges comply with Section 8(4)(e) of POWBONS.	All bilge water passes through a MARPOL-compliant OWS set to limit OIW to <15 ppm prior to overboard discharge.	IOPP certificates are current.
	The OWS are maintained in accordance with each vessel's PMS.	PMS records verify that the OWS are maintained to schedule.
	The OWS are calibrated in accordance with the PMS to ensure the 15 ppm OIW limit is met.	PMS records verify that the OWS is calibrated to schedule.
	Residual oil from the OWS is pumped to tanks and disposed of onshore (no whole residual bilge oil is discharged overboard).	The Oil Record Books verify that waste oil is transferred to shore.
	In the event of OWS malfunction, all oily water is retained onboard for transfer to shore or discharged in waters >12 nm from the shore.	The Oil Record Book verifies that bilge water is transferred to shore or discharged in waters >12 nm from shore.
Hydrocarbon or chemical spills on the vessel are prevented from being discharged overboard.	Hydrocarbon and chemical storage areas (process areas) are bunded and drain to the bilge tank (or equivalent).	Vessel P&IDs verify that hydrocarbon and chemical storage areas are bunded and drain to the bilge tank.
	Portable bunds and/or drip trays are used to collect spills or leaks from equipment that is not contained within a permanently bunded area (non-process areas).	Vessel inspections (and associated completed checklists) verify that portable bunds and/or drip trays are used in non-process areas as required.
The marine crews are competent in spill response and have appropriate resources to respond	The vessel crews are competent in spill response and have appropriate response resources in order to prevent or minimise hydrocarbon or chemical spills discharging overboard.	Training records verify that vessel crews receive spill response training.

to a spill.	Fully stocked SMPEP response kits and scupper plugs or equivalent drainage control measures are readily available to the deck crews and used in the event of a spill to deck to prevent or minimise discharge overboard.	Site inspection verifies that fully stocked spill response kits and scupper plugs (or equivalent) are available on deck in high-risk locations.
		Review of incident reports indicate that the spills of hydrocarbons or chemicals to deck are cleaned up.
Level 1 spills (<10 m^3) of oil or oily water overboard are rapidly stopped.	The vessel-specific SMPEP is implemented in the event of a large spill of hydrocarbons or chemicals overboard.	Incident report verifies that the SMPEP was implemented.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Almost certain	Low
Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise Planned open deck discharges are non-toxic.	Deck cleaning detergents are biodegradable.	SDS verify that deck cleaning agents are biodegradable.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Negligible (ecosystem function)	Possible	Low
Environmental Monitoring		
• Volume of bilge water discharge.		
Record Keeping		
• IOPP certificates. • PMS records. • Oil Record Books. • Crew training records. • Inspection and checklist records. • P&IDs. • SDS (forall hazardous materials, including deck cleaning agents)). • SMPEPs. • Incident reports.		

10.8. Discharge of Control Fluids

10.8.1. Risk Pathway

Control fluid (also referred to as hydraulic fluid) is used to control subsea valves. A small fluid of such fluids is discharged to the marine environment when a wellhead isolation valve closes. It is estimated that 512 litres of control fluid will be discharged per XMT per year (factoring in a 20% contingency, this amounts to a volume of 1,500 litres per year for both XMTs).

During choke change out, the XMT and spool piping would be flushed with MEG or inhibited water, with about 20 litres of control fluid lost to the sea.

Pipeline pigging operations would be from offshore to onshore, so any water discharged from the pipeline would be captured in slug traps onshore.

10.8.2. Known and Potential Environmental Risks

The known and potential environmental risks of subsea operational discharges are:

- Temporary and localised decrease in water quality in the immediate vicinity of the discharge location; and
- Potential toxicity impacts to marine fauna from the ingestion of hydraulic fluid.

10.8.3. EMBA

The EMBA for the discharge of subsea chemicals and hydraulic fluids is likely to be tens of metres from the discharge location (in the down current direction), based on the fact that currents will rapidly dilute low volume discharges.

10.8.4. Evaluation of Environmental Risks

The offshore valves primarily comprise pipeline and wellhead isolation valves that are designed to be fail-safe, that is, to close when there is no hydraulic pressure applied to keep them open. Wellhead control fluid is routinely discharged to sea when the valves close.

Each valve closure releases approximately 2-7 litres of control fluid dependent on the valve. The actuation of the valves is triggered by production changes and from periodic shut down testing of the pipeline control system, to confirm that the shutdown system is functioning satisfactorily. Approximately six (6) well valve movements occur per month with no more than 1,500 litres of control fluid discharged across the two wellheads per year.

The control fluid proposed for use (MacDermid HW443) is a water-based fluid containing only 43% MEG. It contains no active ingredients that present a threat to the marine environment, does not bioaccumulate and rapidly disperses to below the ‘no-effect’ concentration. The product is ranked “D” in the OCNS ranking and has been determined as PLONOR.

The impacts of control fluid discharges to the physical and biological environment are expected to have negligible consequences because of the:

- Low discharge volumes;
- Intermittent nature of the discharges;
- Temporary nature of the discharges;
- High dilution and dispersal factor in open waters; and
- Absence of sensitive habitats in the Project area.

10.8.5. Risks to MNES

Subsea operational discharges will not have significant risks to MNES, as outlined in Table 10.21.

Table 10.21. Risks to MNES from subsea control fluid discharges

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the negligible consequence of this release, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.8.6. Risk Assessment

Table 10.22 presents the risk assessment for subsea operational discharges.

Table 10.22. Risk assessment for subsea operational discharges

Summary		
Summary of impacts	Decrease in water quality at the seabed and in the water column. Potential toxicity effects on marine fauna due to ingestion of subsea operational discharges.	
Extent of Impact	Localised – several metres horizontally and vertically from the valve.	
Duration of Impact	Temporary – sporadically for the duration of the operations phase.	
Level of certainty of impacts	HIGH – the impacts of control fluid discharge on marine fauna are well known.	
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor (threatening processes)	Unlikely	Low
Initial mitigation measures		

Performance outcome	Performance standard (control)	Measurement criteria
Only low toxicity, readily biodegradable and non-bioaccumulating chemicals will be used in the control fluid system.	Only PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated control fluids will be used.	The Project chemical inventory verifies that all chemicals are PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated.
Additional mitigation measures		
No additional mitigation measures identified.		
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor (threatening processes)	Unlikely	Low
Environmental Monitoring		
• Not required.		
Record Keeping		
• Project chemical inventory.		

10.9. Accidental Overboard Release of Waste

10.9.1. Risk Pathway

The risk pathways for handling and storage of materials and waste are the same as those described in Section 8.10.1 with regard to vessels.

10.9.2. Potential Environmental Risks

The risks of the release or accidental overboard release of hazardous and non-hazardous materials and waste to the ocean, creating marine debris, are:

- Marine pollution (litter);
- Putrescible waste;
- Injury and entanglement of individual animals (such as seabirds and seals); and
- Localised (and normally temporary) smothering or pollution of benthic habitats.

10.9.3. EMBA

The EMBA for the accidental overboard release of hazardous and non-hazardous materials and waste is the same as that described in Section 8.10.3; likely to extend for kilometres from the release site (as buoyant waste drifts with currents) or localised for non-buoyant items that sink to the seabed.

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Benthic fauna;
- Benthic habitat (sand and reef substrates);
- Pelagic fish;

- Cetaceans;
- Pinnipeds;
- Turtles; and
- Avifauna.

In particular, the EPBC Act-listed species documented as being negatively impacted by the ingestion of, or entanglement in, harmful marine debris (and known to occur in the EMBA) are (according to DoEE, 2018):

- The five turtle species;
- Eight albatross species and three petrel species;
- Other birds (flesh-footed shearwater, southern fairy prion);
- Australian fur-seal; and
- The southern right, pygmy blue, humpback, sei, pygmy right and killer whales.

10.9.4. Evaluation of Environmental Risks

The environmental risks for the accidental overboard release of hazardous and non-hazardous materials and waste during vessel activities in the operations phase are the same as those described in Section 8.10.4.

10.9.5. Risks to MNES

The accidental overboard release of hazardous and non-hazardous materials and waste will not have significant risks to MNES, as outlined in Table 10.23.

Table 10.23. Risks to MNES from the accidental release of hazardous and non-hazardous materials and waste

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the low risk of this release during infrequent and short-term IMR campaigns, the seasonality of presence of most threatened and migratory marine species, and their temporary presence swimming through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.

MNES	Impact?	Notes
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.9.6. Risk Assessment

Table 10.24 presents the risk assessment for the accidental overboard release of hazardous and non-hazardous materials and waste.

Table 10.24. Risk assessment for the accidental disposal of hazardous and non-hazardous materials and waste

Summary		
Summary of risks	Marine pollution (litter and a temporary and localised reduction in water quality), artificial increase in nutrient content in the case of putrescible waste, injury and entanglement of individual animals (such as seabirds and seals) and smothering or pollution of benthic habitats.	
Extent of risk	Non-buoyant waste may sink to the seabed near where it was lost. Buoyant waste may float long distances with ocean currents and winds.	
Duration of risk	Short-term to long-term, depending on the type of waste and location.	
Level of certainty of risks	HIGH – the effects of inappropriate waste discharges are well known.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
The EPO, EPS and measurement criteria listed below are in addition to those for 'seabed disturbance'.		
Comply with POWBONS (Part 2, Divisions 2, 2A & 2B) to ensure there is no release of hazardous or non-hazardous solid wastes or materials overboard.	A MARPOL Annex V-compliant GMP is in place for the vessels (i.e., for those >100 gross tonnes or certified to carry 15 persons or more) that sets out the procedures for minimising, collecting, storing, processing and discharging garbage.	GMPs are in place, readily available on board and kept current.
	Waste is stored, handled and disposed of in accordance with the GMP. This will include measures such as: • No overboard discharge of general operational or maintenance wastes or plastics or plastic products of any kind. • Waste containers are covered with secure lids to prevent solid wastes	Garbage Record Books (along with the waste manifest) verify that the GMP is implemented. Visual inspections (and associated completed checklists) verify that waste is stored and handled according to its waste classification.

	from blowing overboard. • All solid wastes are stored in designated areas before being sent ashore for recycling, disposal or treatment. • Any liquid waste storage on deck must have at least one barrier to minimise the risk of spills to deck entering the ocean. This can include containment lips on deck (primary bunding) and/or secondary containment measures (bunding, containment pallet, transport packs, absorbent pad barriers) in place. • Correct segregation of solid and hazardous wastes.	Visual inspections (and associated completed checklists) verify that waste receptacles are properly located, sized, labelled, covered and secured for the waste they hold. A licensed shore-based waste contract is in use for the management of onshore waste transport.
	Vessel crews are inducted into waste management procedures at the start of the activity to ensure they understand how to implement the GMP.	Induction and attendance records verify that all crew members have been inducted.
	Crane transfers (if required) are undertaken in accordance with the vessel-specific lifting procedures.	PTW (and associated JSA) is available for each lift or shift (as appropriate).
	The cranes and lifting equipment are maintained fit for use at all times to minimise the risk of dropped objects.	PMS records and/or the sling register verifies that checks and maintenance are undertaken to schedule.
Grease and chemicals are stored in chemical storage lockers.	Chemical lockers are available, bunded and used for the storage of all greases and non-bulk chemicals (i.e., those not in tote tanks) so as to prevent discharge overboard.	Site inspection verifies that greases and chemicals are stored in a chemical locker.
Avoid objects being dropped overboard.	Large bulky items are securely fastened to or stored on the vessel deck/s to prevent loss to sea.	A completed pre-departure inspection checklist verifies that bulky goods are securely sea-fastened.
	A crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects.	Completed handling and transfer procedure checklist, PTWs and/or risk assessments verify that the procedure is implemented prior to each transfer.
	The crane operators are trained to be competent in the handling and transfer procedure to prevent dropped objects.	Training records verify that crane operators are trained in the loading and unloading procedure.
	Visual inspection of lifting gear is undertaken every quarter by a qualified competent person (e.g., maritime officer) and lifting gear is tested regularly in line with the vessel specific PMS.	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.

<table>
<tr><td></td><td>All lifting gear will be supplied with test certification.</td><td>Rigging register is kept onboard the vessel and checked as part of the pre-departure checklist.</td></tr>
<tr><td>Putrescible waste discharges comply with Section 23B of POWBONS.</td><td>No putrescible waste is discharged in the Project area (or state waters in general). All putrescible waste is transferred to shore for suitable disposal.</td><td>The Garbage Record Books verify that putrescible waste was offloaded to support vessels for transfer to shore.</td></tr>
<tr><th colspan="3">Risk assessment (initial)</th></tr>
<tr><th>Consequence</th><th>Likelihood</th><th>Risk rating</th></tr>
<tr><td>Minor (threatening processes)</td><td>Unlikely</td><td>Low</td></tr>
<tr><th colspan="3">Additional mitigation measures</th></tr>
<tr><th>Performance outcome</th><th>Performance standard (control)</th><th>Measurement criteria</th></tr>
<tr><td colspan="3">Rehabilitate</td></tr>
<tr><td>Comply with POWBONS (Part 2, Divisions 2, 2A & 2B) to ensure there is no release of hazardous or non-hazardous solid wastes or materials overboard.</td><td>Solid waste that is accidentally discharged overboard is recovered if reasonably practicable.</td><td>Incident records are available to verify that credible and realistic attempts to retrieve the materials lost overboard were made.</td></tr>
<tr><th colspan="3">Risk assessment (residual)</th></tr>
<tr><th>Consequence</th><th>Likelihood</th><th>Risk rating</th></tr>
<tr><td>Minor (threatening processes)</td><td>Rare</td><td>Very low</td></tr>
<tr><th colspan="3">Environmental Monitoring</th></tr>
<tr><td colspan="3">• Garbage Record Books.
• Waste tracking in the activity-specific waste manifest.</td></tr>
<tr><th colspan="3">Record Keeping</th></tr>
<tr><td colspan="3">• GMPs.
• Garbage Record Books.
• Crew induction records.
• Inspection records/checklists.
• PMS records.
• PTW/JSA records.
• Shore-based waste contract.
• Waste manifest.
• Incident reports.</td></tr>
</table>

10.10. Introduction and Establishment of Invasive Marine Species

10.10.1. Risk Pathway

The risk pathways for the introduction of IMS from IMMR vessels are the same as those described in Section 8.11.1 as they relate to vessels.

10.10.2. Potential Environmental Risks

The risks of IMS introduction (assuming their survival, colonisation and spread) include:

- Reduction in native marine species diversity and abundance;
- Displacement of native marine species;
- Socio-economic impacts on commercial fisheries; and
- Changes to conservation values of protected areas.

10.10.3. EMBA

Receptors most at risk within this EMBA, either as residents or migrants, are:

- Benthic fauna (because of their limited ability to move to other suitable areas);
- Benthic habitat; and
- Pelagic and demersal fish.

10.10.4. Evaluation of Environmental Risks

The environmental risks relevant to the introduction of IMS are the same as those described in Section 8.11.4.

10.10.5. Risks to MNES

The introduction of IMS will not have significant impacts to MNES, as outlined in Table 10.25.

Table 10.25. Risks to MNES from the introduction of IMS

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	There are no threatened benthic marine species (which are more susceptible to the effects of IMS) recorded in the Project area and surrounds. Impacts to threatened and migratory marine species will not be significant given their ability to find resources in other parts of the marine environment. There is no habitat critical to any
Listed migratory species (see Section 6.3)	No	

MNES	Impact?	Notes
		threatened or migratory marine species restricted to the Project area or surrounds.
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest. The long distance between the Beagle AMP (and its deeper, colder waters) and the Project area (with shallower, warmer waters) makes it unlikely that IMS introduced in the Project area would spread to and survive in the AMP.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.10.6. Risk Assessment

Table 10.26 presents the risk assessment for the introduction of IMS.

