ENVIRONMENT PLAN

Beehive Pre-Drill Seabed
Assessment

WA-488-P

23 December 2021

Rev 1

eog resources

Prepared for:

EOG Resources Australia Block WA-488 Pty Ltd

ACN: 648 224 293

Suite 12, Level 12, 37 Bligh Street, Sydney, NSW, 2000, Australia

www.eogresources.com

Prepared by:

Aventus Consulting Pty Ltd

ABN: 68 100 174 202

Suite 307, 75 Tulip Street, Cheltenham, VIC 3192

www.aventusconsulting.com.au

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Project Team

Name	Title	Project role
Giulio Pinzone	Principal Environmental Consultant	Project Manager, co-author
Jannina Stillitano	Senior Environmental Consultant	Co-author
Lachlan McLennan	Environmental Consultant	Co-author

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Acronyms

Acronym	Definition
2D	Two-dimensional
3D	Three-dimensional
AAR	Air to Air Refuelling
ACMA	Australian Communications and Media Authority
AEST	Australian Eastern Standard Time
AEW&C	Airborne Early Warning and Control
AFANT	Amateur Fishermen’s Association of the Northern Territory
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHIS	Aboriginal Heritage Inquiry System
AHO	Australian Hydrographic Office
AIMS	Australian Institute of Marine Science
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
AS	Australian Standard
ASBTIA	Australian Southern Bluefin Tuna Industry Association
AST	Aspartate Transaminase
BACI	Before-After-Control-Impact
BAT	Best Available Techniques
BIA	Biologically Important Area
BOM	Bureau of Meteorology
BPEM	Best Practice Environmental Management
BRAHSS	Behavioural Response of Australian Humpback whales to Seismic Surveys
BRUVS	Baited Remote Underwater Video Systems
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BWMC	Ballast Water Management Certificate
BWMP	Ballast Water Management Plan
BWR	Ballast Water Report

Acronym	Definition
BWRS	Ballast Water Record System
CAMBA	People's Republic of China for the Protection of Migratory Birds and their Environment 1986
CEFAS	Centres for Environment, Fisheries and Aquaculture Science (UK)
CFA	Commonwealth Fisheries Authority
CHARM	Chemical Hazard and Risk Management
CHIRP	Compressed High-Intensity Radar Pulse
CMST	Centre of Marine Science and Technology
CoEP	Code of Environmental Practice
CPUE	Catch Per Unit Effort
CTD	Conductivity, Temperature and Depth
Cth	Commonwealth
DAFF	Department of Agriculture, Fisheries and Forestry
DAWE	Department of Agriculture, Water and the Environment (Cth)
DBCA	Department of Biodiversity, Conservation and Attractions (WA)
DEPWS	Department of Environment, Parks and Water Security (NT)
DITT	Department of Industry, Tourism and Trade (NT)
DMIRS	Department of Mines, Industry Regulation and Safety (WA)
DNP	Director of National Parks
DoD	Department of Defence
DoF	Department of Fisheries (WA)
DoT	Department of Transport
DP	Dynamic Positioning
DPIRD	Department of Primary Industries and Region Development (WA)
DPLH	Department of Planning, Lands and Heritage (WA)
EB	Environmental Benefit
EIA	Environmental Impact Assessment
EIAPP	Engine international air pollution prevention
EMBA	Environment That May Be Affected
EP	Environment Plan
ePAR	Electronic Pre-Arrival Report
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999 (Cth)
EPO	Environmental Performance Objective
EPS	Environmental Performance Standard
ERA	Environmental Risk Assessment

Acronym	Definition
ERC	Emergency Response Coordinator
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESD	Ecologically Sustainable Development
Ev	Evaluation
FPSO	Floating Production Storage and Offloading
FRDC	Fisheries Research Development Corporation
G&G	Geophysical and Geotechnical (investigations)
GEP	Gas Export Pipeline
GHG	Greenhouse Gas
GMP	Garbage Management Plan
GNSS	Global Navigation Satellite System
HFC	High Frequency Cetacean
HFO	Heavy Fuel Oil
HMCS	Harmonised Mandatory Control Scheme
HQ	Hazard Quotient
HSE	Health , Safety and Environment
HVAC	Heating, Ventilation and Air Conditioning
IAFS	International Anti-fouling System
IAGC	International Association of Geophysical Contractors
IAPP	International Air Pollution Prevention
IEE	International Energy Efficiency
IMAS	Institute for Marine and Antarctic Studies
IMCA	International Marine Contractors Association
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMDG	International Marine Dangerous Goods
IMO	International Maritime Organisation
IMP	Impact
IMS	Invasive Marine Species
IMT	Incident Management Team
IOGP	International Association of Oil & Gas Producers
IOPP	International Oil Pollution Prevention
IPIECA	International Petroleum Industry Environmental Conservation Association
IPP	International Pollution Prevention

Acronym	Definition
IR	Infra-red
ISPP	International Sewage Pollution Prevention
ISPS	International Ship and Port Facility Security
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
JBG	Joseph Bonaparte Gulf
JSA	Job Safety Analysis
KCMF	Kimberley Crab Managed Fishery (also referred as the North Coast Crab Fishery).
KEF	Key Ecological Feature
KGBF	Kimberley Gillnet and Barramundi Fishery
KLC	Kimberley Land Council
KPMF	Kimberley Prawn Managed Fishery
LAT	Lowest Astronomical Tide
LFC	Low Frequency Cetacean
LP	Low Pressure
LPG	Liquified Petroleum Gas
Ltd	Limited
LWD	Logging While Drilling
MARPOL	International Convention for the Prevention of Pollution from Ships
MBC	Maritime Border Command
MBES	Multi-beam echo sounder
MDO	Marine Diesel Oil
MFC	Mid Frequency Cetacean
MMF	Mackerel Managed Fishery
MMO	Marine Mammal Observer
MNES	Matters of National Environmental Significance
MoC	Management of Change
MODU	Mobile Offshore Drilling Unit
MP	Marine Park
MSS	Marine Seismic Survey
NatPlan	National Plan for Maritime Environmental Emergencies
NCVA	National Conservation Values Atlas

Acronym	Definition
NDSMF	Northern Demersal Scalefish Managed Fishery
NEBA	Net Environmental Benefit Analysis
NIW	Nationally Important Wetlands
NLC	Northern Land Council
NMFS	National Marine Fisheries Service
NMR	North Marine Region
NNTT	National Native Title Tribunal
NOPSEMA	National Offshore Petroleum Safety and Environment Management Authority
NPF	Northern Prawn Fishery
NPFI	Northern Prawn Fishing Industry Pty Ltd
NRT	National Response Team
NSW	New South Wales
NT	Northern Territory
NT Plan	Northern Territory Oil Spill Contingency Plan 2014
NTSC	Northern Territory Seafood Council
NWMR	Northwest Marine Region
NWSA	North Wildcatch Seafood Australia
NZS	New Zealand Standard
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone Depleting Substances
OIW	Oil In Water
OPEP	Oil Pollution Emergency Plans
OPGGS	*Offshore Petroleum and Greenhouse Gas Storage Act* 2006 (Cth)
OPGGS(E)	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPIC	Offshore Petroleum Incident Coordination
OSMP	Operational and Scientific Monitoring Programs
OSPAR	Oslo-Paris Convention 1992
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response
OWS	Oily Water Separator
P&ID	Piping and Instrumentation Diagrams
PAH	Polyaromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCPT	Piezo Cone Penetrometer Test

Acronym	Definition
PDSA	Pre-drilling Seabed Assessment
PLONOR	Pose Little or No Risk
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
POB	Persons On Board
POLREP	Pollution Report
PPA	Pearl Producers Association
PPE	Personal Protective Equipment
PTS	Permanent Threshold Shift
PTW	Permit To Work
PVC	Polyvinyl Chlorides
PWC	Parks and Wildlife Commission
PWS	Parks and Wildlife Service (WA)
RCC	Response Coordination Centre
REACH	Registration, Evaluation and Authorisation of Chemicals
RO	Reverse Osmosis
ROKAMBA	Republic of Korea Migratory Birds Agreement 2006
ROV	Remotely Operated Vehicle
RQ	Risk Quotient
SBM	Synthetic-based mud
SBP	Sub-bottom profiling
SBTF	Southern Bluefin Tuna Fishery
SDS	Safety Data Sheet
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SIMOPS	Simultaneous Operations
SITREP	Situation Report
SMPEP	Shipboard Marine Pollution Emergency Plan
SPL	Sound Pressure Level
SPRAT	Species Profile and Threats
SRL	Southern Rock Lobster
SSS	Side scan sonar
STCW	Standards of Training, Certification and Watchkeeping for Seafarers
STP	Sewage Treatment Plant

Acronym	Definition
TECS	Threatened Ecological Communities
TTS	Temporary Threshold Shift
UNEP IE	United Nations Environment Programme Industry and Environment
USA	United States of America
USBL	Ultrashort Base Line
UXO	Unexploded Ordnance
VHF	Very High Frequency
VoO	Vessels of Opportunity
WA	Western Australia
WAF	Water-Accommodated Fraction
WAFIC	Western Australian Fishing Industry Council
WBM	Water-based mud
WEL	Woodside Energy Limited
WestPlan	Western Australian Oil Spill Contingency Plan
WHP	Wellhead Platform
WSTF	Western Skipjack Tuna Fishery
WTBF	Western Tuna and Billfish Fishery

1. Introduction

1.1. Background

EOG Resources Australia Block WA-488 Pty Ltd (hereafter referred to as EOG) is the titleholder of exploration permit WA-488-P and proposes to undertake geophysical and geotechnical (G&G) investigations within Commonwealth marine waters approximately 84 kilometres (km) north of the Western Australian (WA) coastline in the Joseph Bonaparte Gulf (JBG) (Figure 1.1).

The activity is referred to as the Beehive Pre-Drill Seabed Assessment (PDSA, hereafter variously referred to as 'the activity' or 'the PDSA').

1.2. Purpose

EOG proposes to undertake the PDSA (in advance of drilling an exploration well (Beehive-1) in permit area WA-488-P. The purpose of the activity is to assess and characterise the seabed for risk mitigation and geohazard identification and to evaluate the sub-seabed conditions to support a jack-up Mobile Offshore Drilling Unit (MODU) that will be used to drill the Beehive exploration well, as well as future wells.

The activity will be conducted entirely within Commonwealth waters in accordance with the *Offshore Petroleum and Greenhouse Gas Storage Act* 2006 (Cth) (OPGGS Act 2006) and Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (herein referred to as the OPGGS(E)).

This Environment Plan (EP) covers all operations associated with the activity. It aims to secure acceptance of the Beehive PDSA from the National Offshore Petroleum Safety and Environment Management Authority (NOPSEMA) by demonstrating that EOG will manage the environmental impacts and risks of the activity (as defined in Section 1.4.1 of this EP) to As Low As Reasonably Practicable (ALARP) and to an acceptable level.

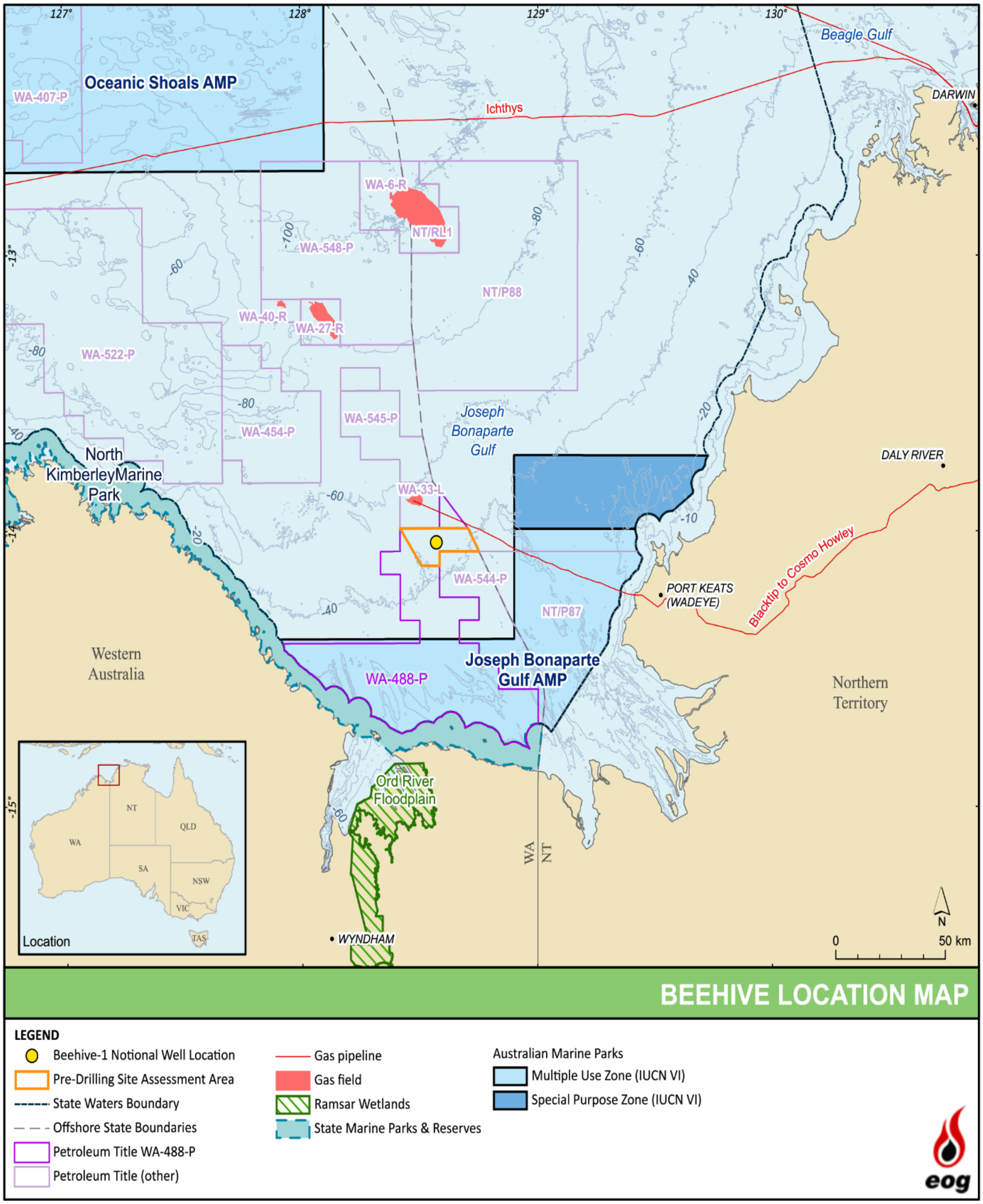


Figure 1.1. Location of the Beehive PDSA area in WA-488-P

1.3. Titleholder and Liaison Person

EOG Resources, Inc. (as the parent company of EOG) was established in 1985 and is listed on the New York Stock Exchange. It is one of the largest independent crude oil and natural gas exploration and production companies in the United States of America (USA) with hydrocarbon reserves in the USA and Trinidad & Tobago. The company has a market cap of approximately USD$49 billion (AUD$69 billion) as of 20th December 2021, and employs around 2,900 people.

EOG Resources, Inc. is the USA based parent company of EOG Resources Australia Block WA-488 Pty Ltd, the Australian entity responsible for the proposed development of permit area WA-488-P.

The Titleholder for this activity is:

EOG Resources Australia Block WA-488 Pty Ltd

Suite 12, Level 12, 37 Bligh Street,

Sydney, NSW, 2000, Australia

The nominated liaison person for this EP is:

Jonathan Chung

Director, Business Development International

1111 Bagby Street, Sky Lobby 2

Houston, TX 77007 USA

Phone: +1 713-651-7000

Email: australia@eogresources.com

EOG will notify NOPSEMA of any change in titleholder, a change in the titleholder's nominated liaison person, or a change in the contact details for either the titleholder or the liaison person including changes to the activity or the EP in accordance with the details provided in Table 1.1.

Table 1.1. OPGGS notification requirements – change of contact details and end of activity

Regulation requirements	OPGGS(E)
A change of Titleholder, change in the Titleholder's nominated liaison person or a change in the contact details for either the Titleholder or the liaison person. Notification to be provided within 7 days of the change.	Regulation 15(3)
The end of operation of the EP (i.e., at completion of the activity). *To be reported using proforma (FM1408) on the NOPSEMA website.	Regulation 25A*
The end of an activity (i.e., within 10 days of completion of the activity). *To be reported using proforma (FM1405) on the NOPSEMA website.	Regulation 29*

1.4. Scope of this Plan

The activity (as defined in Regulation 6 of the OPGGS(E)) is defined as:

> *The physical collection of geophysical and geotechnical data, from the time that the vessel(s) first deploys equipment within the activity area, until the time the vessel(s) retrieves the equipment and departs the activity area for the last time.*

This EP has been prepared in accordance with the OPGGS(E) for assessment and acceptance by NOPSEMA.

In brief, this EP includes a description of:

- The nature of the activity (location, layout, operational details);
- Stakeholder consultation activities;
- The environment affected by the activity;
- Environmental impacts and risks (including emergency incidents);
- Mitigation and management measures;
- Environmental performance outcomes, standards and measurement criteria;
- How impacts and risks are demonstrated to be ALARP and acceptable;
- The implementation strategy to ensure that the environmental impacts and risks are managed in a systematic manner; and
- Reporting arrangements.

1.5. Revisions to this Plan

The manner in which revisions or proposed revisions to this EP will be managed are outlined in this section.

1.5.1 Revisions Triggering EP Re-submission

Revision of this EP will be undertaken in accordance with the relevant OPGGS(E) requirements, as outlined in Table 1.2.

While a revision is being assessed by NOPSEMA, any activities addressed under the existing accepted EP are authorised to continue. EOG's Management of Change (MoC) process (described in Section 8.8) includes capturing changes to the EP.

Table 1.2 OPGGS EP revision requirements

Regulation requirements	OPGGS(E)
Submission of a revised EP before the commencement of a new activity.	Regulation 17(1)
Submission of a revised EP when any significant modification or new stage of the activity that is not provided for in the EP is proposed.	Regulation 17(5)
Submission of a revised EP before, or as soon as practicable after, the occurrence of any significant new or significant increase in environmental impact or risk not provided for in the EP.	Regulation 17(6)
At least 14 days before the end of each period of 5 years commencing on the day in which the original and subsequent revisions of the EP is accepted.	Regulation 19(1)
Submission of a revised EP if a change in Titleholder will result in a change in the manner in which the environmental impacts and risks of an activity are managed.	Regulation 17(7)

1.5.2 Minor Revisions

Minor revisions to this EP that do not require resubmission to the regulators will be made:

- Where minor administrative changes are identified that do not impact on the environment (e.g., document references, contact details, etc.).
- Where a review of the activity and the environmental risks and impacts of the activity do not trigger a requirement for a revision, as outlined in Table 1.2.

Using EOG's document control and MoC process (described in Section 8.8), minor revisions to the EP will not be submitted to NOPSEMA for formal assessment. Minor revisions will be tracked and incorporated as required (e.g., in the event of activity design changes).

2. Activity Description

This chapter provides a description of the proposed activity in accordance with the requirements of Regulation 13(1) of the OPGGS(E).

2.1. Activity Location

The PDSA activity area lies entirely within WA-488-P (which covers an area of 4,100 km^2) in water depths from approximately 35 metres (m) to 50 m Lowest Astronomical Tide (LAT). It is defined as the polygon bounded by the coordinates in Table 2.1. This polygon has as area of 340 km^2.

The activity area is divided into two parts (Figure 2.1), as follows:

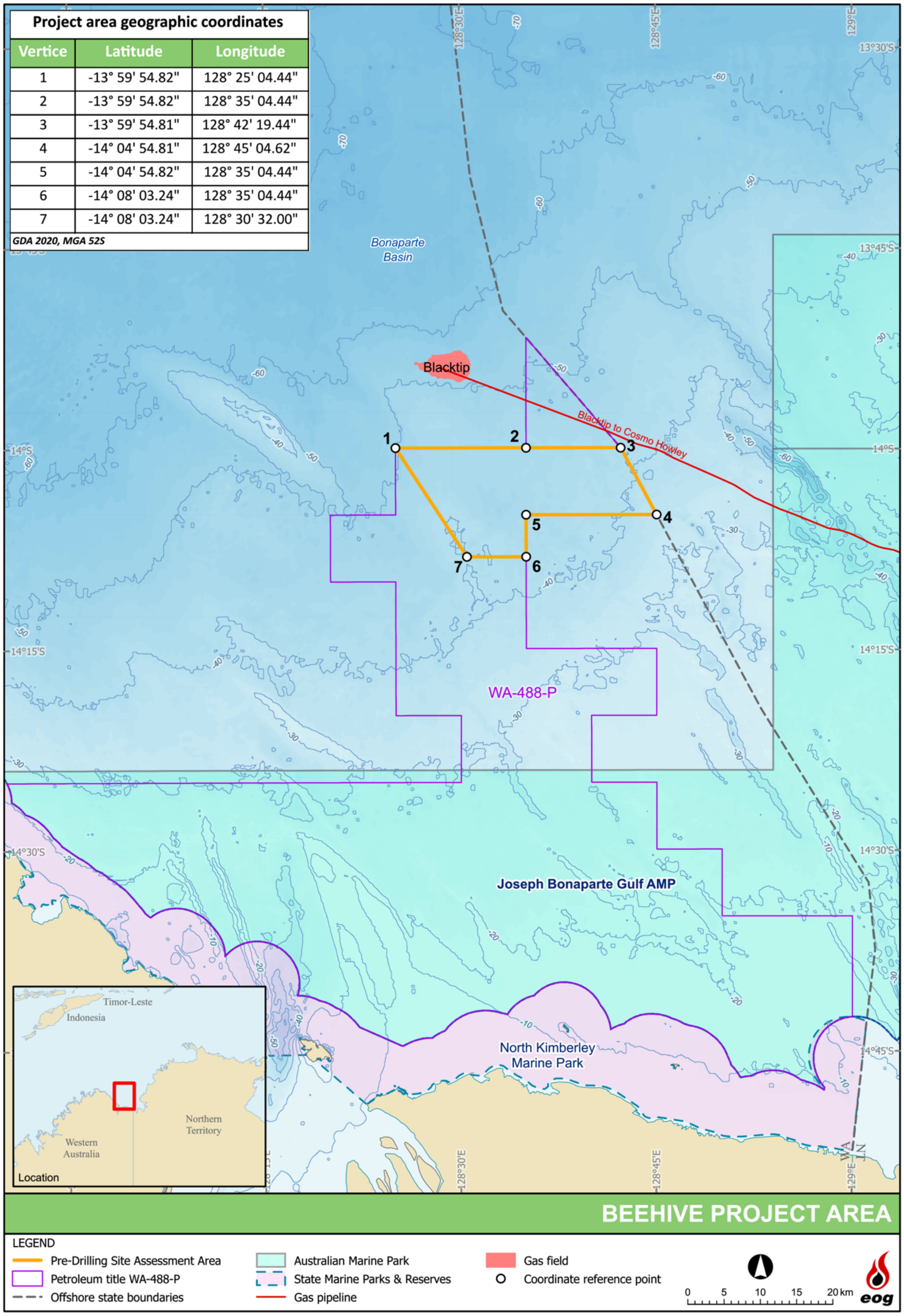
- Geophysical investigation area – this area will be focused on potential drilling and drilling-related locations and is likely to be restricted to an area of 9 km by 6 km (54 km^2) within the PDSA activity area. This investigation will be undertaken prior to the geotechnical investigation.
- Geotechnical investigation area – this area will be focused on potential drilling and drilling-related locations and is likely to be restricted to an area of 3 km by 2 km (6 km^2) within the PDSA activity area. The geotechnical investigation will be conducted following the completion of the geophysical investigation.

At its closest point, the activity area is located approximately 163 km offshore from nearest WA coastline and 73 km from the Northern Territory (NT) coastline. The coordinates of the activity area are provided in Table 2.1 and distances from the activity area to nearby features are provided in Table 2.2.

Table 2.1. Geographic coordinates of the activity area

Point	Latitude	Longitude
1	-13° 59’ 54.82	128° 25’ 04.44”
2	-13° 59’ 54.82	128° 35’ 04.44”
3	-13° 59’ 54.81	128° 42’ 19.44”
4	-14° 04’ 54.81	128° 45’ 04.62”
5	-14° 04’ 54.82	128° 35’ 04.44”
6	-14° 08’ 03.24	128° 35’ 04.44”
7	-14° 08’ 03.24	128° 30’ 32.00”

Source: GDA 2020, MGA 52S.



Vertice	Latitude	Longitude
1	-13° 59' 54.82"	128° 25' 04.44"
2	-13° 59' 54.82"	128° 35' 04.44"
3	-13° 59' 54.81"	128° 42' 19.44"
4	-14° 04' 54.81"	128° 45' 04.62"
5	-14° 04' 54.82"	128° 35' 04.44"
6	-14° 08' 03.24"	128° 35' 04.44"
7	-14° 08' 03.24"	128° 30' 32.00"

Figure 2.1. The PDSA activity area

Table 2.2 Distance to key features from the activity area

Feature	Distance and direction from the nearest point of the activity area to the nearest point of the feature
Towns	
Port Keats (Wadeye) (NT)	85 km east
Wyndam (WA)	163 km south
Kununurra (WA)	182 km south
Kalumbaru (WA)	194 km west
Darwin (NT)	285 km northeast
Marine Protected Areas	
Joseph Bonaparte Gulf Australian Marine Park (AMP)	16 km east & 29 km south
Oceanic Shoals AMP	148 km north
North Kimberley Marine Park (WA)	59 km south
Petroleum Infrastructure	
Blacktip gas export pipeline	1.4 km northeast
Blacktip unmanned wellhead platform	11 km north
Ichthys gas pipeline	164 km north

2.2. Timing and Duration

The activity is scheduled to be completed between April 2022 and August 2022. The exact timing of the activity within this time window is contingent on the receipt of environmental approvals, vessel/equipment availability and fair sea state conditions suitable for the activity.

The activity is estimated to take up to 4-6 weeks in total to complete, although this is dependent on the exact methods and technologies used as well as weather conditions during the activity execution phase.

2.3. Objective of the Activity

The objective of the activity is to identify constraints and hazards that may affect the drilling of a well, specifically:

- Acquire and assess seabed and shallow geology data to support the safe placement of the MODU's jack-up legs and conduct riserless drilling;
- Identify seabed terrain features and hazards that may impact on the exact positioning of the MODU (such as pipelines, shipwrecks, dropped objects, craters or reefs); and
- Confirm the absence of anomalous features throughout the activity area.
- To define any potential hazards or factors of operational significance for drilling rig emplacement.
- To identify geohazards and geological conditions relating to drilling of the top-holes. This may include channeling, faulting and other geological features that may be of significance.
- To identify any seafloor obstructions.

- To establish water depth and seafloor conditions.
- To investigate the seabed in proposed area for potential man-made and geological hazards.
- To assist with future wellsite planning.

The risk to a MODU's integrity through loss of seabed support makes intrusive G&G investigations critical (IOGP, 2017). Investigations must take place in the Beehive drilling area and in the case of a jack-up MODU, must also cover the area of approach to the location (i.e., the commencement of leg pinning activity) (IOGP, 2017). As the proposed drilling location is not finalised, the activity area has been designed to consider the full positional uncertainty of the final surface location of the well.

The primary objective is to obtain site specific information at the drilling location, other information may be collected to characterise the shallow geology in the Activity area. The line spacing, equipment, acquisition parameters will change due to the goals at each particular site. At the drill locations the information will need to be more resolute and concentrate on drilling hazards, including the presence of potential geohazards and man-made seafloor hazards. Whereas information collected outside the specific drill locations will be used to more generally identify surface and shallow subsurface characteristics that will assist with the overall characterisation of the area and help plan future drilling operations.

2.4. Geophysical Investigations

The geophysical investigations will involve the investigations described in Table 2.3. These investigations are designed to support jack-up MODU leg penetration calculations and detect hazards on or below the seabed so that they can be avoided when determining the placement of the MODU. The geophysical investigations will take place ahead of the geotechnical investigations (noting that some components of the geotechnical investigation, such as grab sampling and some coring, may be undertaken during the geophysical investigation). The vessel and various geophysical equipment types are very accurately positioned using Global Navigation Satellite System (GNSS) receivers on the vessel and underwater positioning techniques known as Ultrashort Base Line (USBL).

The geophysical investigations will collect data for assessment of water depths, seabed topography, seabed and shallow sub-seabed conditions and identification of obstructions on the seabed. The proposed techniques may include the following:

- Multi-beam echo sounder (MBES);
- Side scan sonar (SSS);
- Sub-bottom profiling (SBP);
- Magnetometer; and
- 2D shallow seismic.

Due to the lack of data in the top 100 m of the seabed, which is most important for jack-up MODU installation, EOG plans to acquire 2D shallow seismic data to image this upper section. Based on the site's carbonate geology and shallow water depths, a small seismic survey is the best acquisition technique to handle data penetration issues and improve subsurface image clarity.

A simplified pictorial representation of geophysical investigation techniques is provided in Figure 2.2.

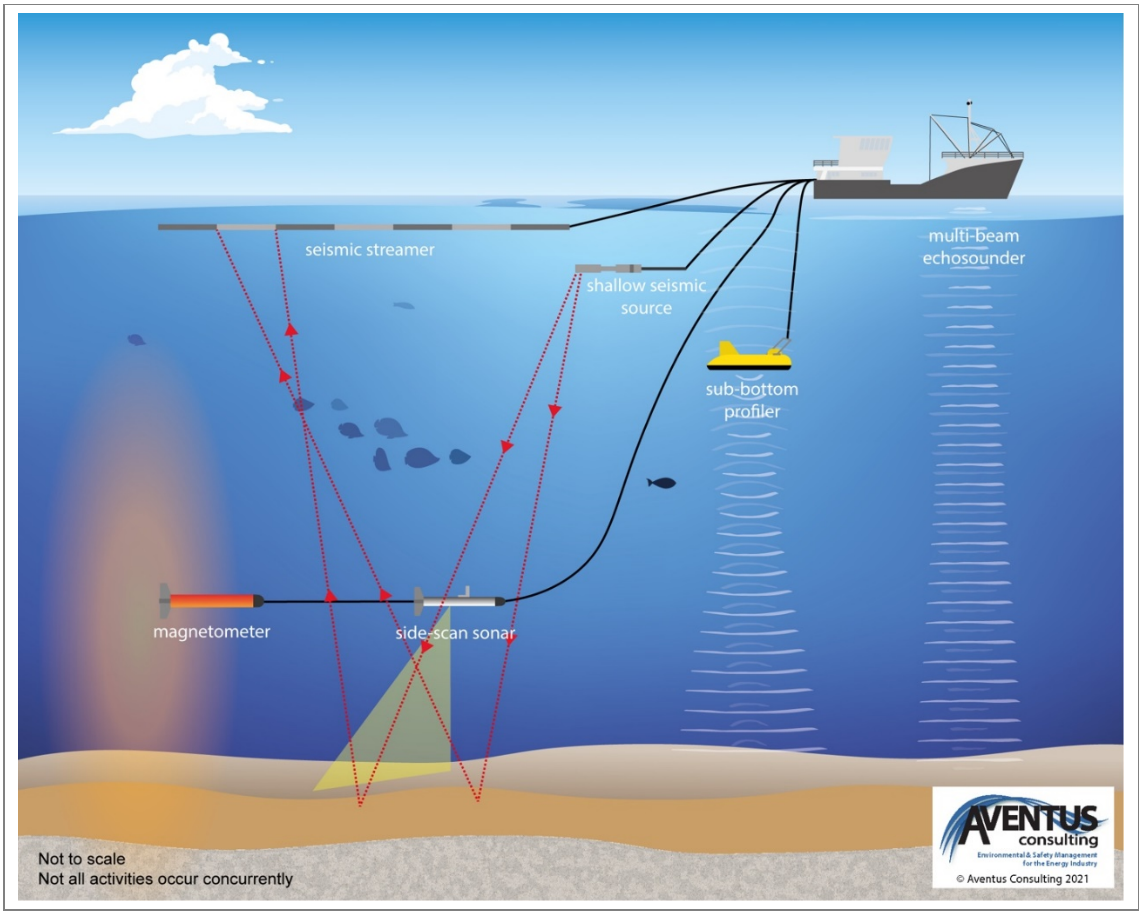


Figure 2.2. Simplified representation of geophysical investigation techniques

2.5. Geotechnical Investigations

Geotechnical investigation methods collect detailed information on the physical properties of the seabed and the underlying shallow sediments to build up a picture of the local geology of the activity area. One of the methods includes collecting sediments that are photographed, described and tested to determine the load bearing properties of the seabed sediments at potential MODU spud can locations and also to validate the results of the geophysical investigations. The geotechnical investigations are planned to take place after the geophysical investigations (noting that some collection may be undertaken during the geophysical investigation).

The objective of the geotechnical investigations is to assess and characterise the seabed and sub-seabed conditions within the activity area, including calibrating and interpreting geophysical results, as well as provide the necessary data for risk mitigation, geohazard identification and clearance, exploration drilling operations and engineering analysis. The proposed techniques will include the following:

- Grab sampling, box coring, piston (or gravity) coring, or vibrocore sampling; and
- Piezo Cone Penetrometer Test (PCPT).

Boreholes may be acquired at the wellsite if the drilling team deems it necessary based on their analysis and other data acquired.

A description of the proposed geotechnical investigation is outlined in Table 2.4. A simplified pictorial representation of geotechnical investigation techniques is provided in Figure 2.3.

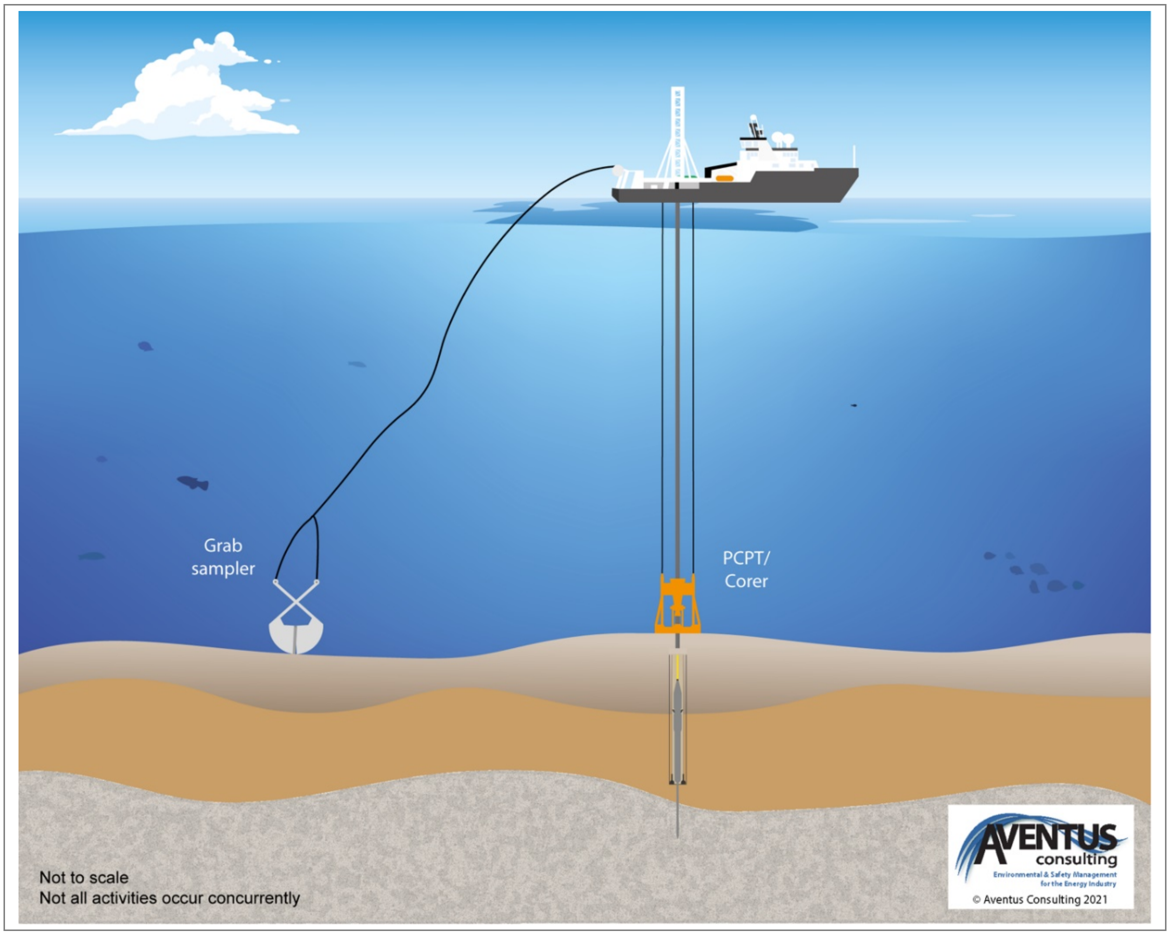


Figure 2.3. Simplified representation of geotechnical investigation techniques

Table 2.3 Description of geophysical investigation techniques

Purpose/function	Method	Technical specifications
Multi-beam echo sounder (MBES)		
The purpose of the MBES investigation is to acquire detailed measurements of water depth (bathymetry) in the activity area.	A hull-mounted MBES will likely be used. A MBES acquires a wide swath (strip) of bathymetry data perpendicular to the vessel track and provides full seabed coverage with no gaps between vessel tracks. MBES systems are available for all water depths between 3 m and 11,000 m. 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. The transducer(s) then 'listen' for the reflected energy from the seabed. In general, if all other parameters are constant, a rougher surface will backscatter more energy than a smooth surface and therefore, return higher amplitude signals. Collecting the fan of received beams establishes the two-way travel time of the acoustic pulse from which the water depth is calculated, using the velocity of seawater. The fans of seabed coverage produce a series of strips along each track, which are lined up side-by-side to generate two dimensional (2D) geo-referenced bathymetric maps of the seabed. The width of each strip depends on water depth and the acquisition system. The MBES equipment is generally operated at a speed of 3-4 knots (5.5–7.4 km/hr). Given the size of the activity area and its shallow waters, the activity would take a couple of weeks to complete. Line spacing will be tight in the general survey area and tighter at the drill centres and dependent on the equipment as well as local geology.	Photo 2.1 illustrates a typical MBES transducer head. They typically measure 48 x 11 x 19 cm and weigh up to 13 kg. MBES operate over a range of frequencies, with a typical shallow water MBES operating between 200–700 kHz (classified as high frequency). The maximum source levels are about 236–242 dB re 1 µPa @ 1 m for the 1° and 2° beams (DoC, 2016). Based on the equipment selection, the maximum source level for this activity is expected to be 210 dB re 1 µPa @ 1 m.
Side scan sonar (SSS)		
Detects seabed hazards such as existing pipelines, shipping containers, boulders, debris, marked/unmarked wrecks, reefs and craters.	The SSS method of surveying generates oblique acoustic images of the seabed by towing a sonar 'towfish.' The towfish is provided with power and digital telemetry services and towed from the vessel using a reinforced or armoured tow cable. The tow-fish is equipped with a linear array of transducers that emit, and later receive, an acoustic energy pulse in a specific frequency range. Typically, a dual-channel, dual-frequency SSS is used. The acoustic energy received by the SSS towfish provides information as to the general distribution and characteristics of the surficial sediment and outcropping	The towfish is constructed of stainless steel and is a cylindrical torpedo-like device, typically ~1.2 m long that weighs 18 kg in the air (12 kg in the water) and can be operated by one person (Photo 2.2). SSS systems typically operate at dual frequencies;

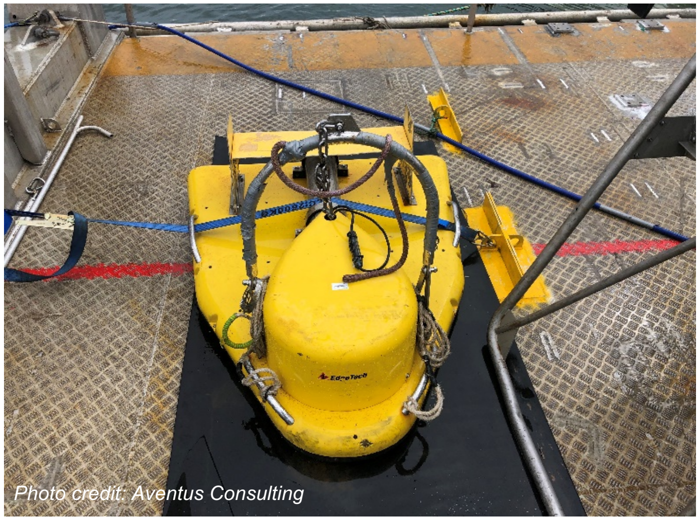
Purpose/function	Method	Technical specifications
	strata. Shadows result from areas of no energy return, such as shadows from large boulders or sunken ships, and aid in interpretation of the sonogram image. The resultant SSS image is created by assembling each swath of data into a geo-referenced composite that represents the acoustic character of the seabed within the study area. All data is digitally recorded and allows for a geo-referenced mosaic of the data so that a digital model of the seabed can be created. The SSS towfish is typically towed 10-15 m above the seabed depending on water depth and the frequency range. The SSS is towed and operated at the same time as the MBES.	• A low frequency of about 100 –120 kHz (with a swath range of 150-200 m); and • A high frequency mostly of 400 kHz to 900 kHz is utilised (with a swath range of 50-100 m or more) The maximum source levels are about 210–220 dB re 1 µPa @ 1 m (DoC, 2016). Acoustic pulse rate shot is a few times per second with consequent along-track resolution of ~1 m depending on the frequency and settings used.
Sub-bottom profiler (SBP)		
A SBP is used to investigate the layering and thickness of the uppermost seabed sediments (shallow geology).	There are three different types of SBP, which exhibit a trade-off between resolution and depth of penetration based on the frequency of the acoustic signal. These are described below.	Photo 2.3 illustrates a typical SBP. Dimensions are generally 100 cm (L) x 67 cm (W) x 40 cm (H), weighing up to 76 kg in air (32 kg in water).
	Very high frequency systems including pingers, parametric echo sounding and Compressed High-Intensity Radar Pulse (CHIRP) These produce a swept-frequency signal. CHIRP systems usually employ various types of transducers as the source. The transducer that emits the acoustic energy also receives the reflected signal. CHIRP signals typically penetrate only about 5-10 m into the seabed (depending on shallow seabed geology) and provide the best resolution, but lowest penetration of all three options. The beam width is usually between 15° and 55°. CHIRP system transducers are usually circular and point downwards. A CHIRP is normally hull-mounted when used for shallow water operations, but may also be towed in a similar fashion to the SSS.	This system utilises an FM signal across a full range of frequencies, typically either 2-16 kHz or 4-24 kHz (low to high frequency). The maximum source levels of a CHIRP are about 200–205 dB re 1 µPa @ 1 m (DoC, 2016).

Purpose/function	Method	Technical specifications
	High-frequency boomers These consist of a circular piston moved by electro-magnetic force (comprising an insulated electrical coil adjacent to a metal plate). The high voltage energy that excites the boomer plate is stored in a capacitor bank. A shipboard power supply generates an electrical pulse that is discharged to the electrical coil causing a magnetic field to repel a metal plate. This energetic motion generates a broadband, high amplitude impulsive acoustic signal in the water column that is directed vertically downward. Boomer sources show some directionality, which increases with frequency. Although they can be considered omnidirectional for frequencies below 2 kHz, they are quite directional in the vertical. A boomer system offers a moderate penetration depth of up to 100 m below the seabed, depending on shallow seabed geology. Boomers are mostly surface towed, but may also be towed below the surface to avoid sea surface wave noise and movement.	The typical frequency spectrum of boomer systems ranges between 0.2 and 10 kHz, with an effective bandwidth of 1 to 10 kHz (low to high frequency). The sound source level can vary from 100 to 220 dB re 1 µPa @ 1 m.
	Medium-frequency sparkers These are seismic sources that create an electric arc between electrodes with a high voltage energy pulse. The arc momentarily vaporises water in a localised volume and the vapour expands, generating a pressure wave. Sparkers can use the same capacitor bank as boomers. Sparkers provide low-resolution data to a much greater penetration depth below the seabed (~100 mbsf), depending on the shallow seabed geology. Sparkers are surface towed. Ideally the SBP should be able to provide imagery that penetrates to a minimum depth of at least 30 m below the mud line or to the anticipated penetration of the MODU legs plus 1.5 times the spud can diameter, however this is dependent on the shallow seabed geology. The receiver for the sparker or boomer system is usually a hydrophone or hydrophone array consisting of a string of individual elements located within a neutrally buoyant synthetic hydrocarbon filled tubing or a solid streamer. They typically contain 8 to 12 hydrophone elements evenly spaced in a tube that is 2.5 to 4.5 m in length and 25 mm in diameter. The cable may be wholly solid-state or filled with approximately 5 litres of hydrophone fluid. The SBP system is towed and operated at the same time as the MBES and SSS.	The generated frequencies are generally between 50 Hz (0.05 kHz) and 4 kHz (low to high frequency). The sound source level is typically between 215 and 225 dB re 1 µPa @ 1 m.

Purpose/function	Method	Technical specifications
Magnetometer		
This equipment detects metallic objects on or below the seabed (e.g., buried pipelines, petroleum wellheads, shipwreck debris and dropped objects such as unexploded ordinance, cables, anchors, chains) that may not be identified by using 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 nuclear magnetic resonance technology, applied specifically to hydrogen nuclei. No sound pulses are emitted from a magnetometer. The magnetometer survey will be conducted simultaneously with the MBES, SSS and SBP, as it can be powered using the same tow cable and power supply.	The magnetometer towfish is constructed of stainless steel and is a cylindrical torpedo-like type device, typically ~1.4 m long and 7 cm in diameter that weighs ~12–18 kg in the air (4–12 kg in the water) and can be operated by one person (Photo 2.4). A magnetometer is capable of a sampling rate of at least 1 Hz.
Shallow Seismic		
Provides near-surface geological structural information and detects geohazards such as shallow gas.	The deeper data acquired through shallow seismic surveying supplements the MBES, SSS and SBP data. The equipment deployed for shallow seismic surveys must be able to provide information to a depth of at least 30 m below the seabed (and generally down to a few hundred metres below the seabed). Shallow seismic investigations typically use a mini airgun, small bubble pulser or small sparker system (Photo 2.5); one of the latter two options will be used for this activity. A multi-channel (approximately 48 channels) streamer is used, typically hundreds of metres long, depending on the quality of data required, and is towed near the sea surface. The shallow seismic activity is likely be undertaken separately to the MBES/SSS/SBP and magnetometer investigation. It would ideally be acquired at the same time as the other geophysical data, but this will depend on data quality and operations.	Shallow seismic typically uses 2D imaging technology operating in a frequency range of 20 Hz to 500 kHz. The sound source is a small compressed air unit less than 100 cubic inches (cui), or an equivalent sound source, depending on local geology. The activation interval will be less than 12.5 m. An example of the sound source equipment is a constructed of stainless steel, typically weighing 50 kg and approximate dimensions of 255 cm (L) x 35 cm (W) x 25 cm (H). The source level is typically 215-225 dB re 1 µPa @ 1 m.