Table 10.26. Risk assessment for the introduction of IMS

Summary	
Summary of risks	Reduction in native marine species diversity and abundance, displacement of native marine species, socio-economic impacts on commercial fisheries and changes to conservation values of protected areas.
Extent of risk	Localised (isolated locations if there is no spread) to widespread (if colonisation and spread occurs).
Duration of risk	Short-term (IMS is detected and eradicated, or IMS does not survive long enough to colonise and spread) to long-term (IMS colonises and spreads).
Level of certainty of risks	HIGH – the impacts associated with IMS introduction are well known and the vectors of introduction are known. Regulatory guidelines controlling these vectors have been established.

Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise *Biofouling*		
The vessels present a low biofouling risk.	The vessels are managed in accordance with the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry. This means: • Conducting in-water inspection by divers or inspection in drydock if deemed necessary. • Biofouling risk will be assessed, with cleaning of hull and internal seawater systems undertaken if deemed necessary. Anti-fouling coating status taken into account, with antifouling renewal undertaken if deemed necessary.	Biofouling assessment report prior to mobilising to site confirms acceptability of pipelay and support vessel entry into Commonwealth waters.
	Vessels >400 gross tonnes carry a current IAFS Certificate that is complaint with and Marine Order Part 98 (Anti-fouling Systems).	The IAFS Certificates are valid.
Ballast water		

The vessels discharge only low risk ballast water.	Vessels will fulfil the requirements of the Australian Ballast Water Management Requirements. This includes requirements to:
	• Carry a valid BWMP.
	• Submit a BWR through the MARS.
	  o If intending to discharge internationally-sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival.
	  o If intending to discharge Australian-sourced ballast water, seek a low-risk exemption through MARS.
	• Hold a BWMC.
	Ensure all ballast water exchange operations are recorded in a BWRS.
		BWMP is available and current.
		BWR (or exemption) is submitted prior to entry to the activity area.
		A valid BWMC is in place.
		An up-to-date BWRS is in place.
		An ePAR is available and signed off by DAWR.

Risk assessment (initial)			
Consequence category	Consequence	Likelihood	Risk rating
Environmental (ecosystem function)	Major	Possible	High
Business (commercial fisheries)	Major	Unlikely	Medium

Additional mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise The vessels carry a low risk of IMS introduction.	A vessel contractor pre-qualification is undertaken to ensure biofouling and ballast water controls meet these EP requirements.	Vessel contractor pre-qualification report verifies the vessels meet the requirements outlined in this table.
Biofouling		
The vessels present a low biofouling risk.	An IMS evaluation takes place prior to the vessels mobilising to site based on the following: • Inspecting the IAFS certificates to ensure they are current. • Reviewing recent vessel inspection/audit reports to ensure that the risk of IMS introduction is low. • Determining recent ports of call to determine the IMS risk of those ports. • Determining the need for in-water cleaning and/or re-application of anti-fouling paint if neither has been done recently in line with Anti-fouling and in-water cleaning guidelines. • Implementing the biofouling guidance provided in part 5 of the Offshore Installations Biosecurity Guideline (v1.3, DAWR, Feb 2019).	An IMS evaluation report (or memo or similar) verifies that the evaluation took place and that the IMS risk is low.
Submersible equipment (e.g., ROV) carries a negligible risk of IMS introduction.	Submersible equipment will be cleaned (e.g., biofouling is removed) prior to initial use in the activity area.	Records are available to verify that towed equipment was cleaned prior to use in the activity area.
Ballast water		
No additional measures identified.		
Reporting		
Known or suspected non-compliance with biosecurity measures is reported to regulatory agencies.	Non-compliant discharges of domestic ballast water are reported to DELWP and DAWE immediately.	Incident report notes that contact was made with DELWP and DAWE regarding non-compliant ballast water discharges.

Risk assessment (residual)			
Consequence category	Consequence	Likelihood	Risk rating
Environmental (ecosystem function)	Major	Unlikely	Medium

Additional mitigation measures			
Performance outcome	Performance standard (control)	Measurement criteria	
Social (commercial fisheries)	Major	Rare	Medium
Environmental Monitoring			
• Ballast water discharges.			
Record Keeping			
• Vessel contractor pre-qualification reports. • Biofouling risk assessment reports. • BWMP. • BWR. • BWMC. • BWRS. • IAFS Certificates. • DAWR-signed ePARs. • DAWR-signed ballast water exchange logs. • Incident reports.			

10.11. Displacement of or Interference with Third-party Vessels

10.11.1. Risk Pathway

The risk pathways for the displacement of or interference with third-party vessels as a result of IMMR vessel activities are the same as those described in Section 8.12.1.

With regard to the subsea infrastructure, a single 500-m radius PSZ (representing an area of 78.55 ha, or 0.7855 km^2) will be in place around the subsea wellheads. PSZs are not declared over offshore pipelines, but the pipeline will be marked on navigation maps with a cautionary area. The subsea wellheads (and/or the PSZ) will also be marked on navigation maps.

Note that this section deals with displacement or interference in a socio-economic sense; collision hazard (and consequent diesel spill impacts) is addressed in Section 8.15. Risks to the subsea infrastructure itself will be dealt with in subsequent safety approvals and are not assessed here.

10.11.2. Potential Environmental Risks

The risks of displacement of or interference with third-party vessels are:

- Collisions between the IMR vessels and third-party vessels (resulting in vessel damage);
- Diversion from navigation paths around an IMR vessel (leading to increased travel times and fuel usage/costs);
- Vessel damage (resulting in financial loss) and/or damage to or loss of fishing equipment; and
- Exclusion from fishing grounds (with resulting lower catches) due to the PSZ and/or loss of commercial fish catches due to snagging with subsea infrastructure (resulting in financial loss).

10.11.3. EMBA

The EMBA for the displacement of or interference with third-party vessels is the same as that described in Section 8.12.3; the PSZ around the subsea wellheads (0.7855 km^2) and wherever IMR vessel movements occur in the Project area (more specifically the immediate area around two intersecting vessels).

The EMBA for the subsea infrastructure is a 500-m radius around the wellheads, while the cautionary zone around the pipeline is not defined.

Receptors most at risk within this EMBA are:

- Commercial and recreational fishing vessels; and
- Commercial fishing equipment (e.g., trawl nets, lobster pots).

There is minimal risk to merchant vessels because the Project area is located within the ATBA, which excludes the non-routine passage of vessels > 200 gross tonnes through this area.

10.11.4. Evaluation of Environmental Risks

The socio-economic risks for the displacement of or interference with third-party vessels and activities are the same as those described in Section 8.12.4.

The presence of the subsea infrastructure may present a risk to fishers during the operations phase. Snagging of commercial fishing nets and subsequent detaching of the equipment from the fishing vessel would result in loss of any associated catch, income and repair or replacement costs. There is very little fishing effort in and around the Project area, so the risks of this hazard occurring are negligible. The risk of entanglement with the wellheads and XMTs is also negated through the installation of the FFS over the wells (see Section 3.4.11).

The one commercial fisher (Mitchelson Fisheries) operating in the Project area uses purse seine methods (see Section 6.6.3 ‘Commercial Fishing’). The area available for fishing to Mitchelson Fisheries is a very large area of Victorian state waters and Commonwealth waters. As such, the exclusion from 0.7855 km^2 of water is not likely to result in any material decrease in catch (and consequential loss of income) given the availability of equivalent fishing grounds in surrounding waters. A Mitchelson Fisheries representative has stated to GB Energy that they are accustomed to working around existing wellheads in Bass Strait and the addition of two wells and a PSZ does not present any operational concerns for them.

10.11.5. Risks to MNES

The displacement of and interference with third-party vessels and activities will not have significant risks to MNES, as outlined in Table 10.27.

Table 10.27. Risks to MNES from the displacement of and interference with third-party vessels and subsea infrastructure

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.

MNES	Impact?	Notes
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species are not relevant to this risk.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.11.6. Risk Assessment

Table 10.28 presents the risk assessment for the displacement of or interference with third-party vessels.

Table 10.28. Risk assessment for the displacement of or interference with third-party vessels

Summary		
Summary of risks	Presence of ISV (and towed equipment), damage to or loss of fishing equipment and loss of commercial fish catches.	
Extent of risk	Highly localised – immediately around vessels and the PSZ (500-m radius around the wellheads).	
Duration of risk	For subsea infrastructure, the risk remains as long as the infrastructure is in place. For IMMR activities, this is short-term (minutes for a third-party vessel detour) to long-term (vessel collision).	
Level of certainty of risk	HIGH – the impacts associated with vessel collisions are well known. The Bass Strait ATBA was established in acknowledgement of the risk posed by merchant vessels and petroleum infrastructure and smaller vessels.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid Third-party marine users are not disadvantaged by	The PSZ for the wells and the pipeline cautionary area are marked on navigational charts.	Navigation charts for eastern Bass Strait have the assets marked.

the subsea infrastructure and ISVs.	GB Energy will provide subsea infrastructure coordinates to fishers (e.g. SETFIA, SIV and Mitchelson Fishing) for inclusion in their vessel navigation systems.	Photo/s of the infrastructure in the electronic navigation system are available.
	The FFS is installed over the wells and is designed to minimise the risk of snagging with trawl nets.	Photos of the installed FFS verify it is in place. FFS design documents confirm a low snag risk.
	The AHO will be notified of the activity no less than four weeks prior to the IMMR activity commencing to enable the promulgation of Notice to Mariners.	Notice to Mariners includes vessel details, location and timing.
	The ISV is readily identifiable to third-party vessels and will display the appropriate lights and day shapes for a vessel with restricted ability to manoeuvre during operations.	Visual inspection (and associated completed checklists) verify that the anti-collision monitoring equipment (e.g., 24-hour radar watch, GMDSS and AIS) is functional and in use.
	Visual and radar watch is maintained on the bridge of the ISV at all times. The ISV Master and deck officers have valid SCTW certificates in accordance with AMSA Marine Order 70 (seafarer certification) (or equivalent) to operate radio equipment to warn of potential third-party spatial conflicts (e.g. STCW95, GDMSS proficiency).	Appropriate qualifications are available to verify the competence of the Vessel Masters and deck officers.
	The ISV Master issues warnings (e.g., radio warning, flares, lights/horns) to third-party vessels approaching the vessel in order to prevent a collision with the vessel.	Radio communications/ bridge log verifies that warnings to third-party vessels approaching the PSZ have been issued as necessary.
The vessels are authorised to operate within the Bass Strait ATBA.	The vessel contractor will apply to NOPSEMA and obtain permission for the ISV to operate within the Bass Strait ATBA.	An 'Area to be Avoided' authorisation from NOPSEMA is granted to the vessel operator.
Vessel-to-vessel collisions are managed in accordance with vessel-specific emergency procedures.	The Vessel Master will sound the general alarm, manoeuvre the vessel to minimise the effects of the collision and implement all other measures as outlined in the vessel or structure collision procedure (or equivalent).	Incident report verifies that the relevant safety procedure was implemented.
	Vessel collisions will be reported to Transport Safety Victoria and AMSA if that collision has or is likely to affect the safety, operation or seaworthiness of the vessel or involves serious injury to personnel.	Incident report verifies that AMSA was notified of a vessel collision.
Risk assessment (initial)		

Risk focus	Consequence	Likelihood	Risk rating
Displacement (shipping)	Negligible	Almost certain	Low
Interference (shipping)	Moderate	Unlikely	Low
Additional mitigation measures			
Performance outcome	Performance standard (control)	Measurement criteria	
Avoid Third-party marine users are not disadvantaged by the subsea infrastructure and ISVs.	GB Energy will liaise with fisheries and navigation agencies ahead of planned IMR activities.	Consultation records verify that consultation is undertaken with marine stakeholders ahead of planned IMR campaigns.	
Risk assessment (residual)			
Risk focus	Consequence	Likelihood	Risk rating
Displacement (shipping)	Negligible	Rare	Very low
Interference (shipping)	Minor	Rare	Very low
Environmental Monitoring			
• Continuous bridge monitoring.			
Record Keeping			
• Navigation chart. • PSZ gazettal. • Stakeholder consultation communication records. • Notice to Mariners. • ATBA authorisation. • Bridge communication logs. • Crew qualifications. • Incident reports.			

10.12. Vessel Strike with Megafauna

10.12.1. Risk Pathway

The movement of the ISVs within the Project area has the potential to result in collision or entanglement with megafauna, this being cetaceans, pinnipeds and turtles.

10.12.2. Potential Environmental Risks

The risks of vessel strike with megafauna are:

- Injury; and
- Death.

10.12.3. EMBA

The EMBA for vessel strike with megafauna is the immediate area around the ISV.

Receptors most at risk within this EMBA are:

- Cetaceans (whales and dolphins);
- Pinnipeds (fur-seals and true seals); and
- Turtles.

10.12.4. Evaluation of Environmental Risks

The environmental risks for vessel strike with megafauna are the same as those described in Section 8.13.4; albeit the risk of colliding with a stationary MODU is replaced by the risk of collision with a stationary or very slowly moving ISV (e.g., less than 1 knot).

10.12.5. Risks to MNES

Vessel strike with megafauna will not have significant risks to MNES, as outlined in Table 10.29.

Table 10.29. Risks to MNES from vessel strike with megafauna

<table>
<tr><th>MNES</th><th>Impact?</th><th>Notes</th></tr>
<tr><td>World Heritage properties
(see Section 6.4.2)</td><td>No</td><td>The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.</td></tr>
<tr><td>National Heritage properties
(see Section 6.4.3)</td><td>No</td><td>The nearest National Heritage property (Australian Alps National Park) is located onshore.</td></tr>
<tr><td>Wetlands of international importance (see Section 6.4.4)</td><td>No</td><td>The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.</td></tr>
<tr><td>Listed threatened species
(see Section 6.3)</td><td>No</td><td rowspan="2">The low likelihood of presence of southern right, pygmy blue and humpback whales in and around the Project area, combined with the lack of a defined migration route for pygmy blue whales in the Gippsland region, and the infrequent and short-term nature of IMR campaigns makes it highly unlikely that vessel strike with threatened whale species will occur.
Vessel collisions are listed as a threat to cetaceans in the:
• Conservation Management Plan for the Southern Right Whale (DSEWPC, 2012b);
• Conservation Management Plan for the Blue Whale (DoE, 2015b);
• Conservation advice for the sei whale (TSSC, 2015a);
• Conservation advice for the fin whale (TSSC, 2015b); and
• Conservation advice for the humpback whale (TSSC, 2015d).
The EPS listed in this Table 10.30 aim to minimise the risk of vessel strike with megafauna, and do not breach the management actions of the above-listed whale conservation plans.</td></tr>
<tr><td>Listed migratory species
(see Section 6.3)</td><td>No</td></tr>
</table>

MNES	Impact?	Notes
Commonwealth marine areas: - AMPs (see Section 6.4.1)	 No	 The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.12.6. Risk Assessment

Table 10.30 presents the risk assessment for megafauna vessel strike and entanglement.

Table 10.30. Risk assessment for megafauna vessel strike

Summary		
Summary of risks	Injury or death of cetaceans and/or pinnipeds.	
Extent of risk	Localised – limited to individuals coming into contact with a vessel.	
Duration of risk	Temporary (if individual animal dies or has a minor injury) to long-term (if there is a serious injury).	
Level of certainty of risk	HIGH – injury may result in the reduced ability to swim and forage. Serious injury may result in death.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Avoid		
No injury or death of megafauna as a result of vessel strike.	Vessel crews will implement The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) for sea-faring activities, which means: • Caution zone (300 m either side of observed whales and 150 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone.	Vessel operation logs note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision.