Photo 2.1. MBES equipment

Photo 2.2. SSS towfish



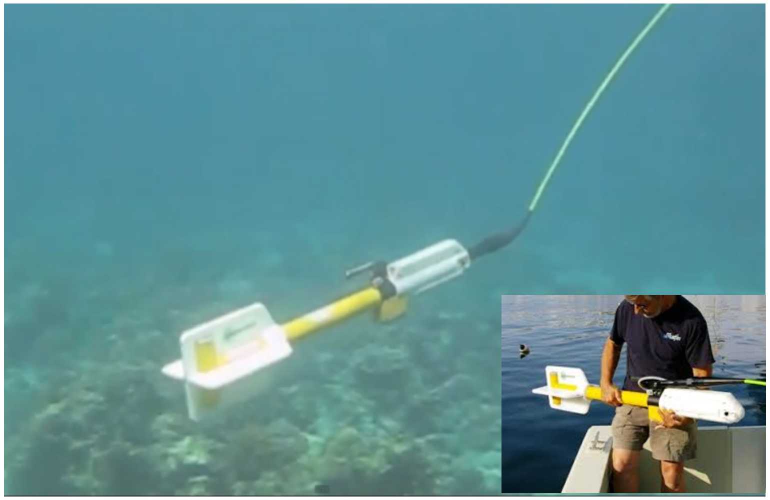


Photo 2.3. SBP transducer

Photo 2.4. Magnetometer towfish

Photo 2.5 Example shallow seismic sound source

Table 2.4 Description of geotechnical investigation techniques

Purpose/function	Method	Technical specifications
Seabed grab sampling		
Seabed grab sampling provides samples for undertaking geological analysis of unconsolidated seabed sediments (e.g., sands, silts and clays).	Grab sampling is a process of collecting small samples of surface sediments from the seafloor. Only surface sediments are collected and the sampler has no ability to penetrate to depth. Grab samples typically use a Van Veen grab sampler, which is a light-weight sampler designed to take large samples in soft seabed sediments. It has long lever arms and sharp cutting edges on the bottom of the scoops, much like a set of jaws, which enable it to cut into the seabed. The weighted jaws, chain suspension, and doors and screens allow flow-through during lowering to the seabed (using a winch) and assure vertical descent where strong underwater currents exist. When the lowering cable is taut the grabs 'arms' are locked open. Then, when the grab touches the seabed, the cable becomes slack, which releases catches and, on recovery, the cables attached at the top of the arms exert tension on the arms extending from the jaws, causing them to lift, and cause the jaws to dip deeper into the sediment, and trap material as they tightly close. Also, when the grab settles on the seabed, the flaps fall back and cover the screens completely, helping to prevent any loss of sediment during retrieval. Typically, one sample is collected from the centre of the MODU location (with a contingency for one sample at each MODU spud can location [i.e., four in total]). Other samples may be obtained at areas of geological change or interest that have been identified by the SSS and SBP data.	Van Veen grab samplers (Photo 2.6) are generally constructed of stainless steel with lead blocks. Depending on the model used, they can weigh 2.4–30 kg in air and generally obtain less than 3 litres of sediment. The grab sample skims the seabed surface and each sample volume is less than 0.5 m^3.
Coring		
The various types of coring (vibro, box and piston) provide samples for undertaking geological analysis of formations below the seabed. One or more of these types of coring may be	**Vibrocoring** Vibrocoring is a technique for collecting core samples in unconsolidated sediments by using a vibrating device (generally referred to as 'vibrohead') to drive a coring tube into the seabed. Typically, two large electrical motors power two concentric weights, which produce the necessary vibration. The motors are adjustable and can run at various frequencies (generally 50 Hz). Once the unit is on the sea floor, the high-power vibrator motors are engaged and drive the core barrel with PVC liner into the seabed.	Vibrocorers (Photo 2.7) typically core to a depth of up to 12 m (using 3 m segments). Corer barrels can be up to 112 mm in diameter, with cores up to 96 mm in diameter. Approximately 0.05 m^3 volume recovered. The width of the winch tower required to lower and operate the corer is typically up to 1.2 m, the dimensions of the base supports is up to 5 x 5 m (25 m^2), and the weight of the equipment varies from 1,450 kg (3 m segment) up to 4,000

Purpose/function	Method	Technical specifications
employed for this activity, so each is described here. Typically, one sample is collected from the centre of the MODU location (with a contingency for one sample at each MODU spud can location [i.e., four in total]), which is used to ground-truth the geophysical data. No drilling muds are required in the coring process and no drill cuttings are generated.	The vibrocoring unit has been designed for easy vertical recovery on to the vessel and then easy recovery of the core barrel to the deck. The corers are lowered by winching a cable wire from the vessel at approximately 1-2 m/s, so the duration of lowering and recovery operations in the activity area will be short (15-30 seconds at each site). Sampling itself is of a very short duration at each location (typically 5 to 10 minutes) and given the small activity area, may only take a few hours in total. Based on a footprint of 25 m^2 and four sampling locations, the area of disturbance for the vibrocoring option is up to 100 m^2 (and up to 0.20 m^3 of seabed sample obtained).	kg (for a 12 m segment) depending on whether the unit uses standard or high power. Vibration force can vary between 44 kN (standard power) and 89 kN (high power).
	Box coring Box corers (Photo 2.8) are designed to take 'undisturbed' samples from the top of the seabed and are suitable for almost every type of sediment. The box core relies on its own weight for penetration of the seafloor and has a single swing arm that closes after being triggered to retain the sample on retrieval. Operation is simple and straightforward; when the frame touches the seafloor, a gimbal suspension combined with the weight of the core box ensures the box is always in the vertical position. When the weight is taken off the hoist cable, the trigger mechanism releases the cylinder-shaped core box. This can penetrate the seabed to depths ranging between 5 cm and 1 m using the weight of the box corer to push it into the sediment. The driving force can be adjusted by adding or removing lead weights. Both the top and bottom of the core box are now automatically closed, and the seabed sample is collected. The box is then removed from the corer enabling unrestricted access to the sample surface and sides. Sampling itself is of a very short duration at each location and given the small activity area, may only take a few hours in total. Based on a footprint of 1 m^2 and four sampling locations, the area of disturbance for the box coring option is up to 4 m^2.	Dimensions of the box vary but typically have a footprint of about 1 m^2 and a volume of 1 m^3 (based on typical box corer dimensions).
	Piston (or gravity) coring A piston corer (Photo 2.9) is normally used on soft, unconsolidated sediments. The coring unit is deployed from the side of the vessel using a dedicated coring deployment system comprising a winch, overhead coring	Piston corers typically core to a depth of up to 6 m (using 3 m segments). Core barrels generally contain an inner PVC liner with a diameter of 0-90 mm that retains the sample.

Purpose/function	Method	Technical specifications
	boom and core handling system. The coring unit consists of the head weight, coring tube, removable inner core liner and core catcher. A piston corer is lowered by wire rope to the seabed. It has a trigger device that hits the seabed before the core barrel and releases the corer allowing it to freefall. As the barrel enters the sediment, a special internal piston creates a vacuum and helps to draw the core into the barrel. Core catchers prevent the sediment from coming out of the coring tube. This suction reduces compaction of the sample in the inner sleeve. The coring system can be assembled with different length cores ranging from 3 m to 24 m (typically no greater than 6 m). Sampling itself is of a very short duration at each location and given the small activity area, this testing may only take a few hours in total. Based on a footprint of 0.0045 m^2 (45 cm^2) and four sampling locations, the area of disturbance for the piston coring option is up to 0.018 m^2 (and up to 0.12 m^3 of seabed sample obtained).	Piston corers with a 6 m length and diameter of 8 cm, for a volume of approximately 0.03 m^3.
Piezo Cone Penetrometer Test (PCPT)		
PCPT determines soil strength and helps to delineate soil stratigraphy. Typically, one sample is collected from the centre of the MODU location (with a contingency for one sample at each MODU spud can location [i.e., four in total]). This ground-truths the geophysical data and provides soil strength data that can be used for geotechnical analysis.	PCPT involves the in-situ measurement of the resistance of ground to continuous penetration. This process involves lowering a frame to the seabed and pushing the PCPT unit into the sediment at a steady penetration rate (usually 2 cm per second). The PCPT measures resistance to the push and these measurements allow high quality interpretation of ground conditions and pore pressure dissipation testing. The resolution of the PCPT in delineating stratigraphic layers is related to the size of the cone tip. A seabed frame is lowered to the seabed with the PCPT unit integrated into it and operated remotely. A PCPT typically takes 2-2.5 hours to complete, depending on water depth. Given the small activity area, PCPT sampling may only take a few hours in total. When the required penetration depth is reached, all equipment is withdrawn from the seabed. A small hole will remain in the seabed, which will eventually collapse and infill with the movement of seabed sediments.	The PCPT unit (Photo 2.10) consists of a rod up to 25 m long (or discrete rod sections to make up a total of 25 m) that has a small cone at its base (with typical cone tips having a cross-sectional area of 2, 5, 10 or 15 cm^2). A PCPT unit typically has a cone tip area of 2 cm^2 and penetration of 10 m.

Purpose/function	Method	Technical specifications
	Based on a footprint of 2 cm^2 and four sampling locations, the area of disturbance for this coring option is up to 8 cm2 (0.008 m^2) (and up to 0.8 m^3 of seabed sample obtained).	
Borehole sampling		
Borehole sampling gathers geotechnical soil data to a minimum depth of the jack-up MODU spud can penetration plus 1.5 x the spud can diameter.	Typically, one borehole sample is collected from the centre of the MODU location (with a contingency for one sample at each MODU spud can location [i.e., four in total]), which is used to ground-truth the geophysical data and provides soil strength data that can be used for geotechnical analysis. The maximum depth of the boreholes ranges between 40 m and 80 m below the seabed. Downhole sampling would be undertaken at predetermined intervals. Sampling will typically consist of rotary cores/push cores for the full length of one of the boreholes. If the standalone PCPT is unable to penetrate the seabed to the desired depth, PCPT's measurements may also be obtained in a separate borehole. Due to the depth and complexity of borehole sampling, a different vessel with this specific equipment may need to collect the borehole samples, as the standard geophysical and geotechnical vessel may not have suitable equipment onboard. Drilling fluids will be used in the borehole sampling process, as described in the following sub-sections of Section 2.6. Based on a footprint of 0.45 m^2 and four sampling locations, the area of disturbance for this coring option is up to 1.8 m^2.	For the borehole PCPT, a wireline deployed cone penetrometer device, using a seabed stabilising device as a base for reaction, is utilised. The actual penetration is dependent on the soil conditions. In the event that premature refusal is encountered within the PCPT, the borehole will be drilled out to the next metre increment and testing recommenced. For borehole coring, wireline-deployed hydraulically-operated push or piston samplers may be used to recover high quality samples as a result of the fixed piston that rests on the bottom of the borehole. The type of sample tube used will depend on the soil type expected and for piston/push would typically be 76 mm (outside diameter), 72 mm (internal diameter), and nominal 1 m length, for a footprint of 0.45 m^2.

Photo 2.6. Van Veen grab sampler

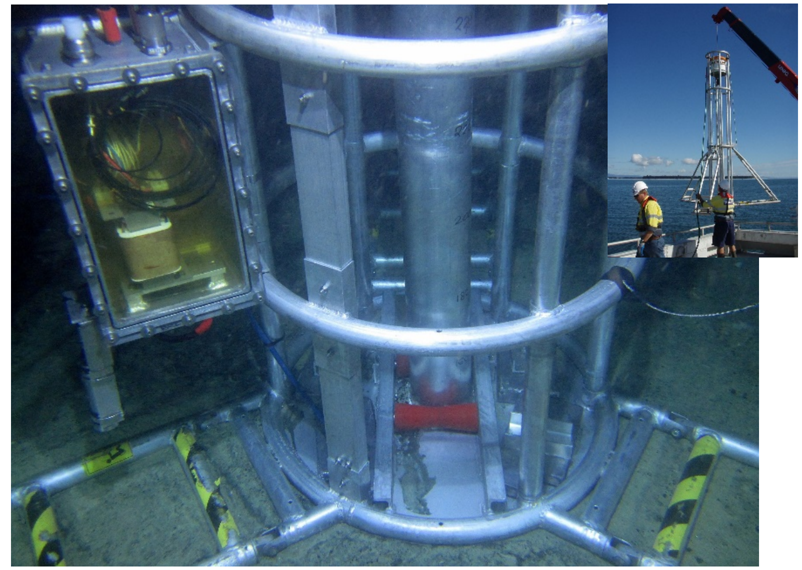


Photo 2.7. Vibrocorer

Photo 2.8. Box corer

Photo 2.9. Piston corer

Photo 2.10. Standalone PCPT unit

2.5.1. Drill Cuttings

Cuttings are discharged directly to the seabed during borehole sampling. Drill cuttings are inert pieces of rock, sand and other particles removed from the borehole during the sampling process. Cuttings range in size from very coarse to very fine particles.

The coring for this activity will generate a very small volume of cuttings at a few locations, as outlined in Table 2.5.

Table 2.5 Approximate cutting discharge volumes for borehole sampling

Total depth (m)	Borehole diameter (mm)	Number of holes per investigation site	Total drill cuttings volume (m^3)
Up to 80 (more likely <50)	Variable, usually about 40-80 mm	Up to 10, expecting 1-2	3.2 each hole. A total of 32 m^3 total for 10 boreholes

2.5.2. Drill Fluids

Drilling fluid will be used during the borehole sampling and PCPT process to lubricate the drill bit, transport cuttings out of the borehole to keep the borehole clean and to prevent the borehole from collapsing during the coring process. For a borehole 80 m deep, the volume of drilling fluid would be in the order of 30 m^3.

Seawater is the primary constituent of geotechnical drilling fluids. Inert drilling fluid additives may be added to the seawater to form a water-based mud (WBM) if challenging boring conditions are encountered. Common WBM additives that may be used during the coring process are listed in Table 2.6.

Table 2.6 Potential drill fluid additives and discharge volumes

Additive	Function	Indicative total volume	OCNS rating*	
			CHARM	Non-CHARM
Guar	Viscosifier. A high-yield organic xanthan gum polymer used to impart viscosity to the drilling fluid. It is readily biodegraded via bacterial activity.	~2 kg/m^3 of drilling fluid (~60 kg for an 80 m deep borehole)	-	E
Bentonite	Viscosifier. A naturally-occurring high-density mineral milled to a uniform particle size and used to increase fluid density. It is inert in the environment.	~25 kg/m^3 of drilling fluid (~2,000 kg for an 80 m deep borehole)	-	E
Barite	Weighting agent. A naturally-occurring high density mineral milled to uniform particle size and used to increase the fluid density. It is inert in the environment.	15 kg/m^3 of drilling fluids (450 kg for an 80 m deep borehole)	-	E

** Ratings current at November 2021.*

The exact types and composition of the WBM will not be known until after the geotechnical contractor has been engaged. EOG will specify that all drilling fluid additives are of low eco-toxicity, with only 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM) OCNS-rated chemicals to be used (see following section) in accordance with the Offshore Chemical Notification Scheme (OCNS).

OSPAR Convention

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 upstream petroleum industry. The OCNS manages chemical use and discharge by the 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 2.4). Data used for the assessment includes toxicity, biodegradation and bioaccumulation.

OCNS Hazard Groupings for CHARM and Non-CHARM Chemical Products

CHARM	Gold	Silver	White	Blue	Orange	Purple
Non-CHARM	E	D		C	B	A
	Lowest Hazard →					*Highest Hazard*

Source: NOPSEMA (2015).

Figure 2.4 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 the Registration, Evaluation and Authorisation of Chemicals (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

EOG 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 an additive is required that has not been registered with CEFAS (and therefore does not have a rating), EOG will apply the CHARM or, in the case of non-CHARMable products, the OCNS process (https://www.cefas.co.uk/cefas-data-hub/offshore-chemical-notification-scheme/hazard-assessment-process/) to calculate the CHARM rating or OCNS grouping. Only additives with a hazard quotient of <30 (gold/silver) or an OCNS grouping of D/E will be used. This will be managed in line with EOG Resource’s MoC process (described in Section 8.8).

2.5.3. Laboratory Testing

Laboratory analysis of the nature and composition of seabed sediments will be undertaken onboard the geotechnical vessel and, if necessary in onshore laboratories. Offshore laboratory testing has the benefit of informing the need for additional testing while the vessel is on location if results indicate variable seabed profiles.

Seabed samples will be measured for visual classification, wet and dry density, moisture content, Torvane and shear strength. Also mobilised to the geotechnical vessel will be the necessary equipment for extrusion, cutting, handling and securing the samples. All tests will be performed according to relevant Australian, British or ASTM standards, or other recognised procedures.

2.6. Associated Non-invasive Investigations

A conductivity, temperature and depth (CTD) probe and drop camera may be deployed within the water column to provide visual and physico-chemical information about the activity area. These devices are static non-invasive survey techniques that do not interact with the seabed and do not generate acoustic sound or other emissions. As such, they are not considered in the activity environmental impact and risk assessment (Section 7).

2.6.1. Conductivity, Temperature and Depth

A conductivity, temperature and depth (CTD) device (Photo 2.11) measures physical properties, specifically conductivity and temperature, of the seawater relative to depth. Conductivity is a measure of how well a solution conducts electricity and is directly related to salinity, which is the concentration of salt and other inorganic compounds in seawater. When combined with temperature data, salinity measurements are used to determine seawater density. In the context of G&G investigations, such measurements are required for sound velocity in order to calibrate the acoustic equipment as the speed of sound through the water column is integral to the calculations.

The CTD rosette (the metal device holding water sampling bottles) is lowered on a cable from the vessel and takes water samples using a Niskin sampler at designated intervals in the water column (usually from three sample depths – near-surface, mid-water and above the seabed). The data is then processed and available onboard. The CTD rosette may also contain other sensors that can measure additional physical or chemical properties.

2.6.2. Drop Camera

A 'drop camera' (i.e., camera housed in water-proof casing and mounted in a stainless-steel frame) may be deployed from the vessel to take representative photos of the seabed types encountered in the activity area (Photo 2.12). The camera is simply lowered to the seabed and the camera triggered. Additionally, if video images are required, a similar frame may be towed behind the vessel close to the seabed using a weighted towfish and communications cable.

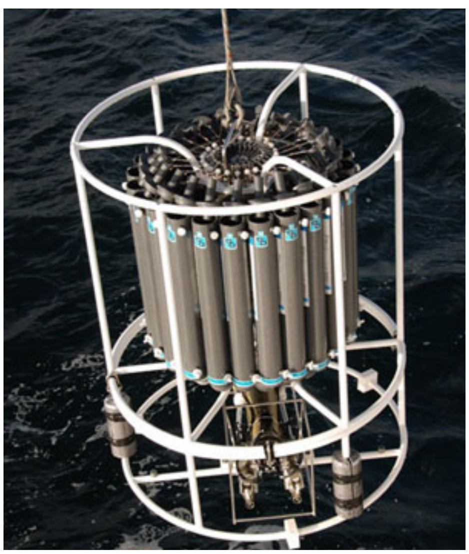


Photo 2.11. CTD

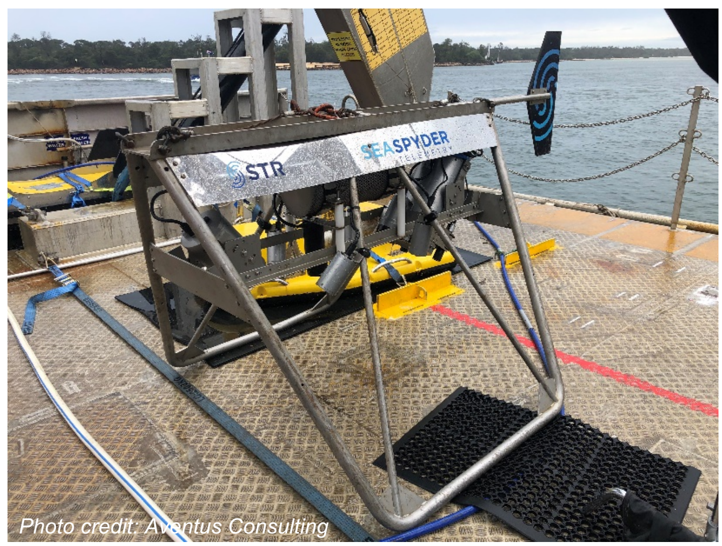


Photo 2.12. Drop camera on frame

2.7. Vessels

2.7.1 Contractors

The geophysical and geotechnical survey contractors are yet to be appointed. Only contractors with a proven history of successful operations will be considered. There may be one or more survey contractors hired or subcontracted to support this activity.

2.7.2 Vessels

Vessels have yet to be selected to undertake the activity. EOG would prefer one vessel be engaged to undertake the entire activity, however it may be necessary to use different vessels as follows:

- Geophysical investigations – a small, regionally-based vessel capable of towing light-weight equipment that may also be equipped with some geotechnical sampling equipment; and
- Geotechnical investigations – for some of the geotechnical samples, a larger specialised vessel with a large deck area and drilling derrick may be necessary. This may likely to be mobilised from elsewhere in Australia or from a global pool of suitable vessels.

Table 2.7 presents the ranges of key vessel dimensions and tank capacities for vessels that have undertaken G&G investigations in Australia in recent years. This provides an indication of the likely size of the vessels required. Photo 2.13 provides images of typical geotechnical vessels.

Table 2.7 Typical geotechnical vessel specifications

Parameter	Specification range
Vessel type	Multi-purpose supply, platform supply
Crew accommodation	20 – 84 people
Tonnage (gross)	300 – 6,543 t
Dimensions	
Length	34 - 104 m
Breadth	13 – 20 m
Draught	3 - 8 m
Deck area	100 – 1,020 m^2
Tank capacities	
Potable water	100 – 1,021 m^3
Mud (liquid)	90 - 880 m^3
Brine	400 – 1,150 m^3
Fuel oil	800 - 1,357 m^3

Initial mobilisation of crew to the vessels will be via port call, which will be selected post-contract award. Given the short duration of the activity, crew changes are not anticipated while on site. No helicopter transfers are planned (although they may be required in the event of medical emergencies).

During the investigations, the vessels will hold station using dynamic positioning (DP) or propellers; anchoring will not be necessary, unless in the event of an emergency. The use of support vessels will not be required.

Given the short duration of the activity, the vessels will not require refuelling on location in order to complete the activity. The vessels will bunker with marine diesel only while in port.

In the event of bad weather during the investigations, the vessels will seek safe shelter or return to port. A weather forecasting service (which provides a look-ahead several days out) will be used to ensure that the vessels are not mobilised immediately prior to forecasted poor weather, thus minimising the need to seek safe shelter and arrange crew transfers.

	The *Fugro Mariner*
	The *Fugro Voyager*
	The *Go Capella*

Source: Specification sheets.

Photo 2.13 Vessels that have recently undertaken geotechnical investigations in Australia

2.8. Simultaneous Activities

Santos is proposing to conduct the Petrel sub-basin 3D marine seismic survey between 1st December 2021 and 31st March 2022, or the same window in 2022/23 (the EP is currently in assessment with NOPSEMA – RMS ID 5660). The acquisition area for the Santos survey is 7 km from the activity area and its operational area is 1.6 km north. At this point, there will be no temporal overlap between the activities because the earliest start time for the Beehive PDSA is 1st April 2022.

2.9. Activity Summary

Table 2.8 summarises the proposed activity parameters.

Table 2.8. Summary of the activity parameters

Parameter	Details		
Timing	April to August 2022		
Duration of the activity	4 to 6 weeks in total		
Water depths	30 – 50 m LAT		
Activity area (overall)	340 km^2		
Geophysical investigation	Duration (estimate)	Sound frequency range (kHz)	Sound source levels (dB re 1 µPa @ 1 m)
MBES	2-4 weeks	200–700	236–242
SSS		100-120 and up to 900	210–220
SBP		2–16 or 4–24 0.05–4 0.2–10	200–205 215–225 100–220
Magnetometer		N/A	N/A
Shallow seismic (sparker or bubble pulser system)		0.2-500	~200-225
Geotechnical investigation	Duration (estimate)	Depth of penetration (m)	Number of investigation sites
Grab sampling	1-2 weeks	0.1–0.2	≥ 4
Coring		Up to 6	≥ 4, depending on penetration
PCPT		Up to 25	≥ 4
Borehole sampling		Up to 80	≥ 1

3. Environmental Regulatory Framework

In accordance with Regulation 13(4) of the OPGGS(E), this chapter describes the legislative requirements that apply to the activities described in this EP.

3.1. EOG Environmental Policy

In accordance with Regulation 16(a) of the OPGGS(E), EOG's Safety and Environmental Policy is provided in Figure 3.1. The policy provides a public statement of the company's commitment to minimise adverse effects on the environment and to improve environmental performance.

3.2. Commonwealth Legislation

A summary of the key Commonwealth legislation and regulations relevant to the environmental management of the activity is provided below. Details of the most pertinent legislation and regulations are provided in **Appendix 1**.

Offshore Petroleum and Greenhouse Gas Storage Act 2006

The OPGGS Act sets up a system for regulating the exploration for and recovery of petroleum in offshore areas and provides for the grant of exploration permits, retention leases, production licences, infrastructure and pipeline licences, among other things.

Under this Act, NOPSEMA is responsible for the administration of the occupational health and safety, structural integrity and environmental management provisions. Offshore areas start 3 nautical miles (nm) from the baseline from which the territorial sea is measured and extend seaward to the outer limits of the continental shelf.

Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

The OPGGS(E) addresses all licensing and environmental issues for offshore petroleum and greenhouse (GHG) activities in Commonwealth waters. This EP has been prepared in accordance with Part 2 of the OPGGS(E) for NOPSEMA's assessment.

The OPGGS(E) requires the preparation of an EP prior to conducting a petroleum activity for acceptance by NOPSEMA. The EP is an activity-specific document that provides a detailed impact and risk assessment and describes how identified risks will be managed. Upon EP acceptance, the activity may commence.

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) is the key legislation regulating projects that may have an impact on matters of national environmental significance (MNES). The Commonwealth Department of Agriculture, Water and the Environment (DAWE) is the Regulator of the EPBC Act. Activities that may have impacts to MNES are required to prepare and submit a Referral to the DAWE for determination on the level of environmental impact assessment (EIA) required.

In February 2014, NOPSEMA became the sole designated assessor of petroleum and GHG activities in Commonwealth waters in accordance with the Minister for the Environment's endorsement of NOPSEMA's environmental authorisation process under Part 10, section 146 of the EPBC Act. Under the streamlined arrangements, impacts on the Commonwealth marine area by petroleum and GHG activities are assessed solely through NOPSEMA. As such, an EPBC Act Referral has not been prepared and submitted to the DAWE for this activity.

Safety & Environmental Policy

Our Goal

Conduct our operations in a responsible manner to avoid harm to people and the environment.

Our Commitment

EOG Resources, Inc. will conduct its business with a commitment to safeguard people and to protect the environment. Good safety and environmental performance is critical to the success of our business and is the responsibility of every EOG Resources, Inc. employee and contractor.

Our Focus Areas

- **Planning** – Make safety and environmental matters an integral part of our business planning, training, development, and decision-making.
- **Compliance** – Conduct our business in a manner designed to comply with all applicable safety and environmental laws and regulations and apply responsible standards where such laws or regulations do not exist.
- **Continuous Improvement** – Strive to continuously drive safety and environmental performance improvement through setting goals, training, monitoring progress and utilizing data-driven decision making and adaptive management.
- **Communication** – Communicate openly with our customers, employees, contractors, neighbors, appropriate officials, public interest groups, shareholders and other stakeholders, regarding significant safety and environmental matters.
- **Leadership** – Provide leadership, professional staff, training, support, and other resources necessary for the implementation of safety and environmental programs that are designed to ensure each individual knows their responsibilities and feels empowered to speak up and take appropriate action.
- **Engagement** – Engage with regulators, industry groups, and others to develop sound, effective laws and regulations, policies and procedures to protect the environment, employees, contractors and the general public and to raise the standards of our industry.
- **Transparency** – Make consistent, informed decisions by promoting knowledge sharing, data stewardship and collaboration within the organization, and with stakeholders.

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Figure 3.1. EOG Safety and Environmental Policy

3.3. State and Territory Legislation

The relevant WA and NT territory legislation is provided in **Appendix 1.** Legislation for these jurisdictions is only likely to be triggered in the event of an emergency situation, such as an oil spill, that requires response activities to be conducted in state or territory waters. Incident reporting requirements under state and territory legislation and regulations is provided in Section 8 of this EP.

3.4. Government Guidelines

This EP has been developed in accordance with the NOPSEMA Guidance Note for *Environment Plan Content Requirements* (N04750-GN1344, September 2020). This document provides guidance to the petroleum industry on NOPSEMA's interpretation of the OPGGS(E) to assist titleholders in preparing EPs.

Other relevant government guidelines that have been incorporated or taken into consideration during the preparation of this EP include:

EPs

- Environment Plan assessment (NOPSEMA Policy N-04750-PL1347, May 2020).
- Reducing marine pest biosecurity risks through good practice biofouling management (NOPSEMA Information Paper N-04750-IP1899, July 2021).
- Environment Plan decision making (NOPSEMA Guideline N-04750-GL1721, June 2021).
- Oil spill modelling (NOPSEMA Environment Bulletin, April 2019).
- Acoustic impact evaluation and management (NOPSEMA Information Paper, N-04750-IP1765, June 2020).
- Petroleum activities and Australian marine parks (NOPSEMA Guidance Note, N-04750-GN1785, Rev 0, June 2020).

Oil Pollution Emergency Plans (OPEPs)

- Oil spill modelling (NOPSEMA Environment Bulletin, April 2019).
- Oil pollution risk management (NOPSEMA Guidance Note N-04750-GN1488, July 2021).
- Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, January 2015).
- Offshore Petroleum Industry Guidance Note Marine Oil Pollution: Response and Consultation Arrangements (Western Australian Department of Transport, Version 5.0, July 2020).
- Western Australia Oil Spill Contingency Plan (Department of Transport, Version 1.0, January 2015).
- Northern Territory Oil Spill Contingency Plan (Department of Transport Marine Safety, Version 5.0, May 2014 – in revision 2021).
- Advisory Note for Offshore Petroleum Industry Consultation with Respect of Oil Spill Contingency Plans (AMSA, 2012).

Operational and Scientific Monitoring Programs (OSMPs)

- Operational and scientific monitoring programs (NOPSEMA Information Paper, N-04750-IP1349, October 2020).

EPBC Act

- EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance (DoE, 2013).
- EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales, Industry guidelines (DEWHA, 2008a).

3.5. International Industry Codes of Practice and Guidelines

A number of international codes of practice and guidelines are relevant to environmental management of the activity. Those of most relevance are described in this section in chronological order. The Commonwealth legislation outlined in **Appendix 1** lists the conventions and agreements that are enacted by, or whose principles are embodied in, that legislation.

While none of the codes of practice or guidelines described in this section have legislative force in Australia (with the exception of MARPOL), they are considered to represent best practice environmental management (BPEM). Aspects of each code or guideline relevant to the impacts and risks presented by the activity are outlined in the demonstrations of acceptability throughout Chapter 7.

3.5.1 MARPOL

The key international convention relating to marine environmental matters is the International Convention for the Prevention of Pollution from Ships (MARPOL). This convention was adopted in November 1973 by the International Maritime Organisation (IMO), with ongoing additions and amendments. MARPOL aims to prevent and minimise pollution (routine discharges and accidents) from ships generally larger than 400 gross tonnes. It contains six annexes and is in force in 174 countries (as of December 2020).

In Australian Commonwealth waters, MARPOL is given effect through the *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 and via Marine Orders made under the *Navigation Act* 2012 and is administered by AMSA. Table 3.1 lists the annexes of the Convention and identifies how they are given effect under Commonwealth legislation.

Table 3.1. Commonwealth, WA and NT legislation enacting the MARPOL Convention

Annex (entry into force in Australia)	Commonwealth waters (*Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 & *Navigation Act* 2012)	WA waters (*Pollution of Waters by Oil and Noxious Substances Act* 1987)	NT waters (*Marine Pollution Act* 1999)	General requirements for operating in Commonwealth, WA and NT state waters
I Regulations for the Prevention of Pollution by Oil (1988)	AMSA Marine Orders Part 91; Marine Pollution Prevention – Oil.	Part II – Pollution by oil.	Part 2 – Prevention of pollution by oil.	Addresses measures for preventing pollution by oil from regulated Australian vessels or foreign vessels, and specifies that: • An IOPP 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)	AMSA Marine Orders Part 93; Marine Pollution Prevention – Noxious Liquid Substances.	Part III - Pollution by noxious substances.	Part 3 – Prevention of pollution by noxious 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 IPP 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)	AMSA Marine Orders Part 94; Marine Pollution Prevention – Harmful Substances in Packaged Form.	Not enacted.	Part 4 – Prevention of pollution by packaged 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:

Annex (entry into force in Australia)	Commonwealth waters (*Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 & *Navigation Act* 2012)	WA waters (*Pollution of Waters by Oil and Noxious Substances Act* 1987)	NT waters (*Marine Pollution Act* 1999)	General requirements for operating in Commonwealth, WA and NT state waters
				• 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.
IV Prevention of Pollution by Sewage from Ships (2004)	AMSA Marine Orders Part 96; Marine Pollution Prevention – Sewage.	Not enacted.	Not enacted.	Addresses measures for preventing pollution by sewage from regulated Australian vessels or foreign vessels, and specifies that: • An ISPP 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)	AMSA Marine Orders Part 95; Marine Pollution Prevention – Garbage. * Not made under the *Navigation Act* 2012.	Not enacted.	Part 6 – 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 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;

Annex (entry into force in Australia)	Commonwealth waters (*Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 & *Navigation Act* 2012)	WA waters (*Pollution of Waters by Oil and Noxious Substances Act* 1987)	NT waters (*Marine Pollution Act* 1999)	General requirements for operating in Commonwealth, WA and NT state waters
				• 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)	AMSA Marine Orders Part 97; Marine Pollution Prevention – Air.	Not enacted.	Not enacted.	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 (3.5% m/m); • 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.

3.5.2 Environmental Management in the Upstream Oil and Gas Industry (2020)

These guidelines were released in August 2020 by the International Association of Oil & Gas Producers (IOGP) and the International Petroleum Industry Environmental Conservation Association (IPIECA). They supersede the United Nations Environment Programme Industry and Environment (UNEP IE) Environmental Management in Oil and Gas Exploration and Production guidelines released in 1997 prepared by the International Exploration and Production Forum (E&P Forum), the precursor to the IOGP. These guidelines provide descriptions of upstream oil and gas activities environmental management practices. Chapter 4 of the guidelines lists the environmental impacts and mitigation measures associated with offshore activities and provide a useful benchmark for BPEM for this activity.

3.5.3 Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (2019)

The Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019) aims to identify best available techniques (BAT) and best risk management approaches for key environmental issues associated with onshore and offshore oil and gas exploration and production activities. The BATs included are not prescriptive nor exhaustive but included as a point of comparison with documents such as this EP to ensure the desired environmental outcomes commensurate with BAT can be achieved for the European context.

3.5.4 World Bank Group EHS Guidelines

The Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015) is a technical reference document with general and industry-specific examples of good international industry practice. These guidelines are applied when one or more members of the World Bank Group are involved in a project.

The document contains measures considered to be achievable in new facilities, using existing technology, at reasonable costs. The guidelines are designed to be tailored to the applicable hazards and risks established for a given project.

While the World Bank Group is not involved in financing or assessing this activity, control measures adopted for this activity that adhere to these guidelines can be referenced as examples of BPEM.

3.5.5 IUCN: Effective Planning Strategies for Managing Environmental Risk associated with Geophysical and other Imaging Surveys (2016)

The *Effective Planning Strategies for Managing Environmental Risk associated with Geophysical and other Imaging Surveys: A Resource Guide for Managers* (Nowacek and Southall, 2016) is prepared as a practical guide to the responsible and effective planning of offshore geophysical surveys and other forms of environmental imaging. The focus of the document is on marine mammals. The four key practices recommended in the document are:

1. Assess and evaluate the environment in the context of the proposed action.
    a) Collect baseline environmental and biological data.
    b) Identify proposed actions and alternatives.
    c) Engage stakeholders.
2. Evaluate risk and develop plans.

a) Evaluate risks of proposed actions and alternatives.

b) Identify mitigation actions.

c) Develop monitoring strategy and methods.

3. Implement mitigation and monitoring of operations.

a) Implement mitigation measures during survey operations.

b) Implement real-time mitigation.

c) Implement monitoring protocol.

4. Evaluate and improve.

a) Report effectiveness of the mitigation program.

b) Review effectiveness of the monitoring program.

c) Promptly analyse and make results available.

3.5.6 Guidelines for the Conduct of Offshore Drilling Hazard Site Surveys

The Guidelines for the conduct of offshore drilling hazard site surveys (International Association of Oil & Gas Producers [IOGP], 2017) provides guidance for the conduct of geophysical and hydrographic site surveys of proposed offshore well locations, specifically describing good oilfield practice to meet country-specific regulatory requirements.

While environmental management guidance is not provided, the guidelines have been used to ensure that the activity design is aligned with accepted industry practice.

3.5.7 IAGC: Environmental Manual for Worldwide Geophysical Operations

The Environmental Manual for Worldwide Geophysical Operations produced by the International Association of Geophysical Contractors (IAGC, 2013) is used to guide various planning aspects of onshore and offshore geophysical projects.

This manual provides broad guidance on environmental issues associated with onshore and offshore geophysical projects, with the preparation of a detailed environmental impact and risk assessment (as contained within Section 7 of this EP) being the key measure in demonstrating that BPEM is applied to this activity.

3.5.8 IMCA: Guidelines for the use of Multibeam Echosounders for Offshore Surveys

In July 2015 the International Marine Contractors Association (IMCA) issued Revision 2 of the Guidelines for the use of Multibeam Echosounders for Offshore Surveys (IMCA, 2015). In March 2017, IMCA also issued Guidance on vessel USBL systems for use in offshore survey, positioning and DP operations (IMCA, 2017). Both documents provide general guidance on environmental issues associated with the use of these two techniques.

3.5.9 IPIECA: Best Practice Guidelines

IPIECA is the International Petroleum Industry Environmental Conservation Association, established in 1974 (since 2002, IPIECA stopped using the full title). As of May 2021, IPIECA's members comprise 72 members, comprising oil and gas exploration and production companies, associations and contractors.

IPIECA's vision is for an oil and gas industry whose operations and products meet society's environmental and social performance expectations, with a focus on the key areas of climate and energy, environment, social and reporting. It develops, shares and promotes good practices and knowledge to help the industry improve its environmental and social performance. IPIECA's work is embodied in publications that are made freely available on its website (www.ipieca.org).

Relevant guidelines have been referenced in this EP (and associated OPEP) as relevant, primarily in the areas of atmospheric emissions and oil spill response and preparedness.

EOG has applied IPIECA's Mapping the Oil and Gas Industry to the Sustainable Development Goals: An Atlas (July 2017) to the activity. Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) is the most relevant to this survey, and has been met by fulfilling the following:

- Incorporating environmental assessments into management plans – this EP satisfies this sub-goal; and
- Accident prevention, preparedness and response – the OPEP and OSMP demonstrate that EOG takes prevention, preparedness and response seriously and is well prepared to act in the event of an environmental emergency.

3.6. Australian Industry Codes of Practice and Guidelines

There are few Australian industry codes of practice or guidelines regarding environmental management for offshore geophysical and geotechnical investigations. Those that do apply to this activity are briefly discussed in this section.

None of these codes of practice or guidelines have legislative force in Australia, but are considered to represent BPEM. Aspects of each code or guideline relevant to the impacts and risks presented by the activity are outlined throughout Chapter 7.

3.6.1. Australian Ballast Water Management Requirements (2020)

The Australian Ballast Water Management Requirements (DAWE, 2020a, v8) detail the mandatory ballast water management requirements and provide information on ballast water pump tests, reporting and exchange calculations. The measures outlined in this EP are designed to minimise the risk of introducing harmful aquatic organisms into Australian waters.

3.6.2. National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (2017)

The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE, 2017a) provides a framework for identifying megafauna species (principally whales, dolphins, turtles and whale sharks) most at risk from vessel collision and outlines mitigation measures to reduce this risk. The measures outlined in this EP are designed to minimise the risk of colliding with megafauna.

3.6.3. Australian National Guidelines for Whale and Dolphin Watching (2017)

The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017b) principally apply to commercial marine tourism operations involves in whale and dolphin watching, outlining measures to comply with the EPBC Act and minimise disturbance to these cetaceans.

In the context of this activity, EOG applies these guidelines to the support vessels so that approach distances to cetaceans are adhered to.

3.6.4. National Biofouling Management Guidance for the Petroleum Production and Exploration Industry

The National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (DAFF, 2009) provides a generic approach to a biofouling risk assessment and practical information on managing biofouling on hulls and niche areas.

The measures outlined in this EP are designed to minimise the risk of introducing harmful aquatic organisms into Australian waters.

3.6.5. APPEA: Code of Environmental Practice

In Australia, the petroleum exploration and production industry operates within an industry code of practice developed by the Australian Petroleum Production and Exploration Association (APPEA); the *APPEA Code of Environmental Practice* (CoEP) (2008). This code provides guidelines for activities that are not formally regulated and have evolved from the collective knowledge and experience of the oil and gas industry, both nationally and internationally.

The APPEA CoEP covers general environmental objectives for the industry, including planning and design, assessment of environmental risks, emergency response planning, training and inductions, auditing and consultation, and communication. For the offshore sector specifically, it covers issues relating to geophysical surveys, drilling and development and production.

The APPEA CoEP has been used as a reference for the environmental impact and risk assessment (Section 7 of this EP) to ensure that all necessary environmental issues and controls for petroleum exploration have been incorporated into the management of this activity.

3.6.6. National Strategy for Ecologically Sustainable Development (1992)

The National Strategy for Ecologically Sustainable Development (ESDSC, 1992) defines the goal of Ecologically Sustainable Development (ESD) as “development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.” Section 3A of the EPBC Act defines the principles of ESD as:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and
- Improved valuation, pricing and incentive mechanisms should be promoted.

Ensuring that any petroleum activity is undertaken in a manner consistent with the ESD principal is a core aim of the OPGGS(E) and it has been taken into consideration in the demonstrations of acceptability in this EP (see Section 6).

4. Stakeholder Consultation

In keeping with EOG's Safety and Environmental Policy (see Figure 3.1), EOG is committed to open communication and engagement with communities and other stakeholders as part of its operations. EOG welcomes feedback and is continuously endeavouring to learn from experience in order to manage its environmental and social impacts and risks.

Stakeholder consultation has been undertaken in accordance with the OPGGS(E) requirements and NOPSEMA's stakeholder consultation guidance.

4.1. Stakeholder Consultation Objectives

The objectives of EOG's stakeholder consultation are to:

- Engage with stakeholders in an open, transparent, timely and responsive manner;
- Design the activity to address and minimise stakeholder concerns;
- Build and maintain trust with stakeholders; and
- Demonstrate that stakeholders have been appropriately consulted.

The objectives are achieved by:

- Identifying and confirming stakeholders ('relevant persons' whose functions, interests or activities may be affected by the activity);
- Ensuring stakeholders are informed about the activity and its environmental and social impacts and risks;
- Providing informative, accurate and timely information;
- Ensuring stakeholders are informed about the process for consultation and that their feedback is considered in the EP; and
- Ensuring that issues raised by stakeholders are adequately assessed, and where requested or relevant, responses to feedback are communicated back to them.

4.2. Regulatory Requirements

Section 280 of the OPGGS Act states that a person carrying out activities in an offshore permit area should not interfere with other users of the offshore area to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.

In relation to the content of an EP, more specific requirements are defined in the OPGGS(E) Regulation 11(A). This regulation requires that the Titleholder consult with 'relevant persons' in the preparation of an EP. A 'relevant person' is defined in Regulation 11A as:

1. Each Department or agency of the Commonwealth to which the activities to be carried out under the EP, or the revision of the EP, may be relevant;
2. Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP, or the revision of the EP, may be relevant;
3. The Department of the responsible State Minister, or the responsible Northern Territory Minister.
4. A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP, or the revision of the EP; and

5. Any other person or organisation that the titleholder considers relevant.

Further guidance regarding the definition of functions, interests or activities is provided in NOPSEMA Bulletin #2 *Clarifying statutory requirements and good practice consultation* (November 2019), as follows:

- Functions – a person or organisation's power, duty, authority or responsibilities;
- Activities – a thing or things that a person or group does or has done; and
- Interests – a person or organisation's rights, advantages, duties and liabilities; or a group or organisation having a common concern.

Regulation 14(9) of the OPGGS(E) also defines a requirement for ongoing consultation to be incorporated into the Implementation Strategy defined in the EP (Chapter 8 of this EP). In addition, Regulation 16(b) of the OPGGS(E) requires that the EP contain a summary and full text of this consultation.

Amendments to the OPGGS(E) that took effect on the 25th of April 2019 specify (in Regulation 9AB) that exploration EPs (as this one is) must be published on the NOPSEMA website for public comment (subject to the EP satisfying a completeness check by NOPSEMA).

4.3. Identification of Relevant Persons

EOG has identified and consulted with relevant persons whose functions, interests or activities may be affected by the PDSA, as well as those who EOG deems necessary to keep up to date with the activities in the Bonaparte Basin. Table 4.1 identifies these relevant persons.

EOG has used maps of existing petroleum permits and infrastructure, commercial fisheries maps, marine sensitivity mapping and NOPSEMA's Guideline on *Consultation with Commonwealth agencies with responsibilities in the marine area* (N-06800-GL1887, July 2020), to develop this list of relevant persons.

In this EP, EOG has distinguished between relevant persons and stakeholders. Relevant persons are those meeting the definition provided in Section 4.2, while stakeholders are considered to be a broader set of people or organisations who made contact with EOG through the public exhibition phase of the EP and are not relevant persons.