	• No approach zone (100 m either side of observed whales and 50 m either side of observed dolphins) – vessels must operate at speeds <6 knots within this zone and should not enter this zone and should not wait in front of the direction of travel or an animal or pod/group. • Do not encourage bow riding. • If animals are bow riding, do not change course or speed suddenly. • If there is a need to stop, reduce speed gradually.	
	Vessel crews have completed an environmental induction covering the above-listed requirements.	Induction and attendance records verify that vessel crews have completed an environmental induction.
	Vessel crews, but most notably the vessel Masters and Mates, will keep watch for whales and dolphins at all times so that the guidelines can be implemented.	Whale and dolphin sighting records verify that watch was maintained at all times and that the guidelines were followed as required.
Rehabilitate Vessel strike is reported to regulatory authorities.	Injury to megafauna serious enough to require intervention/rescue is reported to the Whale and Dolphin Emergency Hotline on 1300 136 017 as soon as possible. No attempts to assist/rescue megafauna should be made by vessel crew.	Incident report verifies contact was made with the Whale and Dolphin Emergency Hotline.
	Vessel strike causing injury to or death of a cetacean is reported to the DAWE via the online National Ship Strike Database (https://data.marinemammals.gov.au/report/shipstrike) within 72 hours of the incident.	Electronic record of report submittal is available.

Risk assessment (initial)			
Consequence category	Consequence	Likelihood	Risk rating
Individual animal (threatening processes)	Minor	Possible	Low
Population level (threatening processes)	Minor	Unlikely	Low
Additional mitigation measures			
No additional mitigation measures identified.			
Risk assessment (residual)			
Consequence category	Consequence	Likelihood	Risk rating
Individual animal (threatening processes)	Minor	Possible	Low
Population level (threatening processes)	Minor	Unlikely	Low
Environmental Monitoring			

• Vessel crew induction presentation and attendance records. • Megafauna sightings by vessel crew.
Record Keeping
• Vessel operations logs. • Induction and attendance records. • Megafauna sighting records. • Incident reports.

10.13. Accidental Bulk Discharge of Chemicals or Hydrocarbons

10.13.1. Risk Pathway

The risk pathways that may result in accidental bulk discharges (spills) of chemicals and hydrocarbons are the same as those described in Section 8.14.1 and would apply to the IMMR vessel operations.

10.13.2. Potential Environmental Risks

The known and potential environmental risks of the bulk discharge of chemicals and hydrocarbons are:

- Temporary and localised reduction of water quality; and
- Acute toxicity to marine fauna through ingestion or absorption.

10.13.3. EMBA

The EMBA for the risk of bulk discharge of chemicals and hydrocarbons is likely to range from tens to hundreds of metres depending on the product and volume spilled, so a precise EMBA cannot be calculated.

Receptors most at risk within this EMBA are:

- Fish;
- Marine mammals; and
- Reptiles.

10.13.4. Evaluation of Environmental Risks

The risks associated with the discharge of chemicals is addressed in Section 8.14.4.

The risks associated with the discharge of MDO are addressed in Section 10.14.

10.13.5. Risks to MNES

Accidental bulk discharge of chemicals or hydrocarbons will not have significant risks to MNES, as outlined in Table 10.31.

Table 10.31. Risks to MNES from the accidental bulk discharges of chemicals or hydrocarbons

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the seasonality of presence of most threatened and migratory marine species, and their temporary presence moving through the area. There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	The nearest AMP (Beagle) is 96 km to the southwest.
- TECs (see Section 6.4.5)	No	The nearest TEC (Subtropical and Temperate Coastal Saltmarsh) is 60 km to the southwest around the Nooramunga Marine and Coastal Park.
- KEFs (see Section 6.4.7)	No	The nearest KEF (Upwelling East of Eden) is 54 km to the east.

10.13.6. Risk Assessment

Table 10.32 presents the risk assessment for the accidental bulk discharge of chemicals and fuel.

Table 10.32. Risk assessment for the accidental bulk discharge of chemicals and fuels

Summary	
Summary of risks	Pollution of the water column. Toxicity to marine fauna.
Extent of risk	Localised – a small mixing zone around the vessel.
Duration of risk	Temporary – sporadically for the duration of vessel activities over the operations phase.
Level of certainty of risk	HIGH – the impacts associated with chemical and hydrocarbon spills at sea are well known and documented.
Initial mitigation measures	

Performance outcome	Performance standard (control)	Measurement criteria
Minimise		
Hydrocarbons and chemicals stored on the ISV are stored in a manner that prevents bulk release.	All hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.	Visual inspection verifies that hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.
	Where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.	Visual inspection verifies that where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.
Planned maintenance will be undertaken on all chemical and hydrocarbon storage systems, hose fittings and so forth.	Planned maintenance is undertaken to the PMS schedule.	PMS records verify that maintenance work (and repairs where necessary) is undertaken.
Vessel crews are well prepared to respond to deck spills.	The Vessel Master ensures that crew undertake spill response training every three months in accordance with the SMPEP and training matrix.	Training records show that relevant crew receive quarterly spill response training.
	In accordance with the SMPEP, oil spill response kits are available in relevant locations around the vessels, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for MDO spills to deck record that the spill is cleaned up using SMPEP resources.
Reporting		
A bulk spill of chemicals or hydrocarbons at surface will be promptly reported to regulatory agencies.	GB Energy will report to DJPR (EMB) within 2 hours of becoming aware of the spill.	Incident reports and logs confirm that regulatory authorities were notified within 2 hours of GB Energy becoming aware of the spill.
Risk assessment (initial)		
Consequence	Likelihood	Risk rating
Minor	Unlikely	Low
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Minimise		

A pre-acceptance inspection of the ISV takes place.	GB Energy's pre-acceptance inspection of the ISV confirms that storage tanks, equipment, bunding and machinery spaces are free of defects.	Vessel pre-acceptance inspection records verify good condition of all equipment.
Risk assessment (residual)		
Consequence	Likelihood	Risk rating
Minor	Rare	Very low
Environmental Monitoring		
• Not applicable.		
Record Keeping		
• Pre-acceptance vessel inspection records. • Inspection records. • Training records. • Daily fluids reports. • PMS records. • PTWs and JSAs. • Incident reports.		

10.14. Diesel Spill

10.14.1. Risk Pathway

The most credible scenario resulting in a major hydrocarbon release to the marine environment for the operations phase is a vessel-to-vessel collision. The size of the ISVs will generally be no larger than a drilling support vessel. As such, the MDO spill scenario modelled for a support vessel during the drilling phase is representative of the risk pathway during the operations phase. The behaviour and fate of the MDO predicted by the OSTM is addressed in Section 8.15.1.

10.14.2. Potential Environmental Risks

The known and potential impacts of an MDO spill are:

- A temporary and localised reduction in water quality;
- Injury or death of marine fauna and seabirds exposed to the MDO; and
- Habitat damage where the spill reaches shorelines.

10.14.3. EMBA

The EMBA for a 155 m^3 spill of MDO is illustrated in Figure 8.6 to Figure 8.11. Receptors most at risk within this EMBA, whether resident or migratory, are:

- Plankton;
- Fish;
- Cetaceans;
- Pinnipeds;
- Turtles;
- Avifauna; and

- Shoreline habitats.

10.14.4. Evaluation of Environmental Risks

The criteria used to determine the sensitivity of the receptors discussed in the risk assessments in this section is provided in Table 8.44 (in Section 8.15).

The effects of hydrocarbons and the risk to relevant receptors within the ISV spill EMBA are the same as those outlined in Table 8.45 to Table 8.54 in Section 8.15.

10.14.5. Risks to MNES

A 155 m^3 MDO spill during the operations phase will not have significant risks to MNES, as outlined in Table 10.33.

Table 10.33. Impacts to MNES from an MDO release

<table>
<tr><th>MNES</th><th>Impact?</th><th>Notes</th></tr>
<tr><td>World Heritage properties (see Section 6.4.2)</td><td>No</td><td>The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.</td></tr>
<tr><td>National Heritage properties (see Section 6.4.3)</td><td>No</td><td>The nearest National Heritage property (Australian Alps National Park) is located onshore.</td></tr>
<tr><td>Wetlands of international importance (see Section 6.4.4)</td><td>No</td><td>The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
It is unlikely that MDO of high enough concentration will enter the lakes system (through the Lakes Entrance channel) to result in significant impacts. Any oil reaching the entrance will be highly weathered and thus non-toxic.</td></tr>
<tr><td>Listed threatened species (see Section 6.3)</td><td>No</td><td rowspan="2">See Table 8.49 and Table 8.52. Impacts to threatened and migratory marine species will not be ‘significant’ as assessed against the EPBC Act Significant Impact Guidelines 1.1 or EPBC Act Policy Statement 3.21.
There is no habitat critical to any threatened or migratory marine species restricted to the Project area or surrounds. This is detailed in Table 8.45 to Table 8.54.</td></tr>
<tr><td>Listed migratory species (see Section 6.3)</td><td>No</td></tr>
<tr><td>Commonwealth marine areas:
- AMPs (see Section 6.4.1)</td><td>No</td><td>The East Gippsland and Beagle AMPs are intersected by entrained hydrocarbons. The minimum time in which they are contacted is 6 days, meaning the MDO will be weathered and non-toxic. Impacts will therefore not be significant.</td></tr>
<tr><td>- TECs (see Section 6.4.5)</td><td>No</td><td>Areas of the subtropical and temperate coastal saltmarsh TEC are intersected by the EMBA. However, this TEC is distributed along much of the central and eastern Victorian coast and into</td></tr>
</table>

MNES	Impact?	Notes
		NSW. Therefore, no significant impact on the TEC is expected. Potential occurrence of the Giant Kelp Marine Forests of South east Australia TEC is also intersected by the EMBA at Point Hicks and Mallacoota. However, this TEC is distributed along much of the Tasmanian and western Victorian coast. Therefore, no significant impact, in accordance with the EPBC Act Significant Impact Guidelines 1.1, is expected to the TEC (see Table 8.46).
- KEFs (see Section 6.4.7)	No	The Upwelling East of Eden KEF is predicted to be intersected by entrained and dissolved hydrocarbons. This would not impact on its values, but if the spill occurs at the time of an upwelling, there is the potential for more plankton to be exposed to hydrocarbons (as they 'bloom' in response to the cold water upwelling).

10.14.6. Risk Assessment

Table 10.34 presents the risk assessment for an MDO spill during the operations phase.

Table 10.34. Risk assessment for an MDO spill

Summary		
Summary of risks	Pollution of sea surface, water column and shoreline. Injury or death of marine fauna and seabirds through ingestion or contact. Disruption to fisheries operations.	
Extent of risk	As illustrated in Figure 8.6 to Figure 8.11. Up to: • 250 km for MDO on the sea surface; • 24.5 km of shoreline contact (maximum of 91.1 m^3); • 894 km for entrained MDO; and • 206 km for dissolved MDO.	
Duration of risk	Short-term (days to weeks, depending on level of contact, location and receptor).	
Level of certainty of risks	HIGH. Spill source volumes are limited in size, the environmental impact of MDO is well understood, a credible spill volume has been modelled and a very conservative threshold has been selected to define the EMBA.	
Initial management measures		
Performance outcome	Performance standard (control)	Measurement criteria

Preventative controls as per 'Interference with Third-party vessels' and avoidance measures for 'Seabed disturbance.' Additional controls are provided here.		
Minimise *Preparedness*		
Vessel crews are prepared to respond to a spill.	The ISV has an approved SMPEP (or equivalent appropriate to class) that is implemented in the event of a large MDO spill.	Current SMPEP is available.
	The ISV crew is trained in spill response techniques in accordance with the SMPEP.	Training records verify that all marine crew are trained in spill response.
	In accordance with the SMPEP, oil spill response kits are available in relevant locations around the vessels, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for MDO spills to deck record that the spill is cleaned up using SMPEP resources.
Reporting		
Reporting and monitoring of an MDO spill to regulatory authorities will take place in accordance with the EP and OPEP.	GB Energy will report the spill to regulatory authorities within 2 hours of becoming aware of the spill.	Incident reports verify that contact with regulatory agencies was made within 2 hours of GB Energy becoming aware of the spill.
Response		
Vessel Master will initiate action to reduce fuel loss in the event of a tank rupture.	The ISV Master will authorise actions in accordance with the vessel-specific SMPEP (or equivalent according to class) and the activity-specific OPEP to limit the release of MDO.	Daily operations reports verify that the SMPEP and OPEP were implemented.

Risk assessment (initial)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Moderate	Unlikely	Low
Macroalgal communities	Minor	Unlikely	Low
Plankton	Moderate	Unlikely	Low
Pelagic fish	Minor	Unlikely	Low
Cetaceans	Moderate	Unlikely	Low
Pinnipeds	Moderate	Unlikely	Low
Marine reptiles	Minor	Unlikely	Low
Seabirds	Moderate	Unlikely	Low
Shorebirds	Moderate	Unlikely	Low
Sandy beaches	Moderate	Unlikely	Low
Commercial fisheries	Minor	Unlikely	Low

Additional management measures		
Performance outcome	Performance standard (control)	Measurement criteria
Preventative controls as per 'Interference with Third-party vessels' and avoidance measures for 'Seabed disturbance.' Additional controls are provided here.		
Prevent No MDO is spilled to sea.	No vessel refuelling will be undertaken at sea (this will be done in port).	Bunker log verifies that refuelling was undertaken in port.

Risk assessment (residual)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Moderate	Rare	Low
Macroalgal communities	Minor	Rare	Very low
Plankton	Moderate	Rare	Low
Pelagic fish	Minor	Rare	Very low
Cetaceans	Moderate	Rare	Low
Pinnipeds	Moderate	Rare	Low
Marine reptiles	Minor	Rare	Very low
Seabirds	Moderate	Rare	Low
Shorebirds	Moderate	Rare	Low
Sandy beaches	Moderate	Rare	Low
Commercial fisheries	Minor	Rare	Very low

Environmental Monitoring
• As per the OPEP.

Record Keeping
• Vessel crew induction presentation. • Vessel crew training records. • SMPEPs. • Incident reports. • OPEP daily operations reports. • OSMP daily operations reports/overall study reports.

10.15. Dry Gas Release from a Subsea Pipeline Rupture

10.15.1. Risk Pathway

The GB Energy Offshore Pipeline Safety Case will detail the design of the pipeline and how it is maintained to ensure its ongoing integrity.

Although the subsea pipeline has been designed to withstand trawling, snagging and potential rupture, it is recognised that a release of hydrocarbons may occur from the pipeline due to several reasons, including:

- Over-pressure;
- Internal corrosion;
- External corrosion;
- Impact from future construction;
- Impact from future drilling;
- Impact from IMMR campaigns;
- Dragged anchors;
- Dropped objects;
- Manufacturing of construction faults;
- Severe storms;
- Earthquake; and
- Hydrates.

Gas Plume Modelling

GB Energy commissioned RPS to undertake gas plume dispersion and fate modelling of a subsea gas release from a pipeline rupture (RPS, 2020b). The assessment focussed on dry gas only as no liquid-phase hydrocarbons are expected to be encountered in the reservoir (see Section 1.4.4). Consequently, the results are more relevant to human health (for ISV crews) than the marine environment. Nevertheless, the results are included here for completeness given that a pipeline rupture is one of the most significant environmental risks during pipeline operations.

Determining Spill Scenario

The spill scenario is based on the most credible (yet highly unlikely) scenario of a rupture at the PLEM spool connection near the wells in a water depth of 18 m. This represents the worst-case release scenario where the spool could become disconnected from the well. The release size is based on the diameter of the spool (16”). The release volume is based on a flow rate of 240 MMscf/day, with the release duration being 10 minutes (1.66 MMscf). This duration is based on the fact that the rupture would be detected by the operating system and would shut the XMT in. This assumes the hydraulic jumper is also damaged and the tree valve is shut through the process of the accumulator bleeding down.