Table 4.1. Relevant persons consulted for the Beehive-1 PDSA

Category 1 – Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant	
1. Australian Hydrographic Office (AHO)	2. Australian Maritime Safety Authority (AMSA)
3. Australian Communications and Media Authority (ACMA)	4. Department of Defence (DoD)
5. Australian Fisheries Management Authority (AFMA)	6. Department of Agriculture, Water and the Environment (DAWE)
7. Director of National Parks (DNP)	8. National Native Title Tribunal (NNTT)
9. Maritime Border Command (MBC)	

Category 2 – Each Department or agency of a State to which the activities to be carried out under the EP may be relevant	
Western Australian	
10. Department of Primary Industries and Region Development (DPIRD) - Fisheries	11. Department of Biodiversity, Conservation and Attractions (DBCA)
12. Department of Transport (DoT) – oil spill response coordination	13. Department of Fisheries (DoF) – under DPIRD
14. Department of Planning, Lands and Heritage (DPLH)	
Northern Territory	
15. Department of Industry, Tourism and Trade (DITT)	16. Department of Environment, Parks and Water Security (DEPWS)
17. DITT – Fisheries Division	18. Department of Transport (DoT) – marine safety branch.
Category 3 – The Department of the responsible State Minister	
Western Australian	
19. WA Department of Mines, Industry Regulation and Safety (DMIRS)	
Northern Territory	
NT DITT (number 15 listed under Category 2)	
Category 4 – A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP	
Commercial Fisheries (Licence Holders)	
20. Northern Prawn Fishery (NPF) (Cth)	21. Southern Bluefin Tuna Fishery (SBTF)
22. Western Skipjack Tuna Fishery (WSTF)	23. Western Tuna and Billfish Fishery (WTBF)
24. Northern Prawn Fishing Industry Pty Ltd (NPFI)	25. Northern Demersal Scalefish Managed Fishery (NDSMF) (WA)
26. Mackerel Managed Fishery (MMF) – Area 2 (WA)	27. Kimberley Prawn Managed Fishery
28. Kimberley Crab Fishery (WA)	29. Kimberley Gillnet and Barramundi Fishery (WA)
30. A Raptis & Sons Pty Ltd	31. Northern Wildcatch Seafood Australia (NWSA)
32. Demersal Fishery (NT)	33. Offshore Net & Line Fishery (NT)
34. Spanish Mackerel Fishery (NT)	35. Coastal Line Fishery (NT)
Fisheries Associations	
36. Commonwealth Fisheries Authority (CFA)	37. Australian Southern Bluefin Tuna Industry Association (ASBTIA)
38. Western Australian Fishing Industry Council (WAFIC)	39. Pearl Producers Association (PPA)

40. Recfish West	41. Northern Territory Seafood Council (NTSC)
42. Amateur Fishermen's Association of the Northern Territory (AFANT)	
Cultural Heritage	
43. Kimberley Land Council (KLC)	44. Miriuwong and Gajerrong Aboriginal Corporation
45. Balanggarra Aboriginal Corporation	
Tourism	
46. Marine Tourism Western Australia (MTWA)	
Petroleum	
47. Eni Australia B.V.	48. Woodside Energy Ltd (WEL)
49. Melbana Energy Limited	50. Neptune Energy Bonaparte Pty Ltd
51. Santos Ltd	
Category 5 – Any other person or organisation that the Titleholder considered relevant	
None identified.	

Note that consultation with contractors will be undertaken by EOG and is not addressed in this section of the EP. This includes organisations that EOG has a contract or agreement with for assistance in the event of oil spill response or operational and scientific monitoring. Discussions with these organisations that are not directly linked to undertaking the activity are not included in the summary of stakeholder consultation in Section 4.5.

Where discussions with these organisations have assisted in the development or refinement of oil spill response strategies described in the OPEP, then these have been incorporated. The 'functions, interests or activities' of these organisations are only triggered in an emergency response. Consultation with these contractors and organisations is undertaken in accordance with Regulation 14(5) of the OPGGS(E), which requires measures to ensure that each employee or contractor working on, or in connection with the activity, is aware of his or her responsibilities in relation to this EP and has the appropriate competencies and training. This is detailed in Section 8.5.1 of the EP.

EOG recognises that the relevance of stakeholders identified in this EP may change in the event of a non-routine event or emergency. Every effort has been made to identify stakeholders that may be impacted by a non-routine event or emergency, the largest of which is considered to be a vessel-based diesel spill (see Section 7.16).

EOG acknowledges that other stakeholders not identified in this EP may be affected, and that these may only become known to EOG in such an event.

4.4. Engagement Approach

Consultation has been broadly undertaken in line with the International Association for Public Participation (IAP2) spectrum, which is considered best practice for stakeholder engagement. In order of increasing level of public impact, the elements of the spectrum and their goals are:

- Inform – to provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solutions.
- Consult – to obtain public feedback on analysis, alternatives and/or decisions.
- Involve – to work directly with stakeholders throughout the process to ensure that public concerns and aspirations are consistently understood, considered and addressed.
- Collaborate – to partner with the public in each aspect of the decisions, including the development of alternatives and the identification of the preferred solution.
- Empower – to place final decision-making in the hands of the stakeholders.

The manner in which EOG has informed, consulted and involved relevant persons with the activity are outlined through this section. Collaboration (partnering on decision-making with relevant persons) has not been required to date.

Under the regulatory regime for the approval of EPs, the decision maker is the regulator. This being the case, the final step in the IAP2 spectrum, ‘Empower’, has not been adopted.

4.5. Engagement Methodology

The tools and methods that have been and will continue to be used for engagement with relevant persons are:

- Project Information Sheets – the first information sheet was focused on the PDSA and broadly introduced the drilling program and was issued to relevant persons on the 17th September 2021 (10 weeks prior to public exhibition of the EP), and provided information on the location and timing of the activity (**Appendix 2**). Some information sheets were sent several days later as a result of email bounce-backs. The information sheet included a high-level impact and risk assessment for the PDSA and contact details to provide the opportunity to provide feedback. A second information sheet was issued on the 2nd December 2021 to inform relevant persons that the EP was available on the NOPSEMA website for public exhibition, along with providing an update on the timing of the PDSA and advising that the title transfer was completed.
- Project phone number and email – A telephone number and email address is provided in the project information sheet. The phone number is monitored by the Environmental Consultant and the email address is monitored by the nominated liaison person.
- Company website – the project information flyer is available on the EOG website (https://www.eogresources.com/) for ease of access. Future information flyers will also be made available here.
- One-on-one briefings – where relevant persons have expressed concerns, one-on-one briefings (via phone) with the project’s environmental consultants have been offered. To date, this has not been taken up.

4.6. Summary of Stakeholder Consultation

Of the 51 relevant persons listed in Table 4.1, only 24 (47%) responded to EOG after receiving the project information sheet or in response to follow up phone calls from EOG. All concerns raised are captured in Table 4.2 and addressed in the EP.

Of the 24 responses, five relevant persons (DoD, NT DITT, NPFI, NT Demersal Fishery, WAFIC) raised concerns about the effects of the activity on their functions, activities or interests. These are summarised as:

- The activity area may restrict military training activities due to the risk of collision with low-flying aircraft;
- The impacts of seismic sound on fish, including avoiding generation of seismic sound during the warmer months (because it coincides with fish spawning);
- Ensuring the EP presents a robust risk assessment process;
- Potential disruption to the Northern Prawn Fishery (NPF) productivity, and disruption and displacement of fishing vessels;
- Opposition to undertaking any PDSA (or drilling) activities during the NPF fishing season (1st August to 1st December each year); and
- Concerns for impacts to prawns and threatened species, including turtles, sawfish and sea snakes.

A summary of all consultation undertaken to date with relevant persons, including EOG's responses and assessment of merit, is included in Table 4.2 (current as of 23rd December 2021).

In line with the requirements of OPGGS(E) Regulation 11B, this EP was publicly exhibited on the NOPSEMA website from 24th November 2021 to 23rd December 2021. One submission was received, which raised concerns about the effects of seismic surveys on fish, whales, benthic assemblages and deep-sea marine life. EOG prepared a titleholder report that accompanies this EP that provides a response to the submission. EOG's assessment of the comments received has not resulted in changes to the activity design or amendments to the EP.

A complete copy of original communications to and from all relevant persons is provided in **Appendix 3**. The reference number provided with the date of communication in Table 4.2 links to each record of correspondence in **Appendix 3**.

4.7. Ongoing Consultation

EOG continues to consult with relevant persons regarding the PDSA. It is envisaged that the only issue that would warrant engagement (as distinct from notification) with relevant persons immediately prior to or during the activity would be in the event of major changes to the activity design or a large-scale hydrocarbon release.

Activity notification requirements are provided in Chapter 8.

Consultation with relevant persons will continue with regard to the drilling campaign, and this consultation will be addressed in a future Beehive-1 drilling EP.

4.8. Management of Objections and Claims

If any objections or claims are raised during ongoing consultation or during the activity, these will be verified through publicly available credible information and/or fishing data from AFMA.

Where the objection or claim is substantiated, it will be assessed in line with the risk assessment process detailed in Chapter 6 and controls applied where appropriate to manage impacts and risks to ALARP and an acceptable level. Relevant persons will be provided with feedback as to whether their objection or claim was substantiated, how it was assessed and if any controls were put in place to manage the impact or risk to ALARP and an acceptable level.

Table 4.2. Summary of consultation undertaken with relevant persons

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
Category 1. Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant					
1. AHO	Responsible for the publication and distribution of nautical charts and other information required for safe shipping and navigation in Australian waters.	18/09/2021 (AHO-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG will continue to consult with the AHO and make the necessary notifications throughout the survey. Notification requirements are included in Section 8.9.2 of the EP.
		20/09/2021 (AHO-02) Email	AHO automated acknowledgment of email.	No concerns raised.	
		26/10/2021 Phone call and email (AHO-03)	EOG called the AHO. AHO advised they had no initial concerns or issues and reiterated the notification requirements in relation to Notice to Mariners prior to activity commencement. EOG confirmed the notification requirements are included in the EP.	AHO emailed EOG acknowledging receipts of the project information and advised that details of the project are required at least four weeks prior to activity commencement to allow AHO to issue a temporary Notice to Mariners.	
		02/12/2021 (AHO-04) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
		06/12/2021 (AHO-05) Email	AHO acknowledgement email and confirmed that the latest data has been registered, assessed, prioritised and validated in preparation for updating the AHO Navigational Charting products.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
2. AMSA	Responsible for maritime safety.	18/09/2021 (AMSA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG will continue to consult with AMSA and provide the necessary notifications for the activity. Notification requirements are included in Section 8.9.2 and Section 9.3 of the EP.
		21/09/2021 (AMSA-02) Email	AMSA responded to EOG notification of activity and reminded them of the requirement to contact the AHO four weeks prior to activity starting and notify AMSA's Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings at least 24-48 hours before operations commence.	No concerns raised.	
		01/10/2021 (AMSA-03) Email	EOG acknowledged AMSA's response and noted that it is undertaking consultation directly with the AHO and will notify the JRCC closer to the time of the activity. The contact details and notification timings will be included in the EPs and EOG has obtained and mapped AIS traffic data for the project area for inclusion in the EPs.	No concerns raised.	
		02/12/2021 (AMSA-04) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
3. ACMA	Administrator of submarine cable protection zones.	18/09/2021 (ACMA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	The location of the cable protection zones is not in the vicinity of the activity area. Consultation with cable owners is therefore not required. No further consultation required with ACMA.
		19/09/21 (ACMA-02) Email	Policy analyst emailed EOG to acknowledge that the activity area is not in the vicinity of any of the three cable protection zones in Australia and encouraged EOG to contact the cable owners directly.	No concerns raised.	
		02/10/2021 (ACMA-03) Email	EOG emailed ACMA noting no further consultation with ACMA was required.	No concerns raised.	
4. DoD	Responsible for Australian defence activities.	17/09/2021 (DoD-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG has incorporated DoD notification requirements in Section 8.9.2 of the EP. No further consultation is required with DoD.
		06/10/2021 Phone call and email (DoD-02)	EOG followed up with a phone call to DoD. DoD stated the project information sheet had not been received and advised EOG to resend. EOG re-issued the email.	No concerns raised.	
		18/10/2021 (DoD-03) Email	Directorate of Property Interests and Acquisition of DoD emailed EOG and provided comment and the notification requirements that EOG will need to comply with prior to commencement of the activity.	DoD's key concerns were that: • Offshore infrastructure may impact military flying training areas. • The safety of air navigation due to the risk of collision	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
				with low-flying aircraft below 500 feet. • Unexploded ordnance (UXO) may be present on and in the sea floor within the North Australia Exercise Area (NAXA).	
		26/10/2021 (DoD-04, 05 & 06) Email	EOG thanked DoD for their detailed response and acknowledged their points were considered in the EP. EOG stated they would keep in contact with DoD (as planning for the future drilling campaign progresses) unless DoD are happy with EOG proceeding with the notification requirements as per DoD's advice. DoD acknowledged EOG's email and provided a contact email for UXO related enquiries. EOG emailed the UXO enquiries team with a project-specific UXO map and requested confirmation of the location of potential UXO in relation to the activity area.	EOG's response to DoD contained the following: • EOG has identified and mapped the NAXA and restricted airspace. • Military flying training areas, low-flying aircraft and the potential UXO within the NAXA are considered in the EP. • Although not yet contracted, the highest point of the geotechnical vessel (the top of the drilling derrick) will be no higher than ~45 m above the keel. • Notification requirements are included in the EP as per DoD's request.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		09/11/2021 (DoD-07 & 08) Email	EOG followed up with the UXO related enquiries team. The Assistant Director Contamination Assessment Remediation and Management (UXO) confirmed that there are no records of specific UXO in the PDSA area.	No concerns raised.	
		02/12/2021 (DoD-09) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
5. AFMA	Manager of fisheries in Commonwealth waters.	18/09/2021 (AFMA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. No further consultation required with AFMA.
		26/09/2021 (AFMA-02) Email	AFMA emailed they were unable to comment on individual projects and suggested EOG liaise with the relevant fisheries associations (weblink provided).	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		02/10/2021 (AFMA-03) Email	EOG responded to AFMA that consultation directly with Commonwealth fisheries associations is being undertaken and that contact will be made with AFMA again if consultation with the associations indicates the need to consult directly with Commonwealth concession holders.	No concerns raised.	
6.DAWE - Biosecurity	Commonwealth department responsible for managing biosecurity for incoming goods and conveyances.	17/09/2021 (DAWE-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	DAWE has not provided any comments to date. EOG is familiar with marine biosecurity requirements and does not need to consult with this stakeholder in the immediate future. Vessel biosecurity controls are provided in Section 7.13.5 of the EP. Biosecurity notification requirements are provided in Section 8.9.2 of the EP.
		06/10/2021 Phone Call	EOG contacted DAWE and left a voice message to confirm whether they had received the project information sheet. No response from DAWE.	No concerns raised.	
		26/10/2021 (DAWE-02) Email	EOG re-issued the project information sheet to DAWE. No feedback provided to date.	No concerns raised.	
		02/12/2021 (DAWE-03) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
7.DNP	Manages the AMP network in Commonwealth waters.	17/09/2021 (DNP-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG has addressed DNP's comments. Section 5.4.1 of the EP describes the values of the AMPs. Spill notification details for DNP are included in Section 9.3 of the EP. EOG has consulted with the Miriuwong and Gajerrong Aboriginal Corporation and Balanggarra Aboriginal Corporation.
		07/10/2021 Phone call and email (DNP-02)	EOG followed up with a phone call to DNP. DNP stated the project information sheet had not been received and advised EOG to resend to an alternative address. EOG re-issued the email.	No concerns raised.	
		11/10/2021 (DNP-03 & 04) Email	DNP confirmed receipt of email with project information and provided feedback to EOG. DNP acknowledged the activity area does not overlap with any AMPs and noted the carbonate bank and terrace system of the Sahul Shelf KEF and foraging areas within the activity area for the green turtle, olive ridley turtle. DNP noted that Aboriginal groups have responsibilities for sea country in the JBG AMP and should be consulted. In addition, DNP made EOG aware of the pollution incident reporting requirements and indicated they may request daily or weekly Situation Reports in the event of a pollution incident.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		19/10/2021 (DNP-05) Email	EOG acknowledged DNP's comments and confirmed the EP will assess impacts and contain all required information. Additionally, EOG confirmed consultation with relevant Aboriginal corporations is being undertaken.	No concerns raised.	
		02/12/2021 (DNP-06) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
8.NNTT	Responsible for administration of the *Native Title Act* 1993.	17/09/2021 (NNTT-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No further consultation required with NNTT in line with their advice.
		06/10/2021 Phone Call	EOG followed up with a phone call to NNTT who confirmed receipt of the project information sheet. EOG reiterated that any feedback or concerns are welcome via the contact details provided.	No concerns raised.	
		13/10/2021 (NNTT-02) Email	NNTT acknowledged receipt of the information and included a link to the NNTT website. NNTT stated if EOG had any further enquiries to contact them directly.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		26/10/2021 (NNTT-03 & 04) Email	EOG thanked NNTT for their response and asked if the NNTT would like to remain included in future project mail outs. NNTT confirmed it was not necessary to include them in future correspondence.	No concerns raised.	
9.MBC	Key agency for border protection.	17/09/2021 (MBC-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. Further consultation will be undertaken if required.
		06/10/2021 Phone Call	EOG followed up with a phone call to MBC via the Department of Home Affairs but was unable to get through.	No concerns raised.	
		07/10/2021 (MBC-02 & 03) Email	EOG followed up with an email to MBC to verify receipt of project information sheet via email. EOG received an automated acknowledgment of email from the Department of Home Affairs.	No concerns raised.	
		08/10/2021 (MBC-04) Email	EOG received email from Transport Security Guidance Centre stating that the project information was forwarded to the Maritime Security policy team.	No concerns raised.	
		26/10/2021	EOG re-issued the email and requested a receipt of email and any	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		(MBC-05, 06 & 07) Email	questions or concerns via reply email. MBC advised EOG that the email was forwarded internally to seek questions or concerns. MBC emailed EOG to confirm they had no issues or concerns.		
		02/12/2021 (MBC-08) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
Category 2. Each Department or agency of a State to which the activities to be carried out under the EP may be relevant					
10. WA DPIRD	Responsible for managed West Australian State fisheries.	20/09/2021 (DPIRD-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	WA-managed fisheries in the activity area and EMBA are described in Section 5.6.1. Further consultation will be undertaken if required.
		21/09/2021 (DPIRD-02) Email	DPIRD emailed EOG to advise the PPA is no longer in a consultative role and to directly consult with individual pearling companies. Informed EOG that email had been forwarded onto WA pearling licensees.	No concerns raised.	
		02/10/2021 (DPIRD-03) Email	EOG responded to acknowledge the role of the PPA.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		04/10/2021 (DPIRD-04) Email	DPIRD emailed EOG to advise of contacts to send future correspondence to.	No concerns raised.	
		26/10/2021 (DPIRD-05 & 06) Email	EOG emailed DPIRD to seek feedback from any of the pearling licensees that DPIRD had contacted on behalf of EOG. DPIRD replied and stated that the pearling licensees were asked to contact EOG directly on this matter.	No concerns raised.	
		02/12/2021 (DPIRD-07) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
11. WA DBCA	Responsible for the management of State marine parks and reserves and protected marine fauna and flora.	18/09/2021 (DBCA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. Spill notification requirements for state waters are included in Section 9.3 of the EP. No further consultation is required with this relevant person in line with their advice.
		18/09/2021 (DBCA-02) Email	DBCA automated acknowledgment of email received.	No concerns raised.	
		14/10/2021 (DBCA-03) Email	DBCA emailed EOG that they had no comments on the project information. DCBA requested EOG continue to provide notifications.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		02/12/2021 (DBCA-04) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
12. WA DoT	Responsible for oil pollution response in State waters.	18/09/2021 (DoT-01, 02 & 03) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. Spill notification requirements for state waters are included in Section 9.3 of the EP. No further consultation is required with this relevant person in line with their advice.
		29/09/2021 (DoT-01, 02 & 03) Email	WA DoT advised EOG that if there is a risk of a spill impacting WA State waters from the activity, then EOG must consult the DoT as per the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020).	No concerns raised.	
		30/09/2021 (DoT-01, 02 & 03) Email	EOG acknowledged the response and noted that the ecological EMBA for a vessel-based diesel spill does not enter WA state waters or reach shorelines; however the socio-economic EMBA does reach state waters and shorelines but is not predicted to have ecological impacts and is highly unlikely to require an on-water response.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
			EOG advised they will provide more information going forward.		
		07/10/2021 (DoT-04) Email	WA DoT acknowledged email from EOG.	No concerns raised.	
		12/10/2021 (DoT-05) Email	EOG provided more detail on spill risk and response in line with the guidance note, as requested. EOG encouraged WA DoT to provide questions on the spill modelling results or proposed response strategy and offered to arrange further information to be provided.	No concerns raised.	
		27/10/2021 (DoT-06) Email	WA DoT confirmed they were satisfied with the level of information provided and given the low risk of the activity to the State, did not require additional information.	No concerns raised.	
13. WA DoF	Refer to WA DPIRD (see entry #10).				
14. WA DPLH	Responsible for protecting Aboriginal heritage, assisting with compliance of the Aboriginal Heritage Act 1972	17/09/2021 (DPLH-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. No further consultation is required with this relevant person in line with their advice.
		06/10/2021 Phone call	EOG followed up with a phone call to DPLH who stated they had not received the project information	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
	and providing access to heritage information.		sheet. DPLH advised to resend the email.		
		07/10/2021 (DPLH-02) Email	EOG re-issued the email.	No concerns raised.	
		26/10/2021 (DPLH-03) Email	EOG re-issued email and requested confirmation of email and any questions/concerns via reply email.	No concerns raised.	
		01/11/2021 (DPLH-04) Email	DPLH thanked EOG for the information flyer and advised that they had no comments or objections.	No concerns raised.	
15. NT DITT	Responsible for NT-managed fisheries.	18/09/2021 (DITT-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	DITT's concerns have been responded to. EOG's response to DITT contained the following: • The shallow seismic survey is very different from a conventional seismic survey, as it uses a much lower sound source (typically less than 100 cui, compared to up to 3,500 cui). • Shallow seismic will take no more than 1-2 days and take place over few survey
		06/10/2021 Phone call and email (DITT-02, 03, 04, 05 & 06)	EOG followed up with a phone call to DITT who confirmed they had not received the project information sheet and that the department email address had recently changed. DITT advised EOG to forward the flyer to the new department email. EOG re-issued the email.	No concerns raised.	
		07/10/2021	EOG responded to administration support at DITT to confirm receipt of test message and requested that the	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		(DITT-03,04,05 & 06) Email	email containing the information flyer be sent to the appropriate individuals at DITT.		lines (note – the regional survey lines to which this related are no longer part of the activity). As such, the impacts to marine life are far lower than conventional seismic surveys. • An EIA will be included in the PDSA EP, taking into account spawning for key commercial fishing targets, especially prawns. • The risk assessment included in the EP follows traditional risk assessment methods, and includes a demonstration of acceptability and ALARP, which is a requirement of the OPGGS(E). • An exploration EP is subject to public exhibition, and all relevant persons and stakeholders will have the opportunity to review the EP and provide comments on its structure and
		13/10/2021 (DITT-03,04,05 & 06) Email	Program Leader, Research and Field Operations at DITT emailed EOG confirming the permit area is contained wholly within WA waters and no NT commercial fisheries operate within the PDSA area.	DITT's key concerns were: • The impact of seismic on fish, including impacts to audio organs, larval survival and other varying spatial and temporal impacts. • Seismic impact during the warmer months of the year for tropical fish spawning seasons. • The EIA should be robust and should align with ERA process and that the risk assessment be reviewed by a third party.	
		19/10/2021 (DITT-03,04,05 & 06) Email	EOG responded to the DITT's concerns and advised the EP will undergo a public exhibition and welcomed DITT to review the EP once available for public comment, or EOG can provide a copy prior to public exhibition.	See the assessment of merit column.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		23/11/2021 (DITT-07) Email	EOG advised DITT that the EP had been submitted to NOPSEMA for a completeness check prior to its publication on the NOPSEMA website; and provided a copy of the EP (in advance of public exhibition).	Not applicable.	content prior to formal submission to NOPSEMA.
		02/12/2021 (DITT-08) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
16. NT DEPWS	Responsible for protecting the environment and natural resources in the NT, including marine fauna management.	18/09/2021 (DEPWS-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	Attempts to elicit concerns from this relevant person have been made and no response provided. Given the long distance of the PDSA from NT coastlines and protected areas and lack of concern from this relevant person, EOG assumes that additional attempts to elicit concerns are not warranted.
		06/10/2021 Phone call	EOG spoke to front reception at DEPWS who confirmed receipt of email.	No concerns raised.	
		26/10/2021 (DEPWS-02) Email	EOG re-issued email to DEPWS advising of EP preparation for submission to NOPSEMA and requested confirmation of email and any questions/concerns via reply email. No feedback received to date.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
17. NT DITT - Fisheries	Responsible for managing NT fisheries and aquatic ecosystems.	20/10/2021 (DITT-Fish-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. EOG believes it is not necessary to follow up with the Fisheries department given EOG is consulting directly with the NT DITT.
		20/10/2021 (DITT-Fish-02) Email	Automated acknowledgment of email received from DITT-Fisheries.	No concerns raised.	
		26/10/2021 Phone call	EOG called DITT reception who confirmed the email was forwarded to the licencing department and they will follow-up with the research managers to seek feedback. EOG reiterated that any feedback be made via reply email. No feedback received to date.	No concerns raised.	
18. NT DoT	Responsible for oil pollution response in NT waters.	18/09/2021 (NT DoT-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. Further consultation will be undertaken if required.
		06/10/2021 Phone call	EOG spoke to the Principal Nautical Officer, Marine Safety Branch who confirmed receipt of email and has read it with no initial concerns. NT DoT advised they will email if they have any questions going forward.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		02/12/2021 (NT DoT-02) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
Category 3 – The Department of the responsible State Minister					
19. WA DMIRS	Responsible for the management of offshore petroleum in the adjacent State waters.	18/09/2021 (DMIRS-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. Notification requirements are included in Section 8.9.2 and spill notifications are provided in Section 9.3 of the EP. Further consultation will be undertaken if required.
		06/10/2021 Phone call	EOG spoke to the General Manager, Petroleum Compliance who confirmed receipt of project information and advised it would be distributed internally for any comments. The GM advised they would provide a response in the next day or so. EOG requested they send through via email and or contact EOG as per details in the information flyer.	No concerns raised.	
		26/10/2021 Phone call	EOG left a voice message to confirm if DMIRS had any questions or concerns regarding the project.	No concerns raised.	
		27/10/2021 (DMIRS-02, 03 & 04) Email	EOG sent a follow up email to the General Manager of DMIRS to check whether they had any questions or concerns and if so, to send	DMIRS replied and stated they had no specific comments given the project location is in Commonwealth waters and NOPSEMA may refer the EP to	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
			comments through via reply email at their earliest convenience.	DMIRS for comment at a later date. DMIRS provided EOG with notification requirements (pre-start and post-activity) including incident notifications.	
		02/12/2021 (DMIRS-05) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
NT DITT	As per entry #15.				
Category 4 – A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP					
20. NPF (Cth)	Peak body representing the Northern Prawn Fishery.	Consultation with this fishery is undertaken via the NPFI. See NPFI entry (#24).			
21. SBTF (Cth)	Peak body representing the Southern Bluefin Tuna (SBT) Fishery.	17/09/2021 (SBTF-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG has made contact with the fishery and they do not appear to have any concerns. Further consultation is not required.
		07/10/2021 Phone call	EOG left a voice message for the SBTF Manager at AFMA to confirm receipt of project information.	No concerns raised.	
		26/10/2021 (SBTF-02 & 03) Email	EOG sent a follow up email to SBTF to check whether there were any questions or concerns with regard to	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
			the activity and if so, to send these via reply email. The SBT Fishery replied stating that the project information had been distributed internally for information and that SBTF would contact EOG directly if they had any issues. No feedback received to date.		
22. WSTF (Cth)	Peak body representing the WSTF.	17/09/2021 & 20/09/2021 (WSTF-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	WSTF confirmed there is no known tuna fishing effort or catch in the activity area. Further consultation is not required.
		07/10/2021 Phone call	EOG left a message for the WSTF Manager to confirm receipt of project information.	No concerns raised.	
		14/10/2021 (WSTF-02) Email	WSTF Manager of Tropical Fisheries emailed EOG to confirm there is fish effort or catch in the project area. The water depths are very shallow and the presence of commercially important tuna and billfish species is negligible in the area; however the activity area did fall in the NPF area and AFMA had acknowledged that EOG were consulting with NPF directly. WSTF had no further comments on the proposed activity.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		19/10/2021 (WSTF-03) Email	EOG acknowledged WSTF comments and confirmed they are aware of NPF annual closure in the Joseph Bonaparte Gulf from 31 March to end June. Depending on any issues raised by NPF, EOG stated they may seek assistance from AFMA with regard to verifying catch rates for the purposes of EIA. EOG asked WSTF if they would like to remain included in future project mail outs.	No concerns raised.	
23. WTBF (Cth)	Peak body representing the WTBF.	Consultation results as per WSTF (see entry #22).			
24. Northern Prawn Fishing Industry (NPFI) Pty Ltd (WA)	Peak body representing the Northern Prawn Fishery.	18/09/2021 (NPFI-01,02 & 03) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG responded to the NPFI concerns with the following: • Acknowledgement of the low fishing effort and catch in the PDSA area, noting that the EP includes an impact assessment for impacts to the fishery, including vessel displacement. • Acknowledgment that the PDSA will aim to be completed prior to the start of August in order to
		28/09/2021 (NPFI-01,02 & 03) Email	NPFI responded requesting GIS shape files of the activity area to help inform their response. EOG responded via email with attached shapefiles.	No concerns raised.	
		27/10/2021 Phone call	EOG called the Project Manager (NPFI) to follow up on email sent. Project Manager stated the shapefiles had been forward to the	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
			CEO to review on 11 October and provided EOG with the CEO's contact details.		avoid disruption to the fishery. This will also negate the need for compensation. • Impacts to threatened species, such as turtles, sawfish and sea snakes, along with impacts to prawns, are addressed in the EP. EOG committed to continuing consultation with the NPFI as planning for the drilling campaign progresses.
		28/10/2021 (NPFI-04 & 05) Email	EOG emailed the CEO to seek any feedback on the project. NPFI acknowledged receipt of the shapefiles and confirmed they would review and provide EOG with a response in the following week.	No concerns raised.	
		08/11/2021 Phone call	EOG phoned to follow up on email sent to the CEO and advised that the activity area had been reduced in size. The CEO had yet to provide comment and was keen to review the revised activity area map and respective coordinates.	No concerns raised.	
		09/11/2021 (NPFI-06) Email	EOG emailed NPFI with the revised PDSA survey area map & coordinates and re-issued the information flyer requesting feedback via reply email.	No concerns raised.	
		10/11/2021 (NPFI-07) Email	NPFI emailed EOG requesting shapefiles for the revised activity area.	No concerns raised.	
		10/11/2021 (NPFI-08) Email	The NPFI provide several concerns by email.	Concerns raised were: • Although there is a low fishing effort and catch in the PDSA area, there is	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
				historically a higher fishing catch and effort and not to underestimate the potential impacts to fishing productivity and disruption. • Opposition to any activity taking place during the fishing season of 1st August to 1st December each year. • Impacts to threatened species, such as turtles, sawfish and seasnakes, and to ensure the EP addresses potential impacts to these species. • Concern about short- and long-term impacts to productivity of the fishery, including larvae, from sound-generating equipment. The fishery will seek compensation from EIG is there are any impacts to it from disruption, displacement or loss of fishery productivity.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		12/11/2021 (NPFI-09) Email	EOG provided a detailed response to the NPFI's concerns, including the provision of maps showing the overlap between the activity and EMBA with the fishing intensity of the fishery in 2019 and 2020. See the assessment of merit columns.	Not applicable.	
		23/11/2021 (NPFI-10) Email	EOG advised NPFI that the EP had been submitted to NOPSEMA for a completeness check prior to its publication on the website; and provided a copy of the EP to NPFI (in advance of public exhibition).	Not applicable.	
		02/12/2021 (NPFI-11) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
25.NDSMF (WA)	Peak body representing the Northern Demersal Scalefish Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#38).			
26. MMF (WA)	Peak body representing the Mackerel Managed Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#38).			

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
27. Kimberley Prawn Fishery (WA)	Peak body representing the Kimberley Prawn Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#38).			
28. Kimberley Crab Fishery (WA)	Peak body representing the Kimberley Crab Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#38).			
29. Kimberley Gillnet and Barramundi Fishery (WA)	Peak body representing the Kimberley Gillnet and Barramundi Managed Fishery.	Consultation with this fishery is undertaken via WA DPIRD. See WA DPIRD entry (#10).			
30. A Raptis & Sons Pty Ltd	Raptis owns and operates 15 commercial fishing vessels in the northern prawn and NT demersal fishery zones.	18/09/2021 (ARAPTIS-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required. All relevant fisheries managers and associations have been contacted.
		07/10/2021 Phone call	EOG contacted the main office to confirm receipt of project information. EOG reiterated any feedback in writing would be preferred and provided a phone number for the CEO to call should they have any questions or concerns. No feedback received to date.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		02/12/2021 (ARAPTIS-02) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
31. NWSA	NSWA operates its fleet from Darwin, fishing from longitude 120° east to the NT/Qld border in the Gulf of Carpentaria out to the limit of the Australian Fishing Zone.	19/09/2021 (NWSA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	NWSA advised the PDSA will not have an impact on the fishery. No further consultation is required.
		07/10/2021 Phone call	EOG contacted NWSA who confirmed receipt of project information which was forwarded to the company Director. NWSA confirmed they have no concerns. EOG requested a written response from NWSA.	No concerns raised.	
		07/10/2021 (NWSA-02) Email	NWSA responded via email stating that Beehive-1 will not have an impact on the NWSA.	No concerns raised.	
		19/10/2021 (NWSA-03) Email	EOG responded to NWSA to acknowledge their email and asked if they would like to be removed from future project mail outs.	No concerns raised.	
32. Demersal Fishery (NT)	Peak body representing Demersal fishing allowed from 15 nm	18/09/2021 (Demersal-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG has addressed this relevant person's concerns regarding the impact and risk assessment methodology (see

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
	from the low water mark to the outer boundary of the Australian fishing zone, excluding the area of the Timor Reef Fishery.	07/10/2021 Phone call and email (Demersal-02)	EOG contacted the Demersal Fishery who confirmed they had not received the project information. The Demersal fishery advised EOG to re-issue it to their new email address. EOG re-issued the email.	No concerns raised.	Chapters 6 & 7) and issues regarding impacts to fish spawning (Section 7.2).
		07/10/2021 (Demersal-03)	Demersal fishery automated acknowledgment of email.	No concerns raised.	
		13/10/2021 (Demersal-04) Email	The Program Leader, Research & Field Ops at NT Fisheries emailed EOG with some concerns.	Concerns expressed about potential impacts to fish from seismic and requested no seismic activity during fish species spawning seasons. They strongly advised EOG to undertake ecological risk assessment (ERA) style process rather than the ALARP and indicated if EOG required more information to refer to DPIRD - fisheries department.	
		18/10/2021 (Demersal-05) Email	EOG responded to the concerns of impacts from seismic activity, noting the sound sources used for G&G activities are lower than traditional seismic surveys and occur over a much smaller area.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
			EOG confirmed that the EIA will take into account spawning for key commercial fishing targets, especially prawns. EOG outlined the risk assessment process must be in line with OPGGS(E) requirements, which include a demonstration of ALARP, and offered the fishery a copy of the EP (prior to public exhibition) to review the risk assessment process.		
		23/11/2021 (Demersal-06, 07 & 08) Email	EOG advised Demersal Fisheries that the EP had been submitted to NOPSEMA for a completeness check prior to its publication on the NOPSEMA website; and provided the fishery with a copy of the EP (in advance of public exhibition). Demersal Fishery replied to EOG but confirmed unable to access the EP via the link and would resolve it internally with their IT team. EOG responded and offered alternative options for file sharing with Demersal Fishery should they wish to do so.	Not applicable.	
		01/12/2021 (Demersal-09) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
33. Offshore Net & Line Fishery (NT)	Fishing is permitted from the low water mark to the outer boundary of the AFZ.	Consultation with this fishery is undertaken via the NT Demersal Fishery. See NT Demersal Fishery entry (#32).			
34. Spanish Mackeral Fishery (NT)	Fishing is permitted between the high-water mark and 15 nm out to sea.	Consultation with this fishery is undertaken via the NT Demersal Fishery. See NT Demersal Fishery entry (#32).			
35. Coastal Line Fishery (NT)	Fishing is permitted between the high-water mark and 15 nm out to sea.	Consultation with this fishery is undertaken via the NT Seafood Council. See NTSC entry (#41).			
36. CFA	Peak body representing the collective rights, responsibilities and interests of a diverse group of commercial fishers in Commonwealth-regulated fisheries	18/09/2021 (CFA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	CFA confirmed they have no involvement in projects outside of the south-east Australian region. EOG has consulted with WAFIC as advised by CFA. No further consultation required.
		07/10/2021 Phone call	EOG contacted CFA to confirm receipt of project information. CFA confirmed receipt and had forwarded the email to the CEO of the South East Trawl Fishing Industry Association (SETFIA)). EOG contacted the CEO of SETFIA who had received the email but deleted it as CFA have no involvement with projects outside of the south-east region. He advised EOG to consult with WAFIC directly on this matter.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
37. ASBTIA (Cth)	Peak body representing the Southern Bluefin Tuna (SBT) Fishery.	17/09/2021 (ASBTIA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	ASBTIA confirmed the fishery does not actively fish in the PDSA area and it is highly unlikely to have any impact on SBT spawning. No further consultation required.
		07/10/2021 Phone call	EOG left a voice message for the ASBTIA to confirm receipt of project information. ASBTIA texted EOG stating the relevant person was on annual leave and would check emails on return to office (week beginning 11 October).	No concerns raised.	
		27/10/2021 (ASBTIA-02 & 03) Email	EOG re-issued email to ASBTIA to request confirmation of email and any questions/concerns via reply email. ASBTIA replied to EOG stating they do not fish in that area and given the location, shallow depth and small size, it is highly unlikely to have any impact on SBT spawning. ASBTIA confirmed they did not need to be kept updated on the project going forward.	No concerns raised.	
38. WAFIC	Peak industry body representing the interests of the WA	17/09/2021 (WAFIC-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG reviewed the concerns raised by WAFIC and in response:

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
	commercial fishing, pearling and aquaculture sectors.	06/10/2021 Phone call	EOG left a voice message for WAFIC to confirm receipt of project information.	No concerns raised.	• Agreed to no fishing from activity vessels (see Section 7.14.5). • Control measures in relation to temporary displacement of commercial fishers and interference with commercial fishing vessels is addressed in Section 7.35 and Section 7.14.5. • Baseline publicly available data on the existing environment is included in Chapter 5 of the EP. • The Oil Pollution Emergency Plan (OPEP) includes the communication strategy between EOG and fisheries. • The Operational and Scientific Monitoring Program (OSMP) framework includes testing for fish tainting. Baseline data on water quality and sediment quality would be obtained from control sites in the event of a large-scale
		06/10/2021 (WAFIC-02) Email	WAFIC confirmed receipt of project information and asked EOG if the information flyer had been sent to other fisheries. WAFIC advised they would provide a detailed response shortly.	No concerns raised.	
		18/10/2021 (WAFIC-03) Email	EOG acknowledged WAFIC's response and confirmed consultation with WA commercial fisheries in the activity area and EMBA were being consulted directly.	No concerns raised.	
		27/10/2021 Phone call	EOG left a voice message with the Industry Development Manager to enquire about the status of their detailed response.	No concerns raised.	
		28/10/2021 (WAFIC-04 & 05) Phone call and Email	EOG emailed WAFIC to follow up on the phone call.	WAFIC replied stating that they request the project does not undertake any fishing from vessels and that project vessels do not interfere with commercial fishing vessels. WAFIC requested further information regarding EOG's plans for responding to an unplanned diesel spill.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		04/11/2021 (WAFIC-06) Email	EOG responded to WAFIC's concerns and confirmed the control measures in place to prevent fishing from activity vessels, minimise interactions with commercial fishers and the response measures for unplanned hydrocarbon spills. EOG confirmed engagement with all commercial fisheries with licences in the JBG. WAFIC provided EOG with comments including: no fishing from support /commercial vessels; all support vessels must divert around commercial fishing activity and remain clear of underwater fishing gear; and requested further information regarding an unplanned spill event.	No concerns raised.	hydrocarbon spill to inform the analysis of impacts. • The OPEP and OSMP are addressed in Chapter 9 of this EP. • EOG is required to provide NOPSEMA with a demonstration of Financial Assurance in the event of a worst-case incident (typically a hydrocarbon spill) and EOG has the financial resources to respond. Consultation will be ongoing as required.
		23/11/2021 (WAFIC-07) Email	WAFIC (via Carli Telfer) thanked EOG for the email sent 4 Nov and stated they had no further comments regarding the proposed activities.	No concerns raised.	
		02/12/2021 (WAFIC-08) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		08/12/2021 (WAFIC-09) Email	WAFIC confirmed they had reviewed the latest information flyer and had no further comment.	No concerns raised.	
39. PPA	Peak representative organisation of the Australian South Sea Pearling Industry.	The PPA is no longer performing a consultative role for the fishery. Consultation with this fishery is undertaken via WA DPIRD. See WA DPIRD entry (#10).			
40. RecFish West	Peak body representing recreational fishers in WA.	20/09/2021 (Recfish-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG assumes that RecFish West has no concerns with the project given the opportunities that have been extended to them to provide comment. No further consultation is considered necessary.
		06/10/2021 Phone call	EOG followed up with a phone call to RecFish West. RecFish West stated the project information sheet had been received.	No concerns raised.	
		06/10/2021 (Recfish-02) Email	Recfish West emailed EOG to acknowledge receipt of project information and that Regional Policy Officer would respond in due course.	No concerns raised.	
		27/10/2021 (Recfish-03) Email	EOG thanked Recfish West for their email and asked if RecFish West had any questions or concerns to provide these via reply email. No feedback received to date.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		30/11/2021 (Recfish-04) Email	Recfish West emailed EOG to inform of new contact details to send future correspondence.	No concerns raised.	
41. NTSC	Represents the seafood industry in NT.	17/09/2021 (NTSC-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG assumes that the NTSC has no concerns with the project given the opportunities that have been extended to them to provide comment. No further consultation is considered necessary.
		07/10/2021 Phone call	EOG contacted NTSC reception who confirmed they would call back once they had checked their records for receipt of the project information.	No concerns raised.	
		27/10/2021 (NTSC-02) Email	EOG followed up with NTSC regarding receipt of information flyer. EOG re-issued the flyer and requested feedback/comment via reply email. No feedback received to date.	No concerns raised.	
42. AFANT	Represents the interests of recreational fishing in the NT.	17/09/2021 (AFANT-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG assumes that the AFANT has no concerns with the project given the opportunities that have been extended to them to provide comment. No further consultation is considered necessary.
		07/10/2021 Phone call (AFANT-02) Email	EOG contacted AFANT administration who were unable access the CEO's email to verify receipt of project information. AFANT advised EOG to resend the flyer to their office email address,	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
			and once received this will be checked with the CEO. EOG re-issued the email.		
		27/10/2021 (AFANT-03) Email	EOG followed up with AFANT and re-issued the information flyer again. EOG requested that feedback be provided via email. No feedback received to date.	No concerns raised.	
43. KLC	Peak indigenous body in the Kimberley region.	17/09/2021 (KLC-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	Given the activity area is distant from land and waters actively managed by the KLC (see Section 5.5.1 of the EP), EOG considers there is no immediate need to chase up the KLC for feedback.
		06/10/2021 Phone call and email (KLC-02)	EOG contacted front desk at KLC who confirmed they had not received the project information. KLC asked EOG to re-issue the flyer using the reception email address. EOG re-issued the email. No feedback received to date.	No concerns raised.	
		02/12/2021 (KLC-03) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
44. Miriuwong and	Native title holders of large areas in the	18/09/2021 (MGAC-01 & 02) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	Given the activity area is distant from land and waters actively managed by this Aboriginal

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
Gajerrong Aboriginal Corporation	north of the East Kimberley region.	20/10/2021 (MGAC-01 & 02) Email	The Corporation replied to EOG advising they would be in contact shortly once the information flyer had been reviewed.	No concerns raised.	Corporation (see Section 5.5.1 of the EP), EOG considers there is no immediate need to chase up the Corporation for feedback.
		27/10/2021 (MGAC-03) Email	EOG thanked Shay for her acknowledgement and requested that the Corporation send any feedback via email. No feedback received to date.	No concerns raised.	
		02/12/2021 (MGAC-04 & 05) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
45. Balanggarra Aboriginal Corporation	Registered native title body corporate. Administers land on behalf of the Barangaroo People.	21/09/2021 (BAC-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	Given the activity area is distant from land and waters actively managed by this Aboriginal Corporation (see Section 5.5.1 of the EP), EOG considers there is no immediate need to chase up the Corporation for feedback.
		06/10/2021 Phone call	EOG contacted the Balanggarra Aboriginal Corporation to confirm receipt of project information. information. The CEO was not available at the time of the call. EOG reiterated that any comments from the CEO are welcome in writing. No feedback received to date.	No concerns raised.	
		02/12/2021 (BAC-02)	EOG emailed Information Flyer #2 to provide notification that the PDSA EP	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		Email	is available for public exhibition on the NOPSEMA website.		
46. MTWA	Represents the fishing charter sector in WA.	17/09/2021 (MTWA-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG will maintain open lines of communication during the consultation period.
		06/10/2021 Phone call	EOG left a voice message with Marine Tourism WA requesting call back to confirm receipt of project information.	No concerns raised.	
		27/10/2021 (MTWA-02) Email	EOG resent information flyer to MTWA and asked if MTWA had any questions or concerns to provide these on reply email at their earliest convenience. No feedback received to date.	No concerns raised.	
		02/12/2021 (MTWA-03) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
47. Eni Australia	Titleholder of adjacent petroleum permit WA-33-L.	15/09/2021 & 17/09/2021 (ENI-01 & 02) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	The planned activities of the nearby titleholder are well understood (see Section 5.7.2 of the EP). The activity area is 1.4 km south of the Blacktip subsea pipeline.