Methodology

As described in RPS (2020b), a two-stage methodology was applied for this assessment.

Stage 1: Subsea modelling of the fate of gas and condensate was undertaken using a two-phase (gas and liquid) subsea plume model (OILMAP-Deep). This assessment focussed on a dry gas well only, assuming no liquid-phase hydrocarbons were present. The gas plume model accounts for processes that affect the proportion of gas that breaches the surface, the time that gas bubbles take to surface and the dimensions of the gas plume at the water surface. These details were calculated over the periods of discharge. Important processes that the subsea modelling considered were the effect of the discharge jet on the size distributions of the gas bubbles that would be generated, the net buoyancy of the gas plume that would lift the two-phase plume of gas bubbles and entrained seawater to the water surface (affecting the surfacing time of the gas), the effect of coalescence, break-up, pressure change and dissolution of gas on the size of gas bubbles that evolve through the water column and the dissolution of gas into the water column from the gas bubbles.

Stage 2: Air dispersion modelling was undertaken using the Phast gas dispersion model. For this scenario, this model took in the rates of discharge through the water surface and dimensions of the gas plume at surface calculated by the OILMAP Deep model (Stage 1). Air dispersion modelling considered the dispersion and transport of gas in the air based on atmospheric conditions (air stability) and defined wind speeds and directions.

Key flammability thresholds relevant to the dispersion of the gas in the atmosphere are summarised in Table 10.35.

Table 10.35. Key fluid dispersion properties

Property	Definition	Value
LFL	The lower end of the concentration range over which the flammable gas can be ignited.	4.7% (47,070 ppm)
HLFL	Because the modelling calculates for spatially-averaged gas concentrations (at the spatial scale of the model) and plumes are likely to be non-homogenous – with higher and lower concentration patches within a given space, a further threshold of 50% LEL was applied as indicative of potentially-flammable concentrations to guard against the occurrence of higher concentration patches.	2.35% (25,535 ppm)
UFL	The highest concentration of a gas that will produce a flash of fire when an ignition source is present. At concentrations greater than this, the mixture is too rich to burn.	17.6% (176,513 ppm)

Six weather conditions representative of those in the Gippsland Basin and summarised in Table 10.36 were adopted as modelling inputs. The dispersion modelling was conducted for the representative wind speeds, at various Pasquill stabilities (stabilities of atmospheric turbulence). For the subsea releases, the hydrocarbon fluid temperature is assumed to arrive at the ambient water temperature at the sea surface.

Table 10.36. Weather categories used as modelling inputs

Weather	Wind Speed (knots)	Pasquill Stability Class	Ambient Air Temperature (°C)	Relative Humidity (%)	Solar Radiation (kW/m^2)	Surface Water Temperature (°C)
2A/B	2.0	Unstable - as with A only less sunny and windier	17	0.77	0.42	15
4F	4.0	Stable - night with moderate clouds and light/moderate wind	17	0.77	0.42	15
6B	6.0	Unstable - as with A/B only less sunny and windier	17	0.77	0.42	15
8.6D	8.6	Neutral - little sun and high wind or overcast/windy night	17	0.77	0.42	15

12.7D	12.7	Neutral - little sun and high wind or overcast/windy night	17	0.77	0.42	15
15.6D	15.6	Neutral - little sun and high wind or overcast/windy night	17	0.77	0.42	15

Note: All sources, target distances and elevations have been estimated by using the water surface as the common point of origin. The water surface has been chosen as the physical effects are impacted by weather as the elevation above the water surface increases.

The ZOC relating to potential human-health effects were calculated based on the criteria summarised in Table 10.37.

Under some Codes of Practice for working in confined spaces, such as those onboard vessels, concentration of any flammable gas, vapour or mist in the atmosphere must be less than 5% of LEL, unless a suitably calibrated, continuous-monitoring flammable gas detector is used in the space. The minimum threshold for the lowest ZOC Level 1 was set as 0.25% methane (2,500 ppm) on this basis.

The codes also stipulate that if concentrations are equal to or greater than 10% of the LEL, workers must be immediately removed from the space. During the Deepwater Horizon (MC52) response in the Gulf of Mexico in 2010, a trigger level of 10% LEL was set to activate control measures by vessel crew to reduce the LEL to less than 10% (i.e, moving the vessel upwind, notifying standby boats with water cannons). Thus, 10% LEL (0.5% methane; 5,000 ppm) was set to trigger ZOC Level 2.

In very high hydrocarbon gas clouds, oxygen levels can be depleted, which may cause dizziness or asphyxiation. Concentrations exceeding 20% LEL may trigger symptoms of dizziness and fainting. Consequently, 20% LEL was set as the lower threshold for ZOC Level 3.

ZOC Level 4 corresponds to 50% LEL and ZOC level 5 corresponds to 100% LEL.

Where concentrations of methane range between 15%-25%, UFL would be exceeded, indicating that risks of ignition will be lowered. However, impaired judgement and performance would be triggered by depletion of oxygen concentrations. The lower level of this range (15% methane; 150,000 ppm) was applied as the trigger for ZOC 6.

At methane concentrations between 25%-50%, available oxygen would be reduced to concentrations that would trigger fainting, with risk of death if exposure continues. The lower concentration (25% methane; 250,000 ppm) was applied as the lower threshold for defining ZOC 7.

Imminent death for anyone without breathing apparatus would be triggered at methane concentrations exceeding 50% (500,000 ppm), which is the concentration applied as ZOC Level 8.

Table 10.37. ZOC criteria for methane gas used in the modelling

Criteria for methane gas ZOC	ZOC level	Percent of LEL	Atmospheric concentration (Vol%)	Atmospheric concentration (Vol%)
UFL exceed and imminent death for anyone without breathing apparatus	8	UFL Exceeded	50-100%	500,000-1,000,000
UFL exceeded and serious oxygen depletion and fainting	7	UFL Exceeded	25-50%	250,000-500,000
UFL exceeded, oxygen depletion and impaired human performance	6	UFL Exceeded	15-25%	150,000-250,000
Flammable limit exceeded; explosion possible if ignition source is present.	5	LEL-UFL	5-15%	50,000-150,000
Some patches of higher concentration gas within explosive range could exist in plume	4	50-100%	2.5-5%	25,000-50,000
Exceeds VOC trigger for onset of dizziness and fainting	3	20-50%	1-2.5%	10,000-25,000
Trigger for Immediate removal of personnel from workspace.	2	10-20%	0.5-1%	5,000-10,000
Level for concern for contaminated workspace if not monitored.	1	5-10%	0.25-0.5%	2,500-5,000

Results

The plume of gas bubbles was estimated to rise quickly to the sea surface (less than 1 second) and the rising gas would entrain water at a maximum terminal velocity of 26.6 m/s, indicating that a geyser of water may rise above the sea surface. The plume of gas bubbles was estimated to spread over a diameter of approximately 2.32 m in the water column. A large proportion of the gas (99.7%) would pass through the water column and breach the water surface.

Table 10.38 presents the results for each weather condition modelled, noting that weather condition 2A/B always resulted in the largest vertical dispersion (Figure 10.4) and weather condition 15.6D always resulted in the largest horizontal dispersion (Figure 10.5). Figure 10.6 illustrates the dispersion for all weather conditions combined.

Maximum concentrations were calculated to remain below ZOC 7, so no results are presented for ZOC 7 and ZOC 8. This means that any personnel nearby (e.g., working on an ISV during IMMR campaign directly above the pipeline at the time of the rupture) would not be exposed to methane gas concentrations likely to result in fainting or death.

Table 10.38. Flammable dispersion of dry gas from subsea pipeline rupture (all weather scenarios)

Dimensional plane	UFL distance	LFL distance	50% LFL distance	20% LFL distance	10% LFL distance	5% LFL distance
	ZOC 6	ZOC 5	ZOC 4	ZOC 3	ZOC 2	ZOC 1
	All distances measured in metres					
Weather 2.0A/B						
Horizontal	16	78	121	Not modelled		
Vertical	142	337	652			
Weather 4.0F						
Horizontal	36	185	327	Not modelled		
Vertical	45	83	122			
Weather 6.0B						
Horizontal	38	190	283	Not modelled		
Vertical	60	111	211			
Weather 8.6D						
Horizontal	51	257	398	510	610	751
Vertical	42	80	147	255	320	376
Weather 12.7D						
Horizontal	66	339	509	Not modelled		
Vertical	31	56	103			
Weather 15.6D						
Horizontal	76	388	574	750	880	1,020
Vertical	25	46	85	145	180	212

Maximum distance travelled is indicated in red

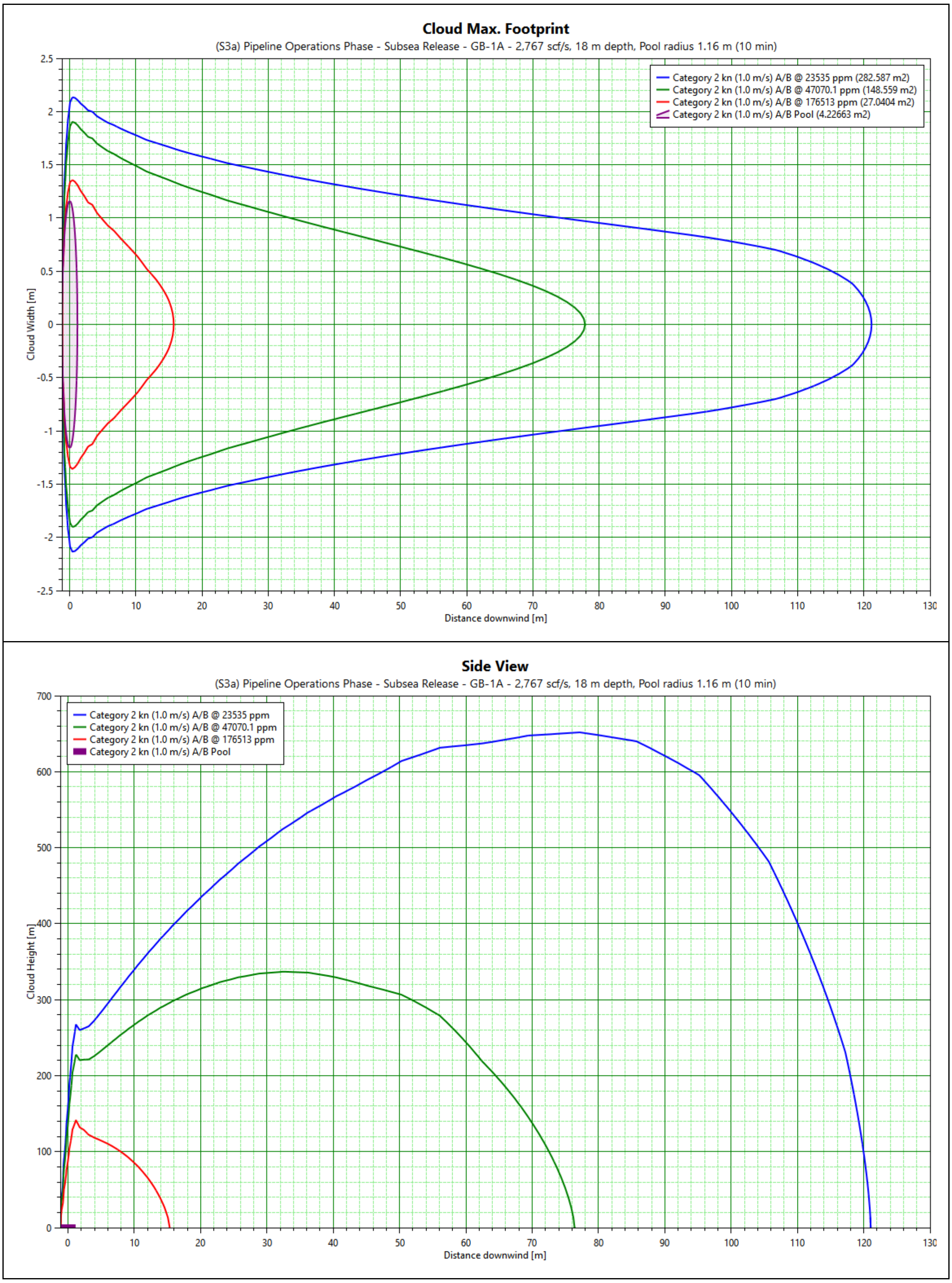


Figure 10.4. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) resulting from a pipeline rupture under 2.0A/B weather conditions. The Cloud Max Footprint shows a plan view of the LFL contours calculated at the water line

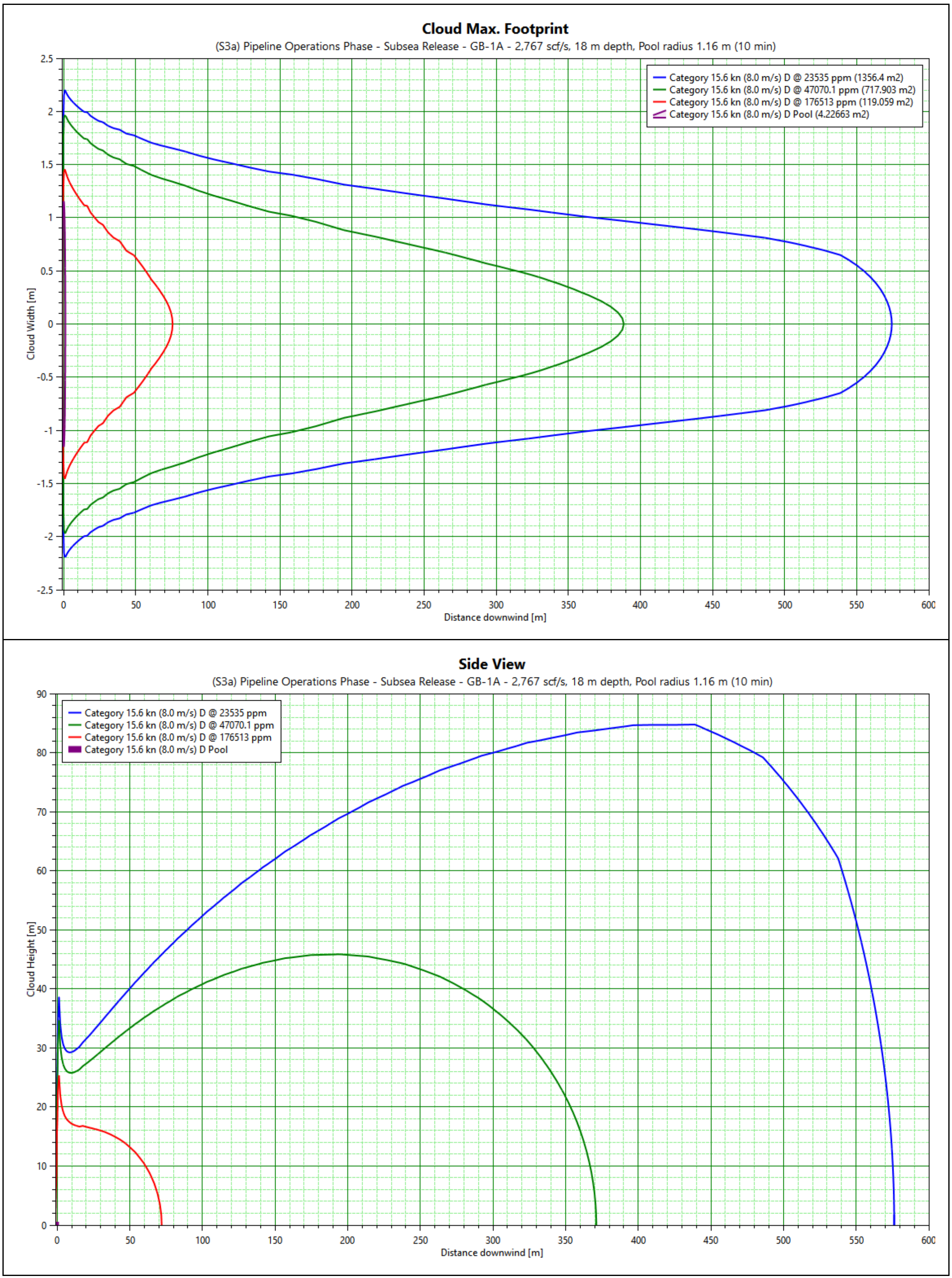


Figure 10.5. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) resulting from a pipeline rupture under <u>15.6D weather conditions</u>. The Cloud Max Footprint shows a plan view of the LFL contours calculated at the water line

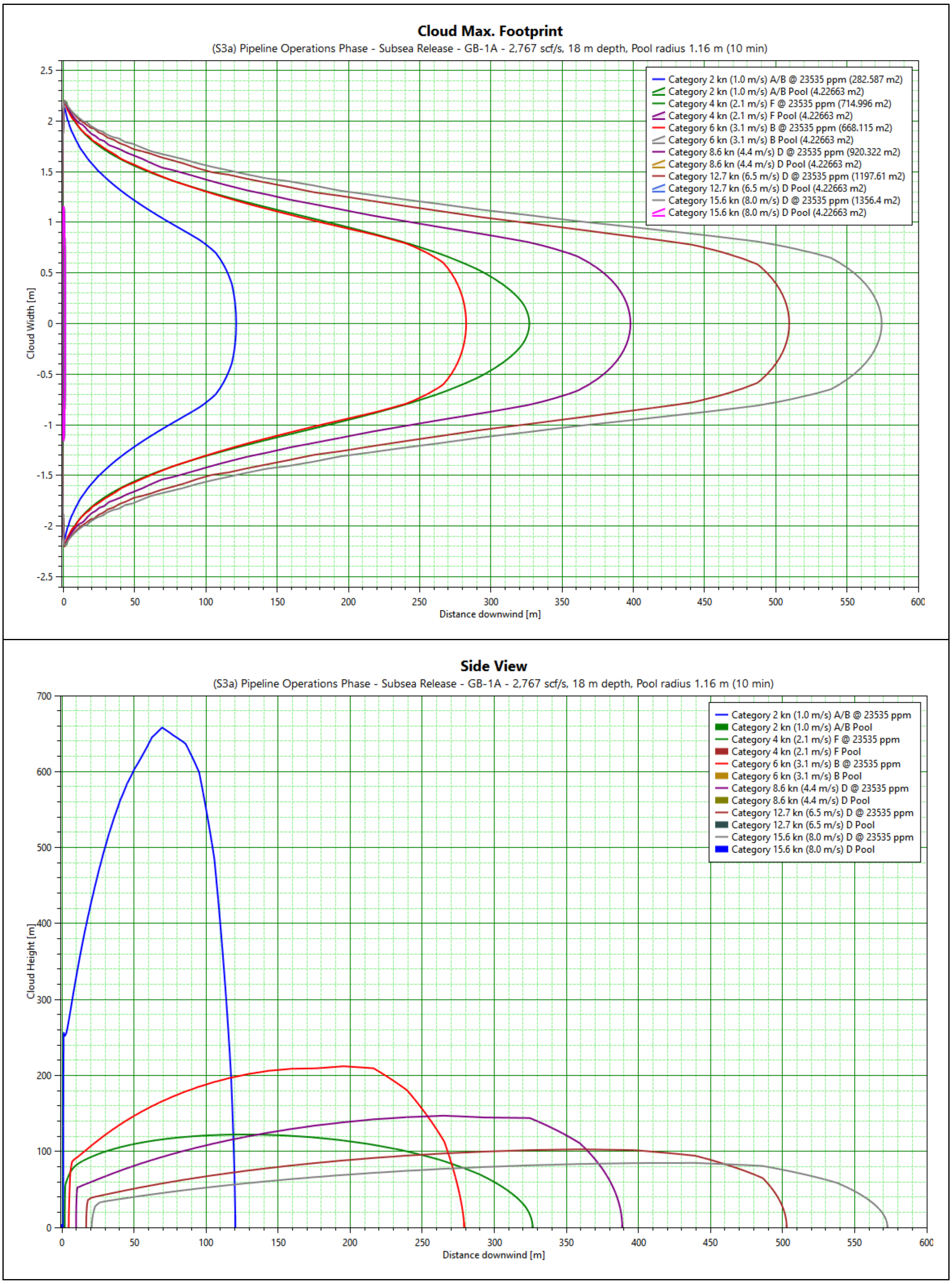


Figure 10.6. Predicted atmospheric dispersion for the 50% LFL (ZOC 4) resulting from a pipeline rupture under <u>all weather conditions</u>. The Cloud Max Footprint shows a plan view of the LFL contours calculated at the water line

10.15.2. Potential Environmental Risks

Environmental receptors most at risk within this EMBA if in the immediate vicinity of the subsea pipeline rupture point are pelagic marine fauna, including:

- Plankton; and
- Fish.

The modelling indicates that at the modelled release location, there is no risk of dry gas at dangerous concentrations reaching people who may be gathered on the beach or residents in Golden Beach.

10.15.3. EMBA

Water column

According to the modelling undertaken by RPS, the width of the gas plume from the rupture point to the sea surface is 2.32 m and is predicted to reach the surface in less than one second.

Atmosphere

Once the gas plume has passed through the water surface, the prevailing weather conditions (e.g., wind speed and direction) determine how far and in what concentrations the plume moves, as presented in Table 10.38.

10.15.4. Evaluation of Environmental Risks

Water column and sea surface

A pipeline rupture and consequent rapid release of gas through the water column environment) means that in the gas plume, oxygen depletion (as a result of displacement by methane) will result in the death of marine fauna (e.g., plankton and fish) trapped within the plume. This impact is mitigated by the very small diameter release plume (2.3 m) and short duration of release (10 minutes or less).

A geyser of water rising above the sea level and turbulent currents displacing outward from the geyser could capsize a small vessel if it was in the immediate vicinity of the release location.

Atmosphere

After breaching the sea surface, the maximum modelled extent of gas dispersion at the UFL concentration (ZOC 6) is 142 m vertically and 76 m horizontally. Gas at harmful concentration to human health is therefore not predicted to reach the shore or the closest occupied houses.

There is no permanently manned offshore platform or installation supporting the wells or pipeline as part of this Project. The risk to project personnel is low is therefore low if no vessels are in the vicinity of the pipeline at the time of the release. If a vessel (such as an ISV) was above the pipeline at the time of rupture, the risk to vessel crew of oxygen depletion is high.

10.15.5. Risks to MNES

A pipeline rupture and subsequent dry gas release during the operations phase will not have significant risks to MNES, as outlined in Table 10.39.

Table 10.39. Risks to MNES from a subsea dry gas release

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the very temporary and localised effects of the gas plume in the water column or in the atmosphere.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas:		
- AMPs (see Section 6.4.1)	No	There are no AMPs predicted to be contacted by the gas plume at the 50% LFL concentration.
- TECs (see Section 6.4.5)	No	There are no TECs predicted to be contacted by the gas plume at the 50% LFL concentration.
- KEFs (see Section 6.4.7)	No	There are no KEFs predicted to be contacted by the gas plume at the 50% LFL concentration.

10.15.6. Risk Assessment

Table 10.40 presents the risk assessment for a gas release from the subsea pipeline during operations.

Table 10.40. Risk assessment for a gas release from the subsea pipeline during operations

Summary		
Summary of risks	Fauna death in the water column. Release of atmospheric emissions and flammable gas from the sea surface.	
Extent of risk	In the water column - 2.32 m diameter gas plume. In the atmosphere - <80 m horizontal and <145 m vertical extent for UFL (ZOC 6) (worst case for effects to humans).	
Duration of risk	Short-term (minutes to hours before gas release depletes).	
Level of certainty of risks	HIGH. Flammability of the gas composition is understood, and a conservative release rate has been selected.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Note: these performance standards related to the operations activities only. Design elements preventing the uncontrolled release of dry gas are not detailed here.		

Prevent There is no loss of control (LoC) from the subsea gas pipeline.	The pipeline will be operated and maintained in line with the NOPSEMA-accepted GB Energy Offshore Pipeline Safety Case. This includes (but is not limited to): • Constant monitoring from the gas plant for over-pressure. • The low-pressure trip is tested every 6 months. • Corrosion is managed in accordance with an Integrity Management Plan (IMP). • The SCSSV will shut in the wells in the event of a loss of pressure.	Third-party independent audit reports available confirming operation of the subsea gas pipeline in accordance with the Safety Case.
		Monthly technical monitoring reports verify operation and maintenance of the pipeline in accordance with the Safety Case.
		Cathodic protection survey reports verify the Safety Case is implemented.
		Monitoring reports (e.g., ROV campaigns, intelligent pigging, sand) verify ongoing inspection and maintenance are undertaken.
	The pipeline is marked on navigation maps in order to minimise the risk of vessel anchoring over the pipeline.	Maritime navigation charts for eastern Bass Strait have the subsea pipeline marked.
	Pipeline production parameters, including flows, pressures, temperatures and sand production are monitored on a 24-hr basis by qualified and trained operators so that abnormalities are quickly detected and resolved.	Electronic records of continuous monitoring are available.
	Operations personnel are qualified, trained and certified as competent to operate and maintain the pipeline	The workforce capability requirements matrix is maintained up-to-date and verifies that operators are qualified, trained and certified as capable.
	An approved Lifting and Load Safety Operations Procedure (or equivalent) for use during IMR activities is used for all transfers over the pipeline to minimise the risk of suspended equipment dropping onto the pipeline.	The Lifting and Load Safety Operations Procedure is current.
		Completed PTWs and/or JSAs verify that the procedure is implemented.
Emergency response		
LoC from the offshore pipeline is stopped in the shortest time possible in line with pre-determined plans.	An ERP is in place and tested annually in desktop exercises by those nominated in the plans to be part of the response strategies.	The ERP is current.
		The ERP training schedule is available and remains live.
		The training matrix is maintained as a live document and verifies that personnel nominated to assist in emergency response are up to date with their training.

		ERP exercise reports verify that exercises have been undertaken.
Reporting		
A LoC from the subsea pipeline takes place in accordance with the ERP.	GB Energy will report a LoC to regulatory authorities within 2 hours of the LoC or becoming aware of the LoC.	Incident report verifies that contact with regulatory agencies was made within 2 hours.

Risk assessment (initial)			
Consequence category	Consequence	Likelihood	Risk rating
Environment (ecosystem function)	Negligible	Unlikely	Very low
Additional mitigation measures			
No additional mitigation measures identified.			
Risk assessment (residual)			
Consequence category	Consequence	Likelihood	Risk rating
Environment (ecosystem function)	Negligible	Unlikely	Very low
Environmental Monitoring			
• Routine environmental monitoring is not required.			
Record Keeping			
• Lifting and Load Safety Operations Procedure. • Completed PTWs. • Completed JSAs. • ERP. • Incident reports.		• Pipeline Safety Case. • Audit reports. • Workforce Capability Requirements Matrix. • Training matrix. • Navigation charts.	

10.16. Dry Gas Release from Well Blowout

10.16.1. Risk Pathway

The GB Energy Offshore WOMP will detail the design of the wells and how they will be maintained to ensure their ongoing integrity.

Although the wells have been designed to withstand trawling, snagging and potential rupture, it is recognised that a LoWC, resulting in a release of hydrocarbons, may occur due to several reasons, including:

- Over-pressure;
- Internal corrosion;
- External corrosion;
- Impact from future construction;
- Impact from future drilling;
- Impact from IMMR campaigns;
- Dragged anchors;

- Dropped objects;
- Manufacturing of construction faults;
- Severe storms;
- Earthquake; and
- Hydrates.

Gas Plume Modelling

GB Energy commissioned RPS to undertake gas plume dispersion and fate modelling of a subsea gas release from a well blowout (RPS, 2020b). The assessment focussed on dry gas only, as no liquid-phase hydrocarbons are expected to be encountered in the reservoir (see Section 3.4.4). Consequently, the results are more relevant to human health (for ISV crews) than the marine environment. Nevertheless, the results are included here for completeness given that a well blowout is one of the most significant environmental risks during well operations.

Determining Release Scenario

The release scenario is based on the most credible (yet highly unlikely) scenario of a leak of the 7” production packer in a water depth of 18 m. The release volume is based on a flow rate of 44 MMscf/day, with the release duration being 100 days. This duration represents the time required to kill the well (i.e., drill a relief well and stop the flow of gas).

While gas discharge rates would decrease over time due to depressurisation, all scenarios were assessed for discharge at a constant rate (the highest initial rate of discharge). This is considered an appropriate approach for the modelling, which considered the potential for flammable gas concentrations to be generated within minutes of release commencing.

Methodology

The methodology is the same as that described in Section 10.15.1. The ZOC are the same as those presented in Table 10.37 in the previous section.

Results

The plume of gas bubbles was estimated to rise quickly to the sea surface (1.7 seconds) and the rising gas would entrain water at a maximum terminal velocity of 15.9 m/s, indicating that a geyser of water may rise above the sea surface. The plume of gas bubbles was estimated to spread over a diameter of approximately 2.32 m in the water column. A large proportion of the gas (99.3%) would pass through the water column and breach the water surface.

Table 10.41 presents the results for each weather condition modelled, noting that weather condition 2A/B always resulted in the largest vertical dispersion (Figure 10.7) and weather condition 15.6D always resulted in the largest horizontal dispersion (Figure 10.8). Figure 10.9 illustrates the dispersion for all weather conditions combined.

Table 10.41. Flammable dispersion of dry gas from subsea well blowout (all weather scenarios)

Dimensional plane	UFL distance	LFL distance	50% LFL distance	20% LFL distance	10% LFL distance	5% LFL distance
	ZOC 6	ZOC 5	ZOC 4	ZOC 3	ZOC 2	ZOC 1
	All distances measured in metres					
Weather 2.0A/B						
Horizontal	7.5	38	63	Not modelled		
Vertical	24	65	123			
Weather 4.0F						
Horizontal	13	69	130	Not modelled		
Vertical	14	27	41			
Weather 6.0B						
Horizontal	18	91	141	Not modelled		
Vertical	9.3	22	41			
Weather 8.6D						
Horizontal	22	114	189	260	326	430
Vertical	7.2	17	31	54	69	82
Weather 12.7D						
Horizontal	28	144	236	Not modelled		
Vertical	5.1	12	22			
Weather 15.6D						
Horizontal	32	161	262	343	415	513
Vertical	4.5	9.6	18	31	39	47

Maximum distance travelled is indicated in red.