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		4/10/2021 (ENI-03, 04 & 05) Email	Eni emailed EOG with an offer to discuss the activity in meeting. EOG confirmed a meeting date and time. Eni advised that an invite would be sent to EOG.	No concerns raised.	Further consultation will be undertaken as required.
		06/10/2021 Meeting (online)	EOG and Eni introductory meeting via online meeting to describe the PDSA activity. EOG confirmed that activities over the gas pipeline would be minimised or avoided. EOG requested the pipeline coordinates so that accurate mapping of the pipeline in relation to the PDSA area could be undertaken.	No concerns raised.	
		06/10/2021 (ENI-03, 04 & 05) Email	EOG thanked Eni for the introductory meeting and requested the detailed pipeline coordinates. EOG asked Eni if they had any formal comments on the proposed activity or information flyer and requested that any comments be made via email.	No concerns raised.	
		19/10/2021 (ENI-06) Email	Eni Operations Manager sent EOG the Blacktip gas export pipeline alignment sheets. There were no technical concerns from ENI.	No concerns raised.	
		10/11/2021 (ENI-07)	EOG followed up with request for Eni's pipeline GIS file and provided	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		Email	an update on the PDSA timing and reduced PDSA area.		
		02/12/2021 (ENI-08) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
48. WEL	Titleholder of nearby petroleum permits WA-522-P & WA-279-P.	17/09/2021 (WEL-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	Given the activity area and EMBA do not overlap any of Woodside's operating assets, EOG considers there is no immediate need to chase up Woodside for feedback.
		06/10/2021 Phone call	EOG contacted Woodside reception who stated that the Senior Corporate Affairs Advisor's phone extension was not available to connect to. Reception advised EOG to contact community adviser's via email instead.	No concerns raised.	
		09/11/2021 Phone call	EOG called the Corporate Affairs Advisor's mobile phone, but this was an old number (voicemail belonged to someone else). No feedback received to date.	No concerns raised.	
		16/11/2021 Phone call	EOG contacted Woodside reception again, who transferred the call to the Senior Corporate Affairs Advisor's phone. EOG left a message. No feedback received to date.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		02/12/2021 (WEL-02) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
49. Melbana Energy	Titleholder of nearby petroleum permits NT/P87 & WA-544-P.	17/09/2021 (Melbana-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	This relevant person has confirmed they have no concerns or issues with the project. No additional consultation if required.
		07/10/2021 Phone call	EOG contacted the Melbana Executive Chairman who advised receipt of project information and they would reply via email later in the day.	No concerns raised.	
		27/10/2021 (Melbana-02 & 03) Email	EOG emailed Melbana to confirm if they had any questions or concerns and to reply via email at their earliest convenience. Melbana replied they had no concerns or questions.	No concerns raised.	
		02/12/2021 (Melbana-04) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
50. Neptune Energy	Titleholder of nearby petroleum permit WA-27-R.	17/09/2021 (Neptune-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	Given the activity area and EMBA do not overlap any of Neptune Energy's operating assets, EOG considers there is
		06/10/2021	EOG contacted Neptune Energy via reception who advised the Managing	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		Phone call	Director would send EOG an email to confirm receipt of project information.		no immediate need to chase up Neptune Energy for feedback.
		27/10/2021 (Neptune-02) Email	EOG emailed Neptune Energy to request that if they had any questions or concerns to reply via email. No feedback received to date.	No concerns raised.	
		02/12/2021 (Neptune-03) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
51. Santos	Nearby titleholder of petroleum permit WA-454-P, WA-545-P and NT/P84.	17/09/2021 (Santos-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	Given the activity area and EMBA do not overlap any of Santos' operating assets, EOG considers there is no immediate need to chase up Santos for feedback.
		06/10/2021 Phone call	EOG contacted Santos via reception who advised the Environmental Adviser was on leave. Reception advised EOG that the Environmental Adviser had been emailed to call EOG upon return to office.	No concerns raised.	
		27/10/2021 (Santos-02) Email	EOG emailed Santos to confirm if they had any questions or concerns regarding the activity to reply via email at their earliest convenience. No feedback received to date.	No concerns raised.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		02/12/2021 (Santos-03) Email	EOG emailed Information Flyer #2 to provide notification that the PDSA EP is available for public exhibition on the NOPSEMA website.	No concerns raised.	
Category 5 – Any person or organisation that the Titleholder considered relevant					
None.					

5. Description of the Existing Environment

In accordance with OPGGS(E) Regulation 13(2), the 'environment that may be affected' (EMBA) by the activity is described in this section, together with its values and sensitivities. While each hazard associated with the activity has its own unique EMBA, the largest one has been chosen for this chapter so as to describe all possible values and sensitivities, which is a full loss of MDO from the largest tank of the activity vessel from within the activity area. Spill modelling of this event used the NOPSEMA Bulletin #1 Oil Spill Modelling (NOPSEMA, 2019) hydrocarbon contact values of four oil phases (surface, dissolved, entrained and accumulated shoreline) that pose differing environmental risks to define the outer extent of the EMBA (see Table 5.1).

The low contact values used to inform the extent of the EMBA are useful for establishing scientific monitoring parameters and identifying potential socio-economic impacts (the socio-economic EMBA); however, they may not be at concentrations that are ecologically significant (NOPSEMA, 2019). Therefore, in addition to the socio-economic EMBA, an ecological EMBA has also been derived from the stochastic spill modelling using hydrocarbon thresholds that are identified by NOPSEMA Bulletin #1 (NOPSEMA, 2019) as having the potential to cause impacts to ecological receptors (Table 5.1). The ecological EMBA considers the four phases of oil previously mentioned (noting that the stochastic spill modelling does not predict shoreline accumulation at concentrations that would cause ecological harm) (RPS, 2021).

The socio-economic EMBA and the ecological EMBA are presented in Figure 5.1 and are referred collectively as the 'spill EMBA'.

Table 5.1. Oil spill thresholds used to define the socio-economic EMBA and the ecological EMBA

Hydrocarbon phase	Exposure values	
	Socio-economic EMBA	Ecological EMBA
Shoreline	10 g/m^2 Potential for some socio-economic impact	100 g/m^2 Area likely to cause environmental impacts and to require clean-up effort (not reached in the modelling)
Sea surface	1 g/m^2 Approximates socio-economic effects and planning area for scientific monitoring	10 g/m^2 Lower limit for harmful contact to birds and marine mammals
Dissolved	10 ppb Planning area for scientific monitoring as potential water quality trigger exceedance	50 ppb Potential toxic effects, particularly sub-lethal effects to sensitive species
Entrained	10 ppb Planning area for scientific monitoring as potential water quality trigger exceedance	100 ppb To inform risk evaluation

Source: NOPSEMA (2019)

This spill EMBA has been established through hydrocarbon spill modelling (see Section 7.15). The EMBA is generated from stochastic modelling and therefore does not represent the possible outcome from a single spill scenario. The EMBA represents the compilation of possible outcomes and encompasses the area predicted to be affected from 100 simulations of the scenario per season (summer, winter, transition). Because of this, the EMBA is large, covering areas that may not be affected by any single spill event.

Where appropriate, descriptions of the JBG environment (beyond the spill EMBA) are provided for context. The 'environment' is defined in the OPGGS(E) regulations 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 these matters.

The key sources of information used in developing this chapter include the:

- EPBC Act Protected Matters Search Tool (PMST) database (DAWE, 2021a), conducted for the activity area on 26th July 2021, for the socio-economic EMBA on 17th August 2021 and for the ecological EMBA on 7th of September 2021 (**Appendix 4**);
- Species Profile and Threats (SPRAT) Database (DAWE, 2021b);
- The Northwest Marine Bioregional Plan Bioregional Profile (DEWHA, 2008b);
- Marine bioregional plan for the North Marine Region (DSEWPC, 2012);
- National Conservation Values Atlas (NCVA) (DAWE, 2021c); and
- Seabed Habitats and Hazards of the JBG and Timor Sea, Northern Australia (Przeslawski *et al*., 2011).

The relevant values and sensitivities considered in this chapter are inclusive of but not limited to the matters protected under Part 3 of the EPBC Act.

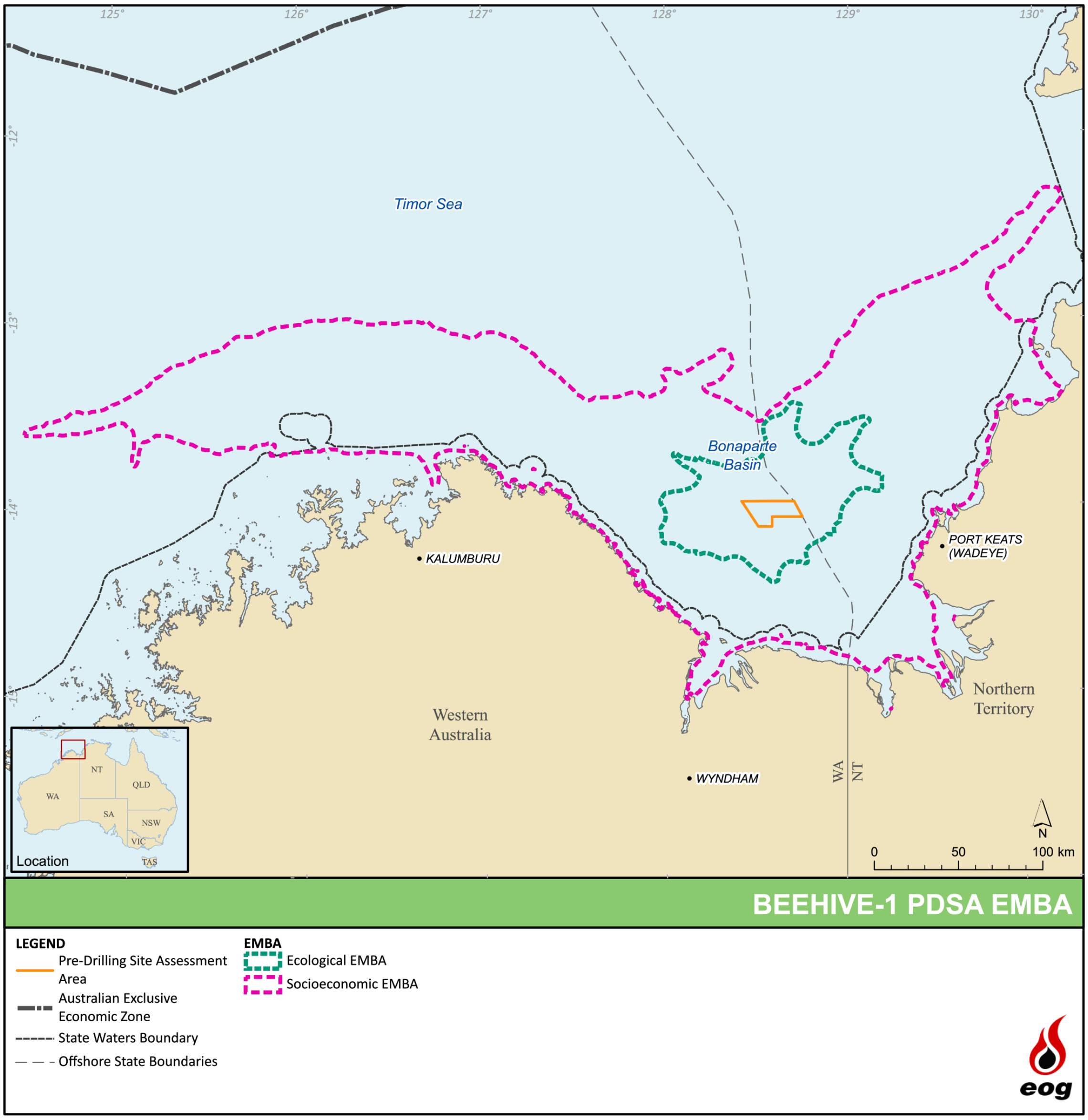


Figure 5.1. The spill EMBA

5.1. Regional Context

The activity area is located within the Northwest Marine Region (NWMR), while the spill EMBA occurs within both the NWMR and the North Marine Region (NMR). The NWMR comprises Commonwealth waters from the Western Australia-Northern Territory (WA-NT) border to Kalbarri, south of Shark Bay, WA (DEWHA, 2008b). The NMR comprises Commonwealth waters from west Cape York Peninsular (Queensland) to the WA-NT border (DSEWPC, 2012).

The NWMR is characterised by the large area of continental shelf and continental slope, highly variable tidal regions and very high cyclone incidence (DEWHA, 2008b). The marine environment of the NMR is known for its high diversity of tropical species but relatively low endemism, in contrast to other bioregions. This region is highly influenced by tidal flows and less by ocean currents (DEWHA, 2008b).

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, the activity area and ecological EMBA are situated completely within the Northwest IMCRA

Transition bioregion while the socio-economic EMBA also intersects the Northwest IMCRA province and the Timor province (CoA, 2006), which is illustrated in Figure 5.2.

The following mesoscale bioregions are intersected by the spill EMBA and are presented in Figure 5.3:

- Cambridge-Bonaparte;
- Bonaparte Gulf;
- Anson Beagle;
- Oceanic Shoals;
- Kimberley; and
- North West Shelf.

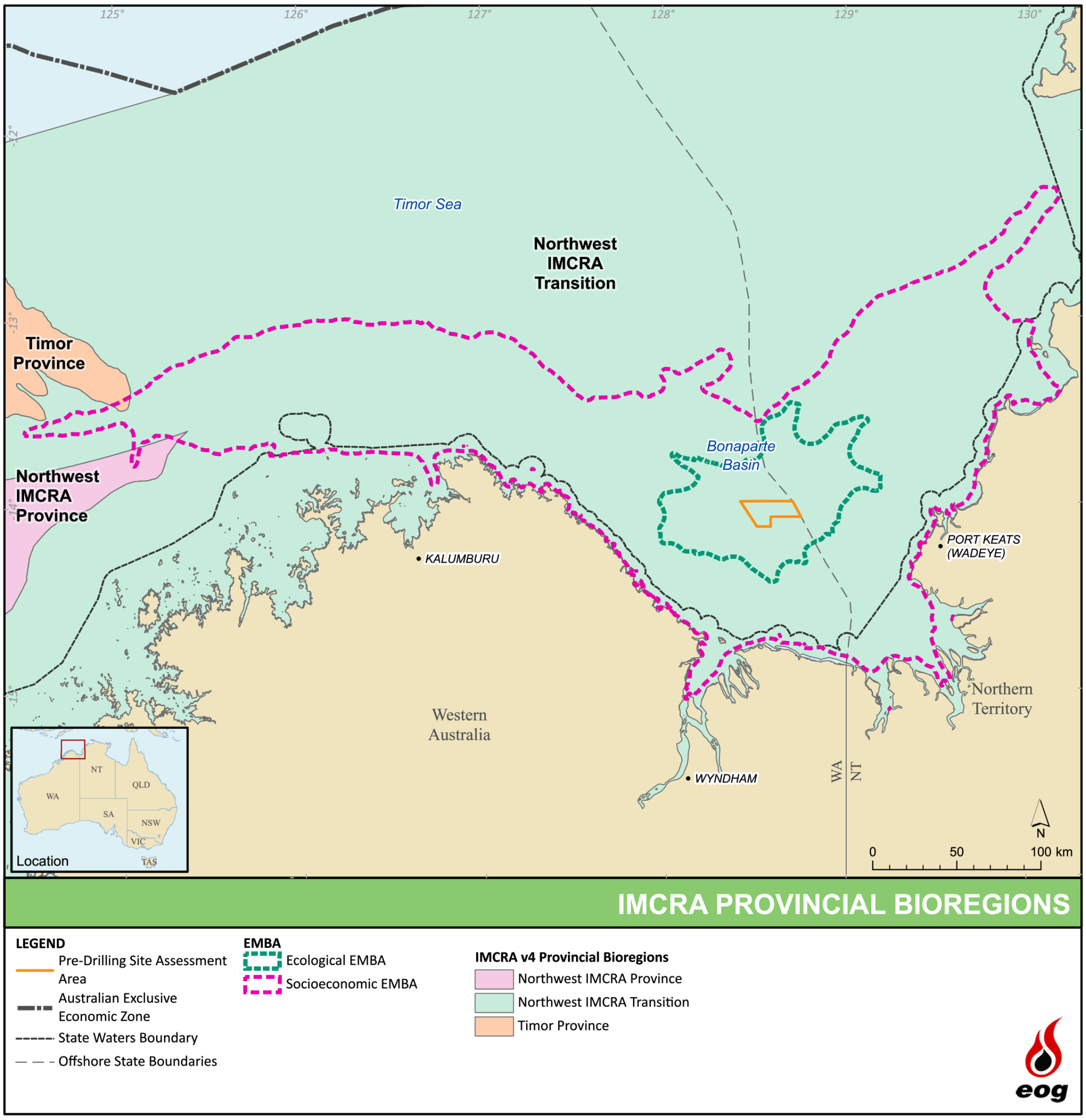


Figure 5.2. Provincial bioregions intersected by the EMBA

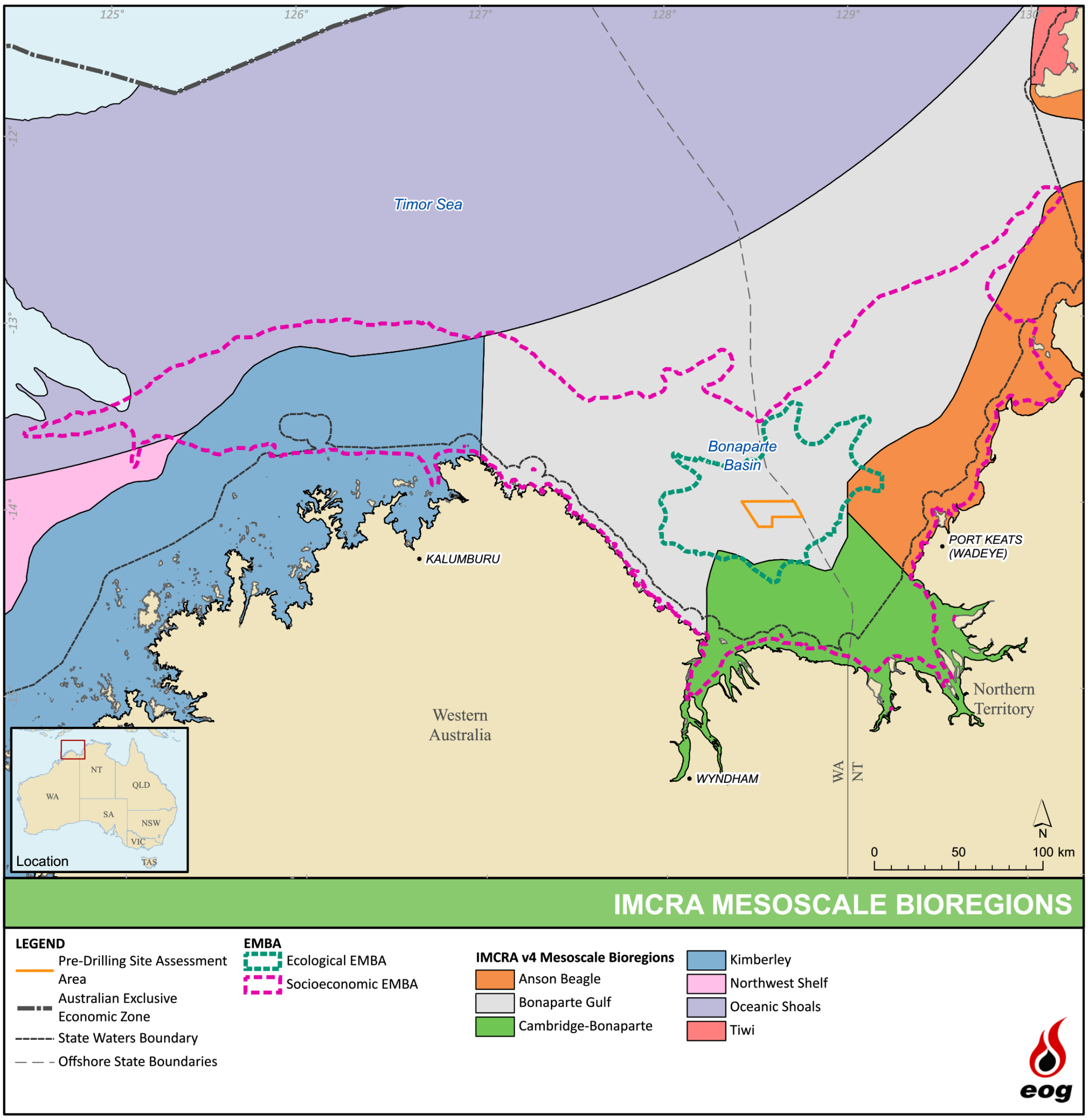


Figure 5.3. Mesoscale bioregions intersected by the EMBA

5.1.1. Climate

The region has a tropical monsoonal climate with two distinct seasons known as the northwest monsoon, which occurs from late October to mid-March (“wet season”); and the southeast monsoon, which occurs from May to mid-October (“dry season”). Regular and high rainfall is a characteristic of the northwest monsoon, mainly over coastal areas and during cyclones. This is caused by large amounts of moisture being gathered as the monsoon crosses the sea from the Asian high-pressure belt on its way to the intertropical convergence zone, which drifts southward close to, or over, northern Australia. On the contrary, the southeast monsoon originates from the southern hemisphere high-pressure belt and is relatively dry and cool.

Cyclones are common in the region, and they occur typically between December and April (BoM, 2021a). Cyclones result in severe storms with gale force winds and a rapid rise in water levels.

Temperature and Rainfall

Wadeye Airport (Port Keats), located on the NT mainland approximately 85 km east of the activity area, is the location of the nearest meteorological station to the activity area. Data collected from 1997 to 2019 show that the highest maximum temperature (mean of 34.4°C) occurs in April, October and November, whilst the lowest maximum temperature (mean of 16.8°C) occurs in July (BoM, 2021b).

Data collected from 1997 to 2019 at the Wadeye Airport weather station show that the mean annual rainfall is 1,317.8 mm, with the highest rainfall in January (312.2 mm) and the least in August (0.7 mm) (BoM, 2021b). Typically, the majority of rain occurs from December to March (mean of 1,025 mm).

Winds

Wind patterns in the region are controlled by the seasonal migration of high-pressure cells from latitudes 25-30°S in winter to 35-40°S in summer (Pearce *et al*., 2003). Sea surface wind data spanning five years sourced from the NCEP/NCAR global reanalysis project shows two predominant (general) directions:

1. West to northwest winds prevail during the months of September to February; and

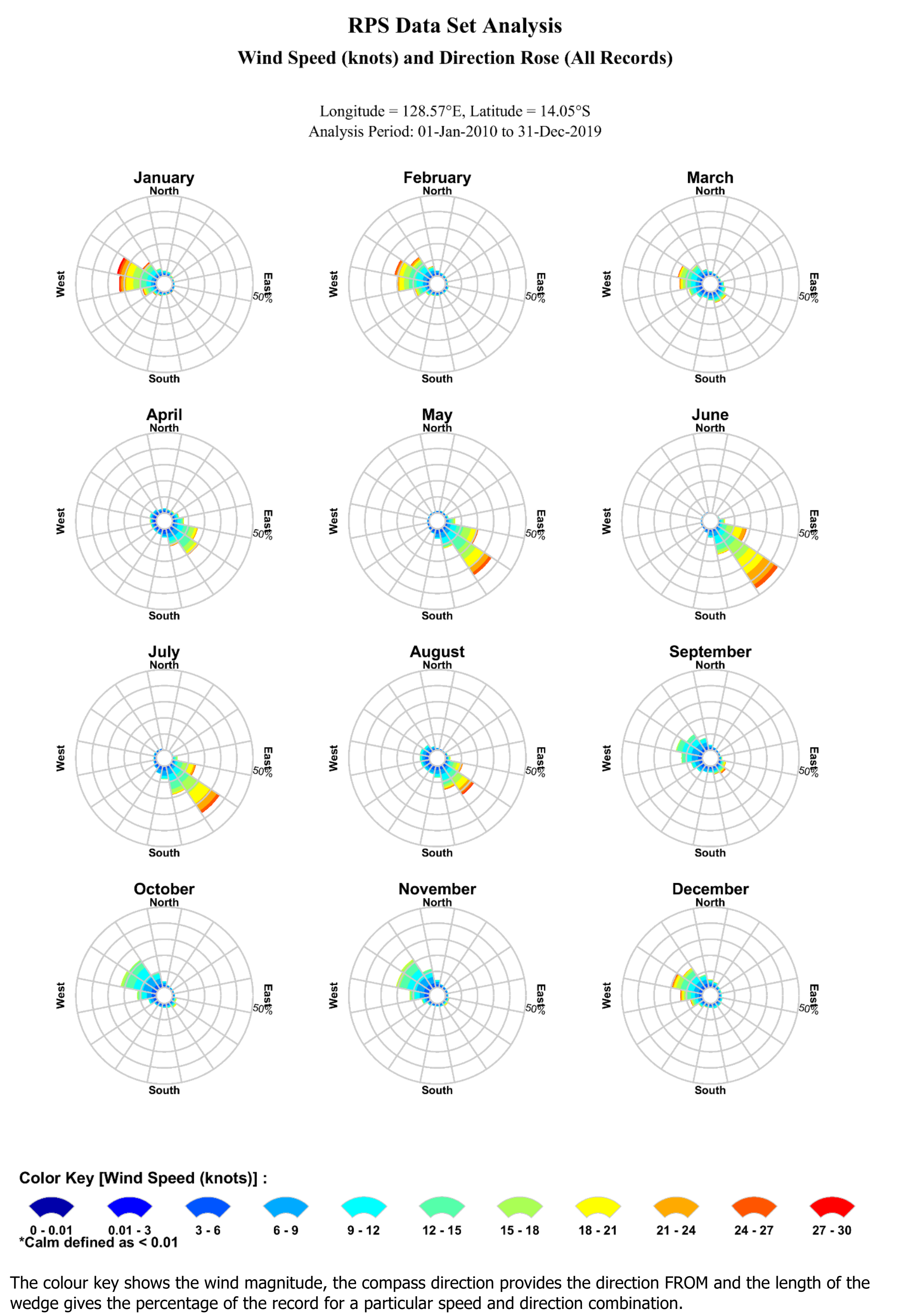
2. Easterly to south-easterly winds prevail from April to July (Kalnay *et al*., 1996; Kistler *et al*., 2001).