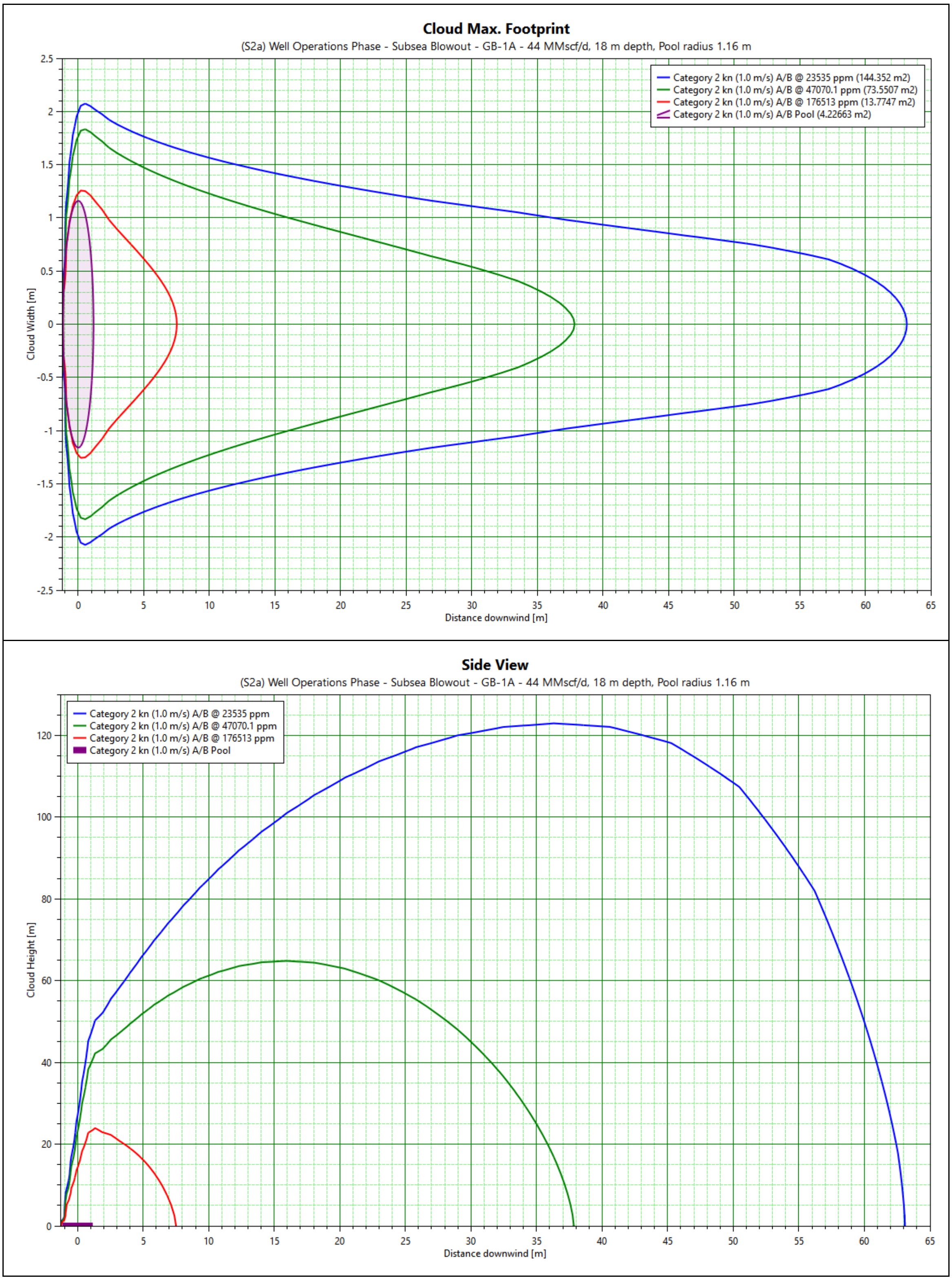


Figure 10.7. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) resulting from a well blowout during operations under 2.0A/B weather conditions. Note the Cloud Max. Footprint shows a plan view of the LFL contours calculated at the water line

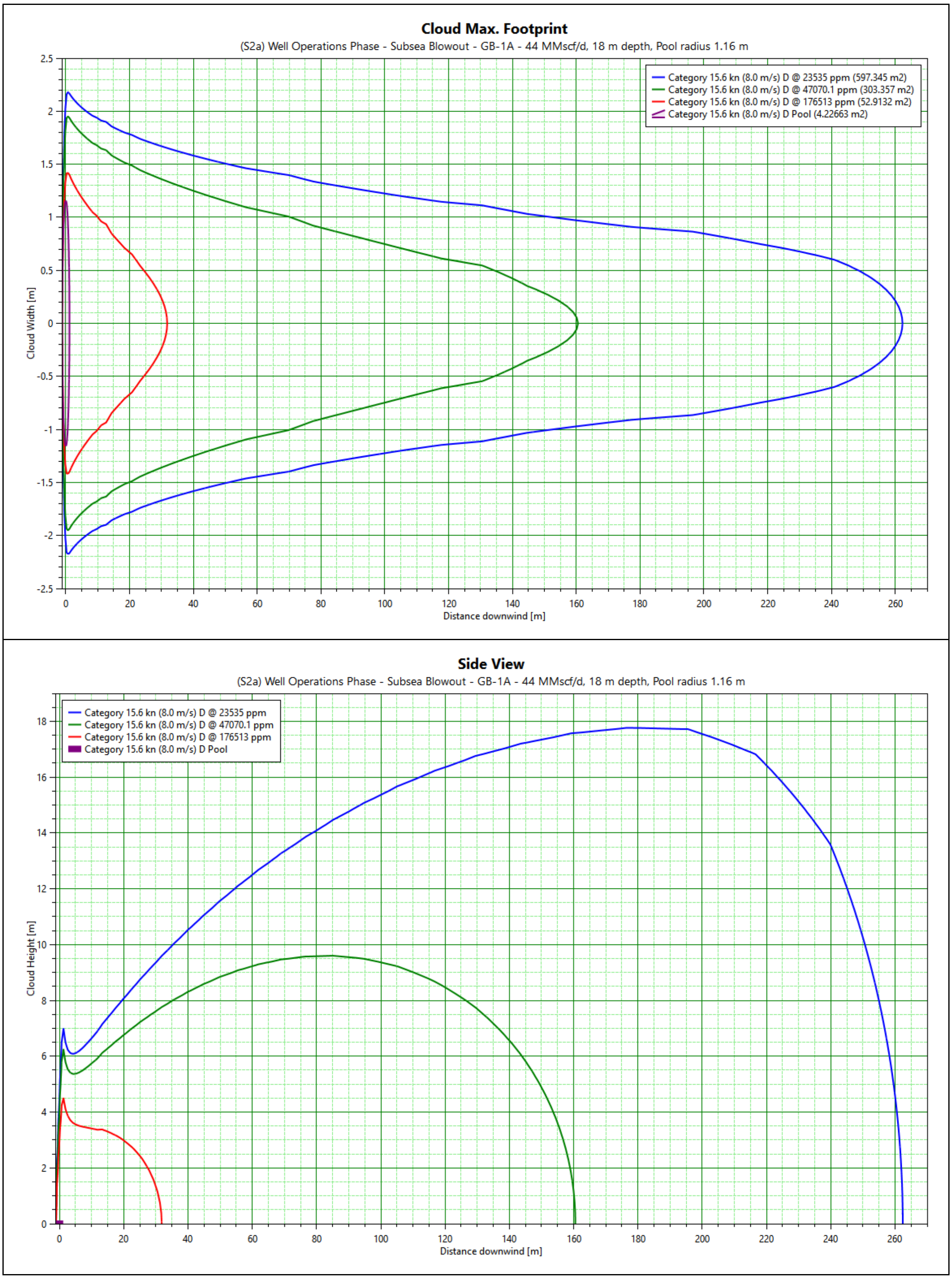


Figure 10.8. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), LFL (ZOC 5) and UFL (ZOC 6) resulting from a well blowout during operations under 15.6D weather conditions. Note the Cloud Max. Footprint shows a plan view of the LFL contours calculated at the water line

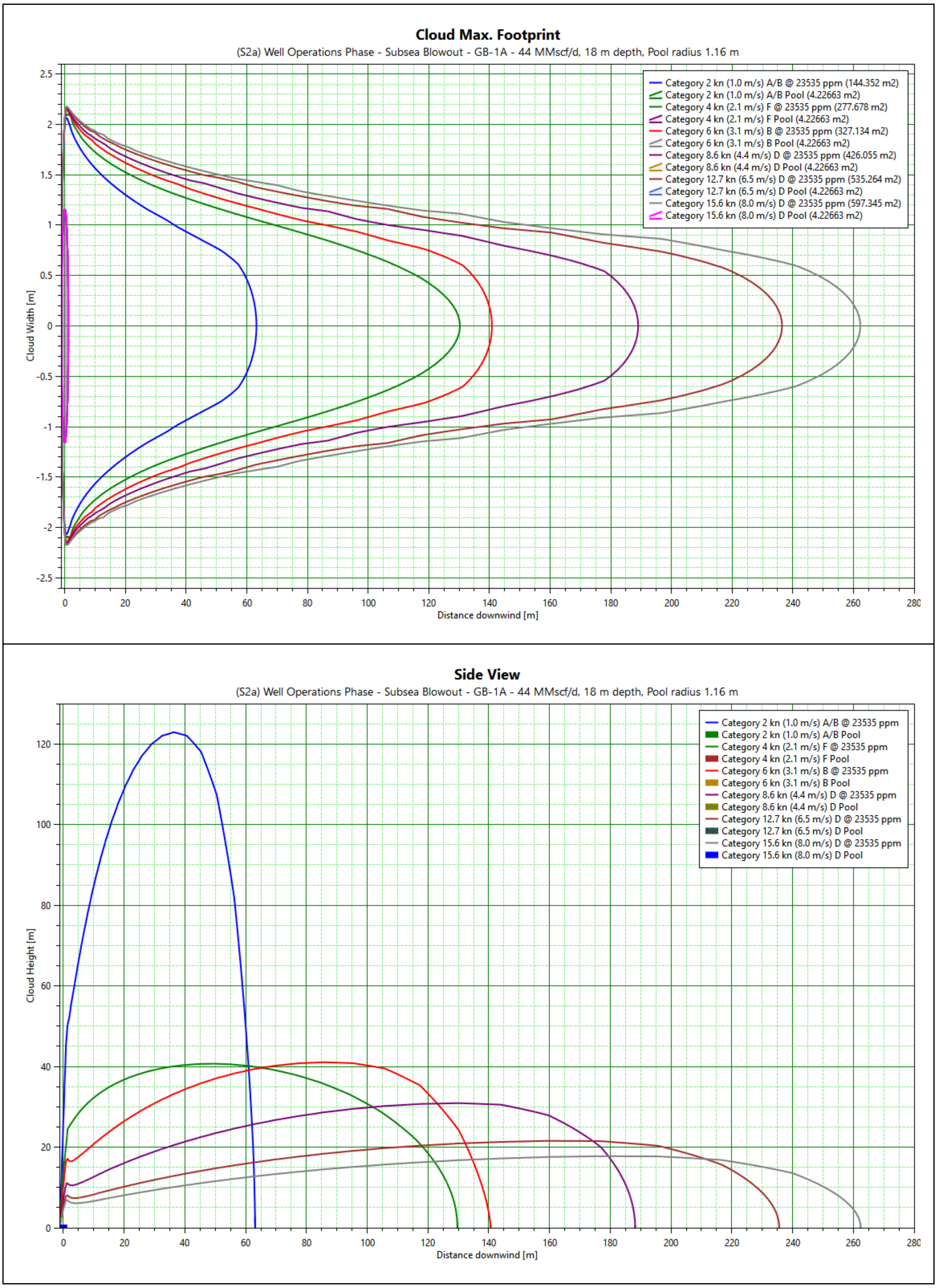


Figure 10.9. Predicted atmospheric dispersion for the 50% LFL (ZOC 4), resulting from a well blowout during operations under all weather conditions. Note the Cloud Max. Footprint shows a plan view of the LFL contours calculated at the water line

10.16.2. Potential Environmental Risks

Environmental receptors most at risk within this EMBA if in the immediate vicinity of the well blowout point are pelagic marine fauna, including:

- Plankton; and
- Fish.

The modelling indicates that at the modelled release location, there is no risk of dry gas at dangerous concentrations reaching the beach or residents in Golden Beach.

10.16.3. EMBA

Water column

According to the modelling undertaken by RPS, the width of the gas plume from the rupture point to the sea surface is 2.32 m and is predicted to reach the surface in less than two seconds.

Atmosphere

Once the gas plume has passed through the water surface, the prevailing weather conditions (e.g., wind speed and direction) determine how far and in what concentrations the plume moves. As presented in Table 10.41, the maximum extent of the LFL extends 65 m vertically and 161 m horizontally.

10.16.4. Evaluation of Environmental Risks

Water column and sea surface

There is a paucity of research undertaken on the effects of methane releases on biological receptors in the water column. However, there is research on the natural phenomena of geological sources seeping methane into the water column via micro seepages, geothermal seeps and mud volcanos and its contribution to the greenhouse effect and global warming (Etiope, 2004; Etiope and Klusman, 2002; Gentz *et al*., 2014). In addition, research following the Macondo oil spill in 2010 is presented here.

Gentz et al (2014) undertook analysis of the mass transfer of methane from rising gas bubbles into the ambient water column from a natural seep in the North Sea. The highest methane concentration (42 nmol L^{-1}) was found at the seafloor in ~230 m water depth. In contrast, the concentration of dissolved methane in the mid and surface water was about 10 nmol L^{-1}. This is significantly higher than the background value of 2.5-3.5 nmol L^{-1} from the Atlantic Ocean reported by Damm et al (2005). Nevertheless, a stratification of methane accumulation was observed by Gentz et al (2014) from a natural seep source. From this research, concentration of dissolved methane in the water column from a natural source is higher towards the seafloor than the surface. This may result in exhaustion of oxygen supply by methane-consuming microbes (methanotrophic bacteria) and consequent kills or exclusion of other marine life from the area of higher methane concentration.

Research undertaken on the Macondo well blowout in the Gulf of Mexico in 2010 provides insight to the fate and effects of methane released to the water column from the seafloor. It is noted that although the Macondo well was in a water depth much deeper (1,500 m) than that of the proposed Golden Beach wells (20 m), there is a paucity of data on this topic and this information provides some context for environmental impacts. The following information is sourced from ‘BP Oil Spill - Crisis in the Gulf’ (Anonymous, 2010). The research trip in the Gulf of Mexico took measurements over a distance that ranged from about 480 m from the Macondo blowout to 13 km away. The team found that methane concentrations were low in the surface water and overlying air, very high at depths greater than 1,000 m and somewhat elevated in between. The researchers interpret this to mean that the vast majority of the methane that escapes is trapped at depths of around 1 km, and that only small amounts are likely to escape through the ocean to the atmosphere. The methane remains in the deep water because in temperate and tropical oceans, seawater forms stable layers that don't readily mix upward.

Analysis of the dissolved gas content from another 90 locations (at various depths for each location) within a 48 km x 64 km radius around the Macondo blowout location revealed a layer within 8 km of the blowout in which the dissolved methane was six times higher than the dissolved oxygen. The main concern of the researchers regarding methane is the possibility that the action of methanotrophic bacteria could exhaust oxygen in the affected layers. That low-oxygen condition would threaten small marine organisms – plankton, fish larvae, and other creatures that can't roam large distances, but form a vital link in the marine food chain. What this means is that methanotrophic bacteria could use up all of the oxygen in that 'lens' of seawater, dropping oxygen levels to zero. However, the breakdown of methane occurs very slowly and microbes need oxygen too. So at some point their activity could slow or stop before all of the oxygen in a methane-heavy parcel of water disappeared. So microbial breakdown of the methane could reduce oxygen concentrations to levels untenable for a range of marine creatures. Just as a lack of vertical mixing in the deep water is holding the dissolved methane at depth, that lack of mixing keeps high levels of dissolved oxygen at the surface from replenishing oxygen levels in the deep water.

However, in the case of a LoWC for the Golden Beach wells, the rapid rise of the gas to the surface (less than 2 seconds) indicates that most of the gas will be released to the atmosphere rather than trapped at depth in the water column. Thermal stratification is not normally expected in the shallow waters of the well locations, thus the 'trapping' of methane in deep cold waters, as observed by Gentz et al (2014) and at the Macondo site (2010), is not likely to occur, meaning that oxygen depletion (and consequent mass kills of marine life) in any one layer of the water column is unlikely.

Nevertheless, a LoWC and consequent rapid release of gas through the water column means that within the gas plume, oxygen depletion (as a result of displacement by methane) will result in the death of marine fauna (e.g., plankton and fish) trapped within the plume. This impact is mitigated by the very small diameter release plume (2.3 m), though it may occur for up to 100 days until a relief well is drilled and the blowout is killed.

A geyser of water rising above the sea level and turbulent currents displacing outward from the geyser could capsize a small vessel if it was in the immediate vicinity of the release location.

10.16.5. Risks to MNES

A LoWC and subsequent dry gas release during the operations phase will not have significant risks to MNES, as outlined in Table 10.42.

Table 10.42. Risks to MNES from a LoWC

MNES	Impact?	Notes
World Heritage properties (see Section 6.4.2)	No	The nearest World Heritage property (Royal Exhibition Building and Carlton Gardens) is located onshore in Melbourne.
National Heritage properties (see Section 6.4.3)	No	The nearest National Heritage property (Australian Alps National Park) is located onshore.
Wetlands of international importance (see Section 6.4.4)	No	The nearest Ramsar-listed wetland (Gippsland Lakes wetlands) is located onshore.
Listed threatened species (see Section 6.3)	No	Impacts to threatened and migratory marine species will not be significant given the very localised extent of the gas plume in the water column and the localised extent of the gas plume in the atmosphere.
Listed migratory species (see Section 6.3)	No	
Commonwealth marine areas: - AMPs (see Section 6.4.1)	No	There are no AMPs predicted to be contacted by the gas plume at the 50% LFL concentration.
- TECs (see Section 6.4.5)	No	There are no TECs predicted to be contacted by the gas plume at the 50% LFL concentration.
- KEFs (see Section 6.4.7)	No	There are no KEFs predicted to be contacted by the gas plume at the 50% LFL concentration.

10.16.6. Risk Assessment

Table 10.43 presents the risk assessment for a LoWC resulting in a dry gas release.

Table 10.43. Risk assessment for a LoWC

Summary		
Summary of risks	Displacement of oxygen in the gas plume in the water column. Release of atmospheric emissions and flammable gas from the sea surface.	
Extent of risk	2.32 m diameter gas plume in the water column. In the atmosphere, <32 m horizontal and <24 m vertical extent for UFL (ZOC 6) (worst case for effects on humans).	
Duration of risk	Duration of well blowout.	
Level of certainty of risks	HIGH – flammability of the gas composition is understood, and a conservative release rate has been selected.	
Initial mitigation measures		
Performance outcome	Performance standard (control)	Measurement criteria
Note that design elements of the wells and production equipment that assist in preventing the uncontrolled release of hydrocarbons are not detailed here. This focuses on performance related to operations only.		

Avoid The wells are operated so there is no LoWC.	The Golden Beach wells are operated in accordance with the NOPSEMA-accepted WOMP.	The well integrity status of the wells is communicated to the operations, engineering, wells, and management teams via the Process Safety Report and/or the quarterly Well Integrity Report.
	Production parameters, including flows, pressures, temperatures and erosion are monitored on a 24-hr basis by qualified and trained operators so that abnormalities are quickly detected and resolved.	Electronic records of continuous monitoring are available.
	Operations personnel are qualified, trained and certified as competent to operate the wells.	The Golden Beach Workforce Capability Requirements Matrix is maintained up-to-date and verifies that operators are qualified, trained and certified as capable.
	The wells PSZ is marked on navigation charts so that vessels are aware of its location and can set navigation paths to avoid it.	The relevant navigation chart illustrates the PSZ and/or cautionary zone.
	Approval from the Operations Manager must be granted to Vessel Masters seeking to enter the PSZ.	The communications log verifies permission is granted for vessels entering the PSZ.
	An approved Lifting and Load Safety Operations is used for all operations inside the PSZ to minimise the risk of suspended equipment dropping onto the wells or associated production equipment.	The Lifting and Load Safety Operations Procedure is current.
		Completed PTWs and/or JSAs verify that the procedure is implemented.
Rehabilitate Well control is regained in the shortest time possible in line with pre-determined plans.	A RWP is in place, developed in line with the Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (IOGP, 2019). The plan outlines the resources (equipment and people) available to respond to a well blowout and is regularly reviewed for currency. The RWP is implemented in the event of the LoWC with the assistance of well control specialists.	The RWP is current.
		Contracts/agreements are in place with well control specialists.
		RWP review reports are available and verify the arrangements remain current.
		Incident reports verify that the RWP was implemented in the event of a LoWC.

	An ERP is in place and tested annually in desktop exercises by those nominated in the plans to be part of the response strategies.	The ERP is current.
		The ERP training schedule is available and remains live.
		The training matrix is maintained as a live document and verifies that personnel nominated to assist in emergency response are up to date with their training.
		ERP exercise reports verify that exercises have been undertaken.
Reporting		
Reporting and monitoring of a LoWC will take place in accordance with the ERP.	GB Energy will report the release to regulatory authorities within 2 hours of the LoWC or becoming aware of the LoWC.	Incident report verifies that contact with regulatory agencies was made within 2 hours.

Risk assessment (initial)			
Risk focus	Consequence	Likelihood	Risk rating
Environment (ecosystem function)	Negligible	Unlikely	Very low

Additional mitigation measures

No additional mitigation measures have been identified.

Risk assessment (residual)			
Risk focus	Consequence	Likelihood	Risk rating
Environment (ecosystem function)	Negligible	Unlikely	Very low

Environmental Monitoring

- Routine environmental monitoring is not required.

Record Keeping

- WOMP.
- Audit reports.
- Workforce Capability Requirements Matrix.
- Training matrix.
- Navigation chart.
- Communications log.
- Lifting and Load Safety Operations Procedure.
- RWP.
- ERP.
- Completed PTWs.
- Completed JSAs.
- Incident reports.

10.17. Oil Spill Response Activities

Section 8.17 in the drilling EIA chapter details the MDO spill response strategies that may be applied in the event of a 155 m^3 MDO spill. As the MDO spill scenario for the operations phase is the same as that for the drilling phase, the same spill response options apply during the operations phase.

The residual risks for these oil spill response activities vary between ‘very low’ and ‘low.’

11. Decommissioning

The production of sales gas from the Golden Beach reservoir is expected to last approximately 18-24 months. However, the storage capabilities of the development extends the lifespan of the Project to 40 years. Thus, decommissioning of the development assets is not likely to occur for several decades.

However, in accordance with the OPGGS Act (Section 621), and/or any other legislation relevant at the time, GB Energy will remove the subsea production equipment as outlined in an activity-specific EP that will be developed and submitted to DJPR ERR (or the relevant government agency at the time) for approval.

The decommissioning design is in the preliminary stage of planning. At this stage, it is envisaged that decommissioning will involve:

- P&A of the wells;
- Removal of well protective structures;
- Removal of the subsea RGP (or retain in situ and fill with inert gas, subject to a risk-based assessment and regulatory requirements at the time); and
- Recovery of all other associated subsea equipment (e.g., PLEM, tie-in spools, SUTA, etc).

Should the subsea RGP be left in situ, the pipeline will be depressurised, cleaned and purged through injection of an inert substance (such as nitrogen) or flushed with seawater. Determination of whether the pipeline poses an environmental or safety risk is likely to govern whether it is removed or left in situ. If the pipeline is to be removed, it will be excavated, cut into sections and disposed of, which will require the use of a vessel, divers and/or ROV.

Regardless of the exact specifics of the decommissioning design, it is likely that vessels and a MODU will be required to complete the full decommissioning process. A high-level analysis of the impacts and risks associated with the decommissioning activities is presented in Table 11.1.

Table 11.1. Summary of decommissioning activity impacts and risks

Phase	Requirements	Impacts & risks
Well P&A and removal of protective structures	MODU Support vessels	Impacts and risks relevant to the MODU and support vessels completing P&A activities are largely the same as those presented in Chapter 8, noting that drill cuttings and muds will not be generated. Cement will be used in the plugs, and as such some cement may be discharged in accordance with Section 8.4. The risk of a gas release from the reservoir (Section 8.16) is greatly reduced because of the depleted nature of the gas reservoir. The conductor of both wells will be cut several metres below the seabed to avoid any risk to fishing. Seabed habitat and refuge (although artificial) created by the trawl guards will be lost following removal.

Phase	Requirements	Impacts & risks
Removal of subsea production equipment	Vessels ROVs/divers	The impacts and risks generated by vessel activities, in order to carry out removal of the subsea production equipment, are largely the same as those presented in Chapter 9. However, the MDO spill risk is more accurately presented in Section 8.15 due to the smaller vessel/s likely to be used (compared to a pipelay vessel). Seabed disturbance will occur with the removal of the subsea equipment. If the pipeline is also removed, this too will result in seabed disturbance.
Pipeline remaining in situ	Flushing and capping	If the pipeline remains in situ, seabed disturbance resulting from removal is avoided. If not buried, the pipeline may continue to act as a barrier to the natural movement of sediments and fauna across the seafloor (if has not been trenched in or naturally buried). However, given the short length of the pipeline relative to the actions that generate sediment movements in shallow waters (i.e., currents, wind and waves), the risk of the pipeline remaining in situ for natural seabed processes is likely to be very low. If not buried, the pipeline is also likely to provide hard substrate for flora and fauna anchoring, which will facilitate the continued growth of biofouling species and create an artificial reef structure. The pipeline would be flushed and filled with an inert gas and no hydrocarbons will remain in the pipeline. The pipeline may pose a risk, albeit very low, to fishing equipment particularly trawling equipment, though it will remain marked on navigation charts.

12. Environmental Management and Monitoring

This chapter presents the environmental management and monitoring relevant to the marine aspects of the Project. Further detail will be provided in the Environmental Management Framework for the Project and in the relevant activity-specific EPs for approval by DJPR ERR.

12.1. Measures to be Undertaken to Minimise Risks

The control measures to be undertaken to minimise, mitigate and avoid risks from the Project are presented throughout Chapters 8, 9 and 10 of this report. Specific EPO and EPS have been assigned to each of the risks and these will be further refined in response to project design in the activity-specific EPs that will be submitted to DJPR ERR for approval prior to the commencement of each phase of work.

An environmental risk register for each phase of the Project is included in **Appendix 6**, which includes the control measures that will be implemented to mitigate Project impacts and risks.

12.2. Residual Risk Assessment/Review

As presented throughout Chapters 8, 9 and 10 of this report, there are no residual risk ratings higher than 'medium.' The EPS and EPO presented throughout this report effectively reduce the likelihood and consequence of the risks, though many of these were already low because of the:

- Low environmental sensitivity of the Project area (sandy sediments and an absence of rocky reefs);
- Localised extent of impacts relating to planned activities;
- The short-term nature of the construction activities; and
- The benign nature of pipeline and well operations.

12.3. Roles and Responsibility

The environmental roles and responsibilities for the Project are split between onshore and offshore GB Energy and contractor personnel, depending on the phase. Table 12.1 lists the roles and responsibilities of GB Energy personnel; this table will be expanded upon in the EPs for drilling, pipeline installation and operations to provide more information for key personnel involved in each phase of work.

Table 12.1. Environmental roles and responsibilities

Role	Environmental responsibilities
GB Energy	
Chief Executive Officer	• Ensures GB Energy is adequately resourced to implement the environmental control measures. • Undertakes consultation with senior government personnel and other Titleholders.
Chief Operating Officer	• Ensures that contractors have appropriate equipment and systems in place to undertake activities in accordance with industry best practice and the EPs. • Attends daily operational meetings. • Facilitates clear communications between GB Energy and the offshore contractors. • Ensures the Project vessels and equipment are appropriately

Role	Environmental responsibilities
	inspected, certified and fit for purpose. • Ensures compliance with the EPs. • Approves major changes to the Project design in accordance with the Management of Change procedures. • Liaises with and approves incident reports for submission to regulators. • Approves the Environmental Performance Report of each EP for submission to DJPR ERR. • Approves the end-of-activity notification for submission to DJPR ERR.
Regulatory & HSE Manager	• Reviews legislation and updates the legal register. • Ensures all regulatory approvals are obtained before commencement of activities. • Reviews all regulatory approvals documentation. • Leads stakeholder consultation for the Project. • Monitors environmental performance against each EPS. • Reviews operational reports and gathers evidence to demonstrate compliance with EPS. • Ensures effective emergency response arrangements are in place for the Project. • Ensures all project personnel are inducted and are aware of their activity-specific environmental responsibilities. • Ensures all required plans, audits and reviews are undertaken. • Leads the investigation and reporting of any environmental or safety incidents. • Supports the Emergency Response Team in the event of an incident. • Attends daily operational meetings. • Reviews major changes to operations. • Prepares monthly and end-of-activity environmental performance reports.
Stakeholder Engagement Coordinator	• Reviews and endorses the Stakeholder Engagement Plan. • Ensures thorough and timely stakeholder consultation is undertaken prior to, during and after the activities. • Undertakes consultation with stakeholders and records all feedback. • Liaises with the Regulatory & HSE Manager to provide technical feedback to stakeholders.

12.4. Further Regulatory Approvals

As the Project design advances, further detail on the activity-specific EMF, roles and responsibilities and control measures, particularly in relation to the offshore vessel and drilling contractors, will become available and presented in future EPs.

Table 12.2 presents the EP series required for the Project, which will be submitted to DJPR ERR for approval before any works can commence.

Table 12.2. EP series summary

EP	Project component
Drilling and completions	Drilling of two subsea wells and installation of XMTs and protective equipment.
Pipeline installation	Installation of subsea pipeline and associated subsea equipment including PLEM, tie-in spools, umbilical, etc.
Operations	Operation of the offshore infrastructure to support gas extraction and injection. Revisions every 5 years will be required over the life of the project.
Decommissioning	Decommissioning and removal of subsea infrastructure in accordance with the legislation of the day and environmental best practice.

12.5. Consultation and Communication

GB Energy implements open and transparent engagement to inform its stakeholders and the community in its planning processes. Community feedback relevant to the marine component of the project is summarised in Chapter 5 of this report.

The stakeholder engagement undertaken to inform this EES is presented in Chapter 24 of the EES main report and Attachment III to the EES.

GB Energy will continue its stakeholder consultation through each project development phase, which will be reported in more detail in each EP.

12.6. Environmental Management System

12.6.1. GB Energy

GB Energy has in place a Health, Safety and Environmental Management System (HSEMS) that is aligned with ISO 14001:2015 (Environmental Management Systems – requirements with guidance for use).

The HSEMS contains 14 elements for identifying, managing and reducing the company's impact on health, safety and the environment (HSE), based on the principle of continual improvement and the 'plan, do, check, act' cycle in line with ISO14001. The elements of the EMS are briefly described in Table 12.3.

Table 12.3. Summary of the GB Energy HSEMS

Element		Intent
1	Policies, Leadership and Accountabilities	GB Energy directors, managers, employees and contractors understand their respective responsibilities, and demonstrate leadership and commitment to the values of the HSE Policy and the performance requirements specified in the HSE Elements.
2	Commitments, Legal and other Requirements	Relevant legal and other requirements including HSE commitments are identified, understood and applied to all aspects of the organisation's activities and operations.
3	Risk Management	HSE hazards are identified and risk assessed, controlled and managed to as low as reasonably practicable.
4	Goals and Improvement Plans	HSE considerations are integrated into the GB Energy business planning process and these plans drive continual improvement in HSE performance.

Element		Intent
5	Awareness, Behaviour and Competence	GB Energy personnel and visitors are appropriately skilled, trained, aware and competent to conduct activities in accordance with the behaviours expected in the HSE Policy and these HSE Elements.
6	Change Management	Changes whether planned or unplanned, permanent or temporary or as the result of incremental change are assessed for potential HSE risks and appropriate action is taken to ensure existing performance levels are not compromised.
7	Communication and Consultation	Open and consultative communication practices are established with personnel and external stakeholders on HSE matters and encourage participation in HSE performance improvement initiatives.
8	Document Control and Records Management	HSE management system documents and records are controlled, readily available, current and appropriate to ensure compliance with the HSE Policy and these HSE Elements.
9	Project Design, Construction and Commissioning	HSE risks and opportunities are considered for all phases of projects including design, construction and commissioning.
10	Operations and Maintenance	Procedures for the operation, maintenance, inspection, testing and calibration of facilities, equipment and instruments are established and maintained such that activities are carried out in a manner that minimises adverse HSE effects.
11	Suppliers and Contractors	Contracted services and purchase, hire or lease of equipment and materials are carried out to minimise adverse HSE consequences and to improve HSE performance.
12	Non-conformances and Incident Investigation and Reporting	Non-conformances and incidents are identified, reported and investigated, with corrective and preventive actions implemented, and learnings shared.
13	Crisis and Emergency Management	Procedures and resources are established for the identification, preparation and effective response to crisis and emergency situations.
14	Monitoring, Audit and Reviews	HSE performance is monitored, audited and reviewed to ensure the effectiveness of HSE management system towards meeting the requirements of the HSE Policy and these Elements, and to drive continual improvement in HSE performance.

12.6.2. Contractors

GB Energy contractors used to carry out offshore activities will be required to have an HSEMS that meets the requirements of the GB Energy HSE Policy and HSEMS. Part of GB Energy's contractor selection process will involve evaluating the HSE performance of its key contractors through a contractor HSE evaluation process.

12.7. Training and Awareness

12.7.1. Recruitment and Training

During its contractor selection process for each phase of the Project, GB Energy will conduct a due diligence review to ensure that the chosen contractors have procedures in place to ensure the correct selection, placement, training and ongoing assessment of employees, with position descriptions (including a description of HSE responsibilities) for key personnel being readily available.

12.7.2. Environmental Induction

For each phase of the Project, an activity-specific HSE induction for all personnel working on the activity will be undertaken prior to its commencement. The environmental component of the induction will include information on the following relevant environmental issues:

- Description of the environmental sensitivities, conservation and heritage values of the Project area;
- Overview of cetacean interaction procedures;
- Importance of following procedures and using JSAs to identify environmental risks and mitigation measures;
- Procedures for responding to and reporting environmental hazards or incidents;
- Overview of emergency response and spill management procedures;
- Overview of the waste management requirements; and
- Roles and environmental responsibilities of key personnel.

GB Energy will have a representative onboard the MODU and pipelay installation vessel who is responsible for ensuring personnel receive this induction prior to commencement. All personnel will be required to sign an attendance sheet to confirm their participation in and understanding of the induction.

The contractors will conduct their own relevant company and vessel-specific inductions independently of GB Energy's project HSE induction.

12.7.3. Oil spill training

Quarterly training of vessel crews in SMPEP procedures is a MARPOL requirement for vessels (including MODUs) over 400 GRT (Annex 1, Regulation 37).

During its contractor selection process, GB Energy will assess the vessel contractors' implementation of their SMPEPs (or equivalent, relevant to class).

An office-based desktop spill response exercise of the OPEP will be conducted by GB Energy (in conjunction with its oil spill response contractor, Oil Spill Response Australia [ORCA]) within four weeks prior to the commencement of the drilling campaign.

12.7.4. Toolbox Talks and HSE Meetings

Environmental matters will be included in daily toolbox talks for each phase of the Project as required by the specific task being risk assessed (e.g., waste management onboard the MODU during drilling).

12.8. Environmental Emergencies and Preparedness

12.8.1. Offshore Emergencies and Oil Spills

GB Energy will ensure that activity-specific emergency response procedures are included in each key contractor's ERP. The emergencies that will be considered are outlined below.

Environmental Emergencies

Environmental emergencies to be considered will include (but not be limited to):

- IMS incursions;
- Injury or death of a cetacean (from entanglement, collision or vessel strike); and
- Introduction of animal diseases into aquaculture.

Oil Spill Emergencies

The management of oil spill-related emergencies (specifically, the release of MDO) will be addressed in the Project OPEP and vessel-specific SMPEPs.

Vessel-specific ERPs and SMPEPs typically include vessel-specific procedures for the following:

- Vessel incidents – collision, grounding, hull damage, man overboard, equipment failure;
- Waste management;
- Hazardous materials and handling; and
- Hydrocarbon and chemical spills.

Accompanying each activity-specific EP (listed in Table 12.2) will be an OPEP, which will be implemented (and supplements the vessel-specific SMPEP) in the event of a large-scale hydrocarbon spill that requires response resources beyond those immediately available to GB Energy. The OPEP details the response actions aimed at minimising the impacts of an MDO spill on sensitive resources.

The relevant contractors will ensure that their crews are fully aware of the vessel-specific requirements and that exercises for vessel-related incidents are conducted.

Non-environmental Emergencies

An activity-specific ERP bridging document (which bridges between the contractors' ERPs and GB Energy's requirements) will be prepared for each phase of the Project.

The vessel-specific ERPs will be reviewed to ensure that the following non-environmental emergencies are considered as listed in Section 9.1 of the Marine Emergencies (non-search and rescue) Plan, Part B, Operational Plan (EMV, 2017):

- Maritime casualties requiring salvage and intervention, emergency towage and requests for a place of refuge;
- Marine pollution from floating or sunken containers of hazardous materials;
- Debris originating from a maritime casualty;
- Physical damage caused by vessels;
- Fire or explosion on the vessel;
- Hijack/terrorism; and
- Adverse weather (e.g., storm, tsunami).

Where these emergencies are not dealt with in the vessel-specific ERPs, they will be included in the project-specific ERP.

12.8.2. Emergency Response Training

The readiness and competency of GB Energy (and its oil spill response contractor ORCA) and the contractors to respond to incidents and emergencies will be tested by conducting a desktop emergency response exercise within four weeks prior to drilling and pipe lay contractors commencing their respective activities.

A scenario will be chosen that combines an emergency with risk to human life (such as fire) and risk to the environment (large hydrocarbon spill) so that several plans (i.e., the ERP and OPEP) can be tested simultaneously.

These exercises will be facilitated by an experienced facilitator. At the completion of the exercises, the facilitator will hold a debrief session during which the exercise is reviewed, and lessons learned and areas for improvement are identified.

Any learnings, findings or recommendations identified as part of the exercises will be addressed and incorporated into the relevant ERPs and procedures to ensure they remain effective.

12.9. Simultaneous Operations

Simultaneous operations (SIMOPS) refers to two or more operations occurring simultaneously in the same area that have the potential to interfere with each other. This could be project vessels interacting with other (e.g., the pipeline installation vessel working at the same time as the MODU) or third-party vessels interacting with Project vessels. There is currently no plan for the MODU to be in the Project area at the same time as the pipelay installation vessel.

In the event of simultaneous operations that may impact on the Project, GB Energy will engage that operator and conduct a joint SIMOPs assessment.

12.10. Recording and Reporting

Routine HSE recording and reporting will be undertaken using methods such as (but not limited to):

- Daily teleconferences – held between the vessels and MODU personnel to provide an update on the previous day's progress and the forward plan for the next 24 hours, including any HSE issues.
- Daily operations reports – generally prepared by the Onboard GB Energy Representative, which includes data on activities conducted for the previous 24 hours and any HSE issues arising.
- HSE reporting – the Regulatory and HSE Manager will collate key HSE performance statistics on a daily basis and report these to the project team during the daily teleconferences.
- Weekly HSE meetings – the MODU and vessels will hold weekly HSE meetings with all crew to review issues and statistics from the previous week and plan for safe operations for the coming week.
- Monthly environmental report – GB Energy will prepare a monthly recordable incident report for submission to the DJPR (ERR Branch) not later than 15 days after the end of the calendar month.
- EP performance report – the Regulatory and HSE Manager will prepare an end-of-activity performance report that reports on the outcomes of each EPS listed in this report (and subsequent EPs), based on compliance monitoring, inspections and/or audits. This will be submitted to the DJPR (ERR Branch) within 3 months of completion of each phase of the activity.

Notifications to relevant authorities will be undertaken in accordance with the relevant EP that will be developed for each phase of work. In general, the following pre-activity notifications will be made:

- Notify AMSA in order to issue daily AusCoast warnings;
- Notify DJPR ERR with the activity start and end date;

- Notify the AHO of the activity start date and duration to enable Notices to Mariners to be issued;
- Notify MSV of the activity start date and duration to enable Notices to Mariners to be issued; and
- Notify all other stakeholders in the stakeholder register with the activity start date.

12.10.1. Incident Recording and Reporting

Contractors will report all environmental near-misses and incidents, including non-compliances with the relevant EPO and EPS, to the GB Regulatory & HSE Manager. This expectation will be reinforced at inductions, daily toolbox meetings and weekly HSE meetings.

All environmental near-misses and incidents will be recorded in GB Energy's Incident and Correct Actions Register in accordance with the HSE Incident, Investigation, Management and Reporting Procedure. Where the incident is classified as recordable or reportable under the OPGGS Regulations, the incident will be reported to the DJPR (ERR Branch) in accordance with the activity-specific EP.

12.11. Management of Change

GB Energy's Management of Change (MoC) procedure will be used as the over-arching document to guide the MoC process for the Project activities. The GB Energy MoC procedure will be used to determine whether any changes to the design of the relevant activity (or other factors) trigger the need to amend environmental management of the activity and/or revisions to the relevant EP that require re-submission to DJPR (ERR Branch).

12.12. Monitoring

This section describes the environmental monitoring that will conducted during the Project's development and operations.

GB Energy will maintain a quantitative record of emissions and discharges generated on location.

The method of collection and reporting of this data will be outlined in the activity-specific EPs. Table 12.4 presents the summary of environmental data that will be monitored.

Table 12.4. Summary of the environmental monitoring to be undertaken during the Project

Aspect	Monitoring requirement	Project phase		
		Drilling	Pipelay	Ops
Underwater sound	Megafauna visual observations	Yes	Yes	Yes
Cement	Chemicals and volumes used in the cement system	Yes	No	No
Drilling muds	Chemicals used in the mud system	Yes	No	No
	Volume of muds discharged overboard	Yes	No	No
	Continuous observation of the separation system on the MODU	Yes	No	No
Atmospheric emissions	Fuel consumption	Yes	Yes	Yes

Aspect	Monitoring requirement	Project phase		
		Drilling	Pipelay	Ops
Bilge water	Volume of bilge water discharged	Yes	Yes	Yes
Waste disposal	Weight/volume of wastes sent ashore (including oil sludge, solid/hazardous wastes, putrescible waste, etc)	Yes	Yes	Yes
Displacement of or interaction with third-party vessels	Continuous bridge watch for (and communications with, as necessary), third-party vessels	Yes	Yes	Yes
Introduction of IMS	Volume and location of ballast water discharges	Yes	Yes	Yes
Vessel strike or entanglement with cetaceans	Continuous bridge watch	Yes	Yes	Yes
MDO spill	Operational monitoring in line with the relevant OPEP	Yes	Yes	Yes
Gas release from well blowout	During drilling: BOP pressure testing, BOP function testing and well casing pressure testing	Yes	No	No
	During operations: management in accordance with the relevant WOMP	No	No	Yes
Gas release from pipeline rupture	IMMR activities in accordance with the pipeline safety case	No	No	Yes

12.13. Compliance Management

Ensuring that each phase of work complies with the EPS outlined in this report (and future EPs) requires continuous compliance management, including during the activities. This is achieved through preparing and implementing an inspection and auditing program.

In general, the following arrangements will be established to ensure the environmental performance of each activity:

- HSE due diligence pre-activity inspection – an inspection of the MODU, pipelay installation vessel and support vessels will be carried out prior to the activity starting to ensure that each contractor's management team and crew are well prepared to meet the environmental controls outlined in the EPs.
- Activity audit – pre-activity inspections will be followed up with one or more onboard audits against relevant documents (e.g., EP, WOMP, Safety Case) during the activity.
- Operations inspections – the GB Energy Onboard Representative (during drilling and pipelay) will continually supervise the activity, ensuring adherence to the environmental controls specified in the relevant EP. Regular inspections using an HSE checklist issued by GB Energy will be completed to ensure day-today compliance with all environmental commitments.

Inspections and audits will be conducted by personnel suitably qualified and experienced to do so.

A summary of the activity-specific environmental commitments will be distributed to relevant personnel, and implementation will be monitored in accordance with the relevant EP.

Environmental performance of each activity will be reviewed at its completion. These reviews are undertaken to ensure that:

- Compliance with all controls was achieved; and
- Non-compliances or potential non-compliances and opportunities for improvement are identified so that these issues can be avoided for the next phase of work.

13. Conclusion

The purpose of this report is to undertake a marine EIA to inform the EES.

A summary of the existing environmental conditions and values in and around the Project area and the associated risks are summarised here.

13.1. Existing Conditions

As presented throughout Chapter 6, the dominant seabed habitat in the Project area is sandy sediments with sparse macroalgae and sponges in water depths ranging from 10-20 m. Inhabiting the sandy sediments are benthic invertebrates such as polychaetes, bivalves, molluscs and echinoderms. The geophysical survey conducted in March 2020 confirms the absence of subtidal rocky reef in the Project area, with the closest known area of rocky reef located 500 m to the west of the Project area and other reefs located more than 1 km from the Project area.

Table 13.1 presents the threatened species that were identified by the EPBC PMST, VBA and Atlas of Living Australia databases for the Project area.

Table 13.1. Threatened species identified by the PMST and VBA databases that may be present in the Project area

Species group	EPBC Act Listing				FFG Act Listing
	Threatened status			Migratory*	Threatened*
	Critically endangered	Endangered	Vulnerable		
Shorebirds	5	4	3	15	8
Seabirds	-	4	17	17	9
Reptiles	-	2	1	3	1
Cetaceans	-	2	1	6	2
Fish	-	-	4	3	2

**Note: a single species may be listed as both migratory and threatened under the EPBC Act and FFG Act.*

The Project area is located within the Bass Strait ATBA, which encapsulates the Gippsland hydrocarbon province and numerous offshore petroleum installations. Commonwealth and Victorian fisheries are licensed to operate in the region, with Lakes Entrance being the key port of relevance to the Project area. Fishing intensity in the Project area is low, with only one fisher working infrequently in these waters.

13.2. Risk assessment

There are no residual risk ratings above 'medium' for each phase of the Project with the majority rated as 'very low' and 'low'. Impacts resulting from planned activities will be limited to the immediate Project area, generally within a few hundred metres. While unplanned activities could result in impacts that extent far wider than the Project area, the likelihood of these occurring is very low. No significant impacts to MNES are predicted from planned or unplanned activities. The mitigation and control measures that will be implemented are presented in Chapters 8, 9 and 10.

It is demonstrated through this EIA that risks during:

- Construction (drilling and pipeline installation) – are temporary, highly localised and because of the low sensitivity of the Project area, predominantly range from 'very low' to 'low' risk.
- Operations – the presence of the subsea infrastructure and the infrequent and short-duration maintenance and repair activities have risk ratings ranging from predominantly 'very low' to 'low.'

'Medium' risk is associated with the introduction of IMS for each phase of the Project, an inherent risk for most maritime operations, and for the discharge of drill cuttings and muds during the drilling phase.

Project decommissioning will occur at the end of project life in approximately 40 years and will involve activities similar to those outlined in this report that have been demonstrated to have 'low' environmental risks through this EIA.

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