March and August are transitional periods with a higher variability in wind directions. Wind speed and direction used in the stochastic spill modelling are provided in Table 5.2 and presented in Figure 5.4 (RPS, 2021).

Table 5.2. Predicted average and maximum winds for the wind station nearest the activity area for 2010-2019 (inclusive)

Season	Month	Avg. wind speed (knots)	Maximum wind speed (knots)	General direction (from)
Summer	January	13.2	44.9	West-northwest
	February	11.4	35.2	
Transitional	March	9.7	46.2	Variable
Winter	April	9.3	32.7	Southeast
	May	11.7	28.8	
	June	14.1	27.4	
	July	12.3	30.9	
	August	10.4	29.5	
Transitional	September	8.7	29.3	Variable
Summer	October	8.8	24.7	West-northwest
	November	8.8	24.1	
	December	9.9	35.9	
Minimum		8.7	24.1	
Maximum		14.1	46.2	

Source: RPS (2021).



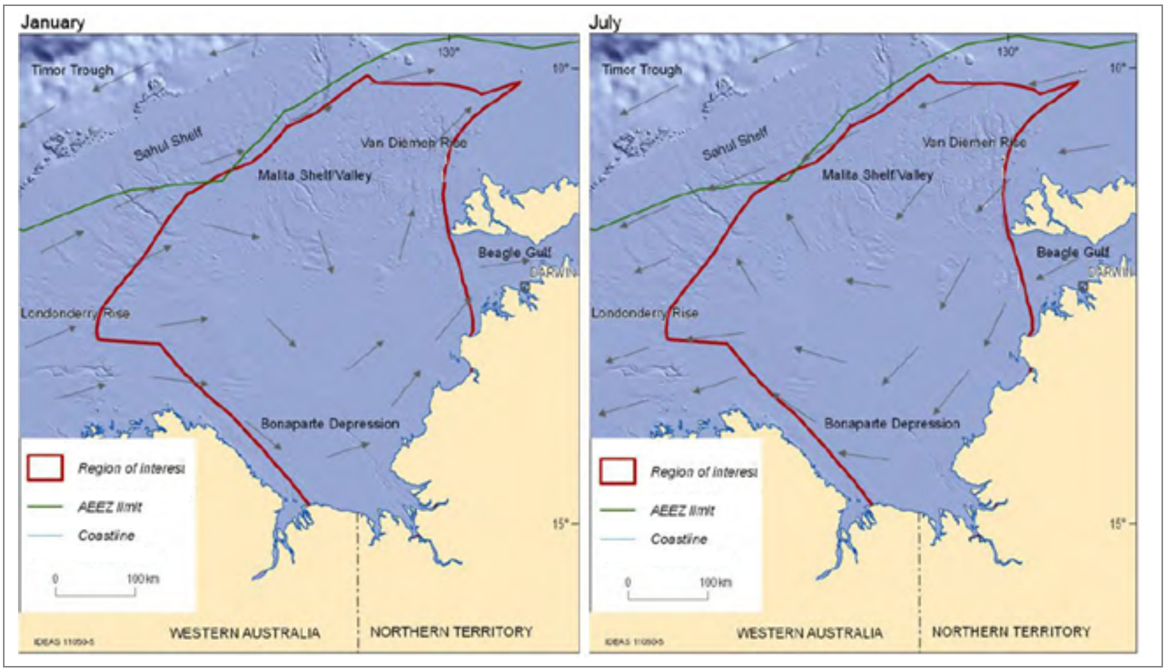
Source: RPS (2021).

Figure 5.4. Modelled monthly wind rose distributions from 2010-2019 (inclusive) for the wind station closest to the activity area

5.1.2. Oceanography

Water Currents

Broad-scale ocean circulation of the North Australian Shelf is dominated by the Indonesian Throughflow current system. Circulation in the JBG is dominated by tidal and wind driven currents according to the season (Figure 5.5) (Przeslawski *et al.*, 2011).



Source: Przeslawski et al 2011.

Figure 5.5. Currents of the JBG

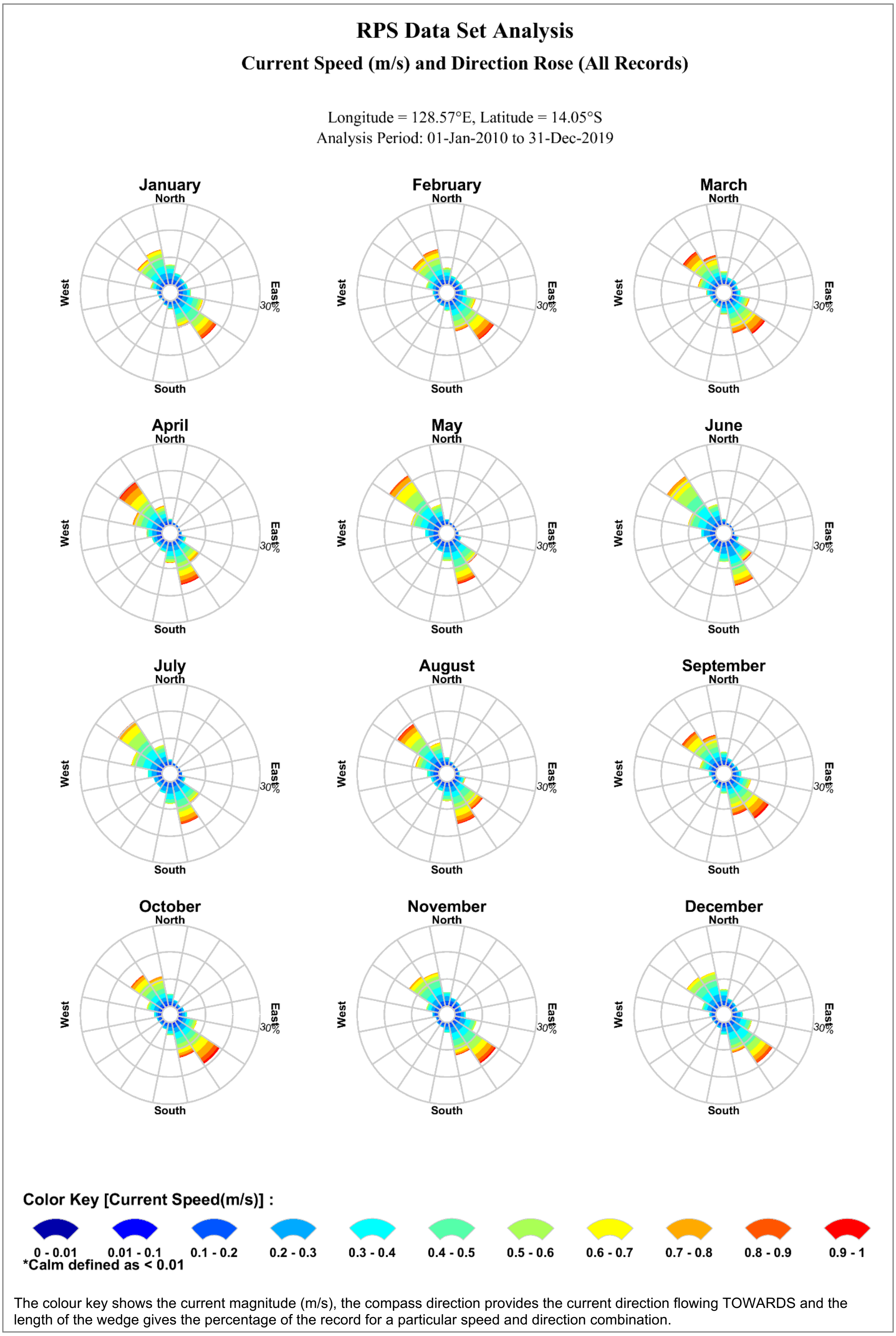
Table 5.3 provides the average and maximum combined surface current speeds (ocean plus tides) located within the activity area. This data indicates that surface currents flow predominantly along the northwest to southeast axis. The monthly current speeds averaged between 0.33 to 0.40 m/s and reached a peak of 0.96 to 1.17 m/s.

Figure 5.6 illustrates the monthly surface current rose plots located in the activity area from 2010 to 2019 (inclusive). Figure 5.7 represents the major ocean currents in north-western Australian waters.

Table 5.3. Predicted average and maximum surface current speeds within the activity area from 2010-2019 (inclusive)

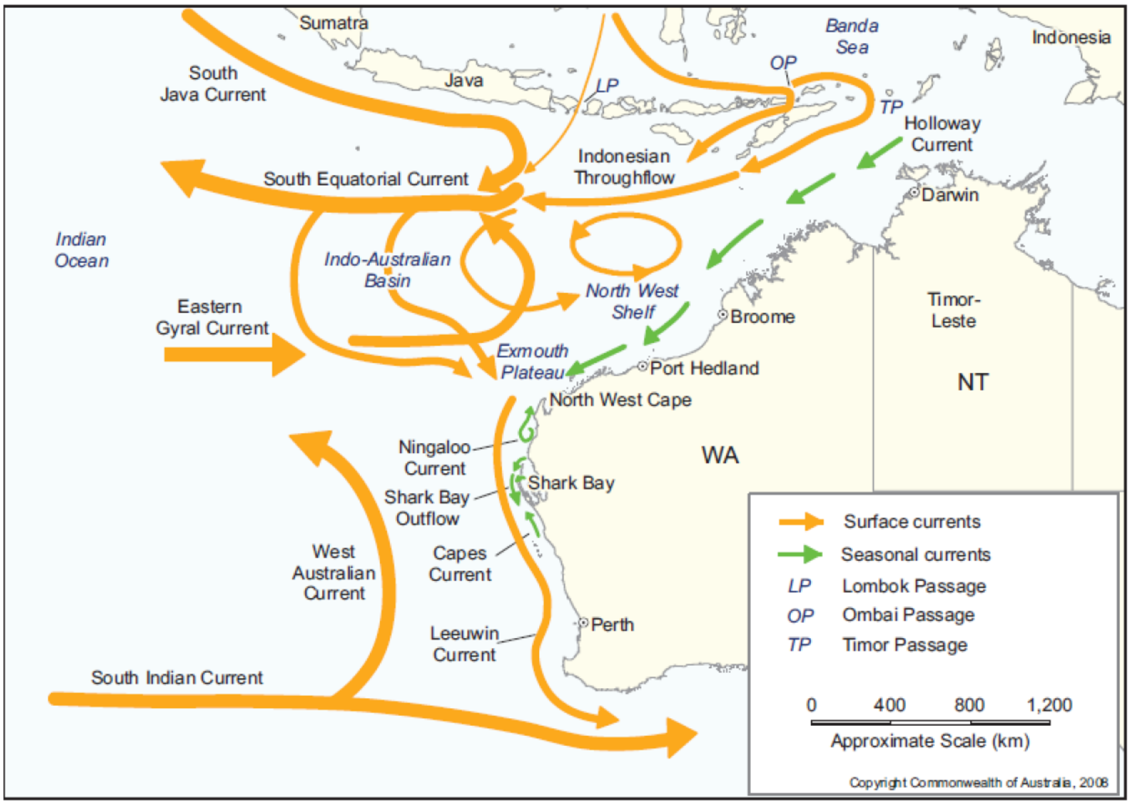
Season	Month	Avg. current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.35	1.10	Northwest and southeast
	February	0.37	1.12	
Transitional	March	0.40	1.05	
Winter	April	0.39	1.06	
	May	0.35	1.17	
	June	0.34	1.07	
	July	0.35	0.96	
	August	0.37	1.15	
Transitional	September	0.39	1.10	
Summer	October	0.37	1.09	
	November	0.34	1.06	
	December	0.33	0.98	
Minimum		0.33	0.96	
Maximum		0.40	1.17	

Source: RPS (2021).



Source: RPS (2021).

Figure 5.6. Monthly surface current rose plots nearby the activity area (2010-2019 inclusive)



Source: DEWHA, 2008b.

Figure 5.7. Ocean currents along the Northwest Australian continental shelf

Sea Temperature and Salinity

Surface water temperatures and salinities vary seasonally and are influenced by the Indonesian Throughflow. During the northwest monsoon, a thermocline flow of relatively cool water dominates resulting in the tropical Indian Ocean being cooled rather than warmed. The region typically has average sea surface temperatures of 28-30°C and salinities of 34-35 psu.

Tides

The JBG is subject to semi-diurnal tides with two high and low tides per day, and has the largest tidal energy observed anywhere in the world (>7 m) (Rothlisberg *et al.*, 2005). Within the JBG mesoscale bioregion, tides range from 2-3 m offshore (microtidal) rising to 3-4 m inshore (mesotidal).

Waves

In the JBG, the Southern Ocean swell is higher in winter than in summer as a result of northerly migration of swell-generating storms. The wave period and significant wave height generated by this swell is highly dependent on the exact location within the basin. For example, the JBG is protected from the Southern Ocean swell; therefore, swells affecting the area are limited to those generated by cyclones or prolonged storm winds (Maxwell *et al.*, 2004). The region is considered a moderate-energy environment except when influenced by tropical cyclones which generate short-term but major fluctuations in sea levels. Swells generated may have periods of

6-18 seconds and wave heights of 0.5-9 m and are dependent on the size, intensity, speed and relative location of the cyclone.

Water Quality

The Indonesian Throughflow brings in oligotrophic waters (low in nutrients) from the western Pacific Ocean through to the Indian Ocean (DEWHA, 2008b). Exceptions in the region occur in the event of local or regional upwelling activity at the shelf break, where deeper, cooler nutrient-rich water is brought to the surface (DEWHA, 2008b). These upwelling activities include, but are not limited to, internal wave and tide regimes, horizontal shear due to strong tidal currents and tropical cyclones. However, understanding of the nature and spatial distribution of biological productivity in the region is limited (DEWHA, 2008b).

Major inputs of fine silt sediments from the Ord, Victoria and Keep River systems occur during the wet season, creating vast areas of high turbidity, particularly in the southern part of the Gulf. The sediments are deposited to form sand bars and mud flats which are themselves the source of high turbidity throughout the year as sediments are resuspended by tidal movements. Though there is only limited marine and nearshore water quality data available, as there are no major developments or population centres near the activity area, the potential for existing pollution is limited.

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 $1\mu Pa^2/Hz$ 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 $1\mu Pa^2/Hz$ and magnitude 4 earthquakes have been reported to have spectral levels reaching 119 dB re $1\mu Pa^2/Hz$ at frequency ranges of 5-15 Hz.

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 5.4 presents a comparison of biological and anthropological sounds in the marine environment.

Table 5.4. 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	4
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
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
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)	5
Floating Production Storage and Offloading (FPSO)	176	10 – 500 (up to 2,000)	6

Source	Sound intensity (dB re 1 µPa)	Frequency (Hz)	Reference
(maximum at Griffin Venture)			

References		
1 – Richardson et al (1995).	*2 – APPEA (2004).*	*3 – WDCS (2004).*
4 – Matsumoto et al (2014).	*5 – Woodside (2003).*	*6 – Apache Energy (2008).*

5.1.3. Physical Environment

Bathymetry

The benthic environment of the JBG is linked to its geomorphic features, with the majority of the area characterised by infaunal plains, with some localised reefs and outcrops supporting sponge gardens. Water depths in the activity area is approximately 40-45 m, while water depths in the spill EMBA range from ~100 m (offshore) to <10 m (inshore).

Bathymetry in parts of the south of the JBG is strongly influenced by the strong tidal movement and channels of the Ord, Keep, Victoria and Fitzmaurice rivers. A series of extensive sandbars, known as the King Shoals and Medusa Banks, have been generated in the southwest by the strong outflows of sediment-laden water from the Cambridge Gulf. Similar sandbars can be found in the southeast of the JBG. Bathymetry of the JBG and the activity area is presented in Figure 5.8.

Sedimentology

The sedimentology of the NWMR is varied due to the diversity of physical features from coral reefs to major canyons that act as conduits for sediment and nutrient transport (DSEWPC, 2012). Sedimentology in the NMR is also varied, with physical features including shallow canyons, which mainly consist of calcium carbonate, based sediments, as well as limestone pinnacles and reefs (DEWHA, 2008b).

The continental shelf in the JBG is the widest in Australia, extending up to 400 km from the shore. The sedimentology of the JBG is unique, with most of the inner shelf being characterised by relatively flat expanses of soft sediment seabed with localised rocky outcrops, gravel deposits and sands banks. The soft sediments in the region typically consist of sandy and muddy substrate, occasionally made up of patches of coarser sediments (Baker *et al*., 2008). The inner shelf section of the JBG receives significant loads of sediments from several large rivers including the Daly and Victoria rivers (Przeslawski *et al*., 2011).

The distribution of seabed sediments in the JBG, and in particular within the Sahul Shelf, reflects the present-day oceanographic condition and displays a distinct seaward fining pattern (Lees 1992, in Baker *et al*., 2008). Sediment sampling undertaken by Environmental Resource Management Australia Pty Ltd (ERM) in 2010 and 2011 (within WA-6-R and NT/RL1, 96 km north of the activity area) confirms that the area is mainly dominated by sand, with similar proportions of smaller gravel, silt and clay (ERM, 2011).

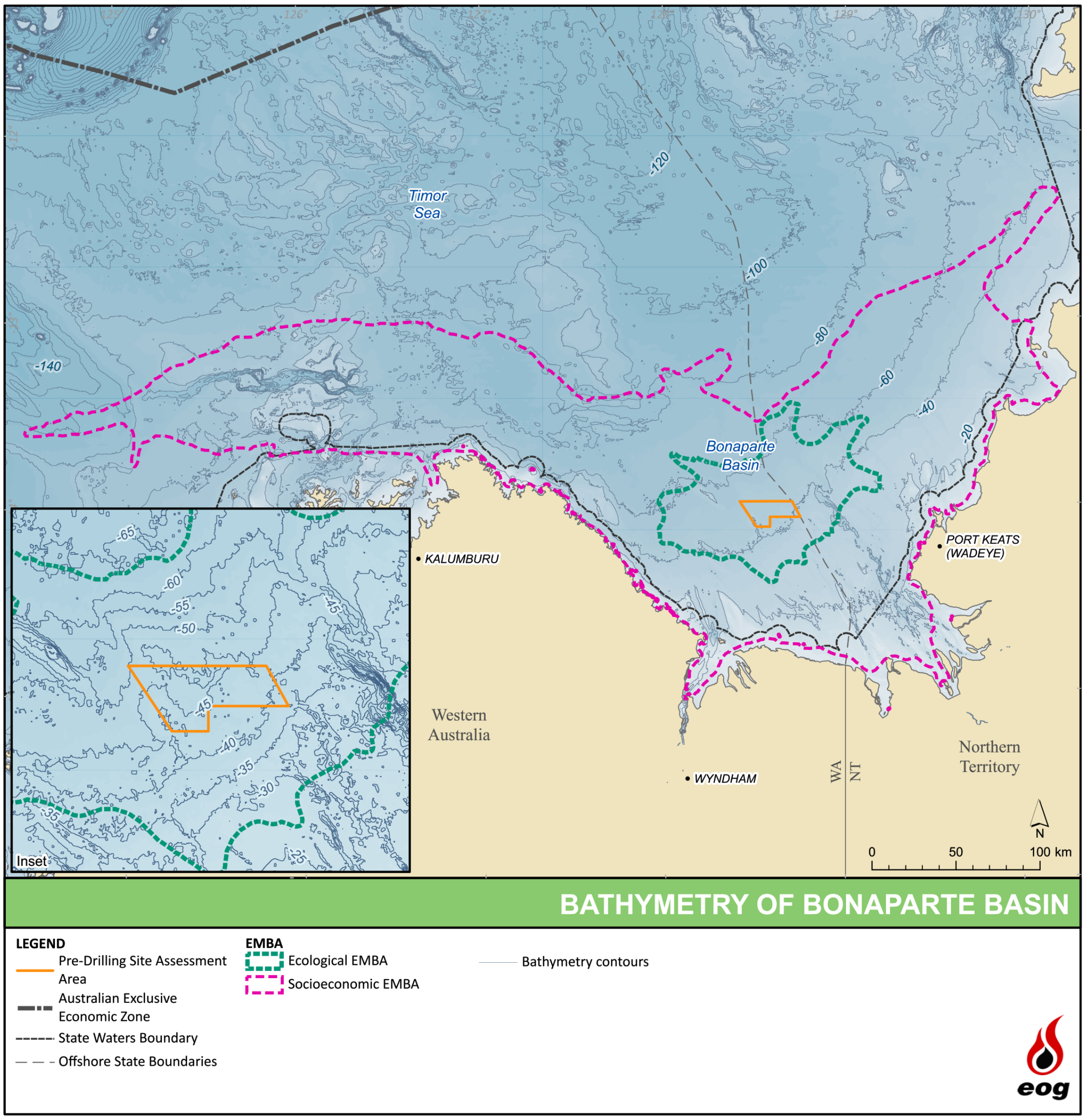


Figure 5.8. Bathymetry of the JBG

The top layer of sediment in the JBG from ~3 km to 35 km offshore is expected to be greater than 1 m in depth and consists of sand and gravel with variable proportions of clay. This material is primarily alluvium, derived from sedimentary sandstones and basal conglomerate. Sonar images indicate some minor paleochannels in this area containing mega-ripple or sand waves. These sediments are generally unconsolidated coarse sand, fine gravel interspersed with areas of flat and featureless seabed containing very soft to firm gravelly clays (Woodside, 2004).

The main drainage channels for the Victoria River System occur from approximately 35 km to 58 km offshore. This area is dynamic as currents and tidal influence are constantly changing the seabed features in the area. Due to the dynamic nature of the channels, the thickness of the top layer of sediment is expected to be variable. A top layer greater than one metre in depth and consisting of sands and gravels with variable proportions of clay is expected from 59 km to 65 km offshore, with some minor paleochannels occurring. The influence of alluvial inputs diminishes from around 60 km offshore to the Blacktip Wellhead Platform (WHP), which is located ~10 km north and west of the activity area (depending on the exact point of reference). This top layer increases to greater than two metres in depth from 66 km offshore and the sediments range from loose silty/clayey sands from 66 km to 75 km and very soft clayey silt and silty clay from 75 km offshore to the Blacktip WHP location (Woodside, 2004). Again, the seabed alternates between flat and featureless seabed containing very soft to firm silty clay and an area of hummocky seabed containing mega-ripple or sand waves, though the seabed is generally flat to gently sloping from about 66 km offshore to the Blacktip WHP location (Woodside, 2004).

Seabed

Seabed morphology in parts of the JBG is influenced by the strong tidal movement and channels of the Ord, Keep, Victoria and Fitzmaurice rivers. A series of extensive sandbars, known as the King Shoals and Medusa Banks (approximately 50 km south of the activity area), have been generated by the strong outflows of sediment-laden water from Cambridge Gulf. Similar sandbars can be found in the south-east of the JBG. The activity area is located entirely within the 'shelf' geomorphic feature, which is typically characterised by extensive sediment plains and high sediment deposition from the coastal rivers to the south (Figure 5.9).

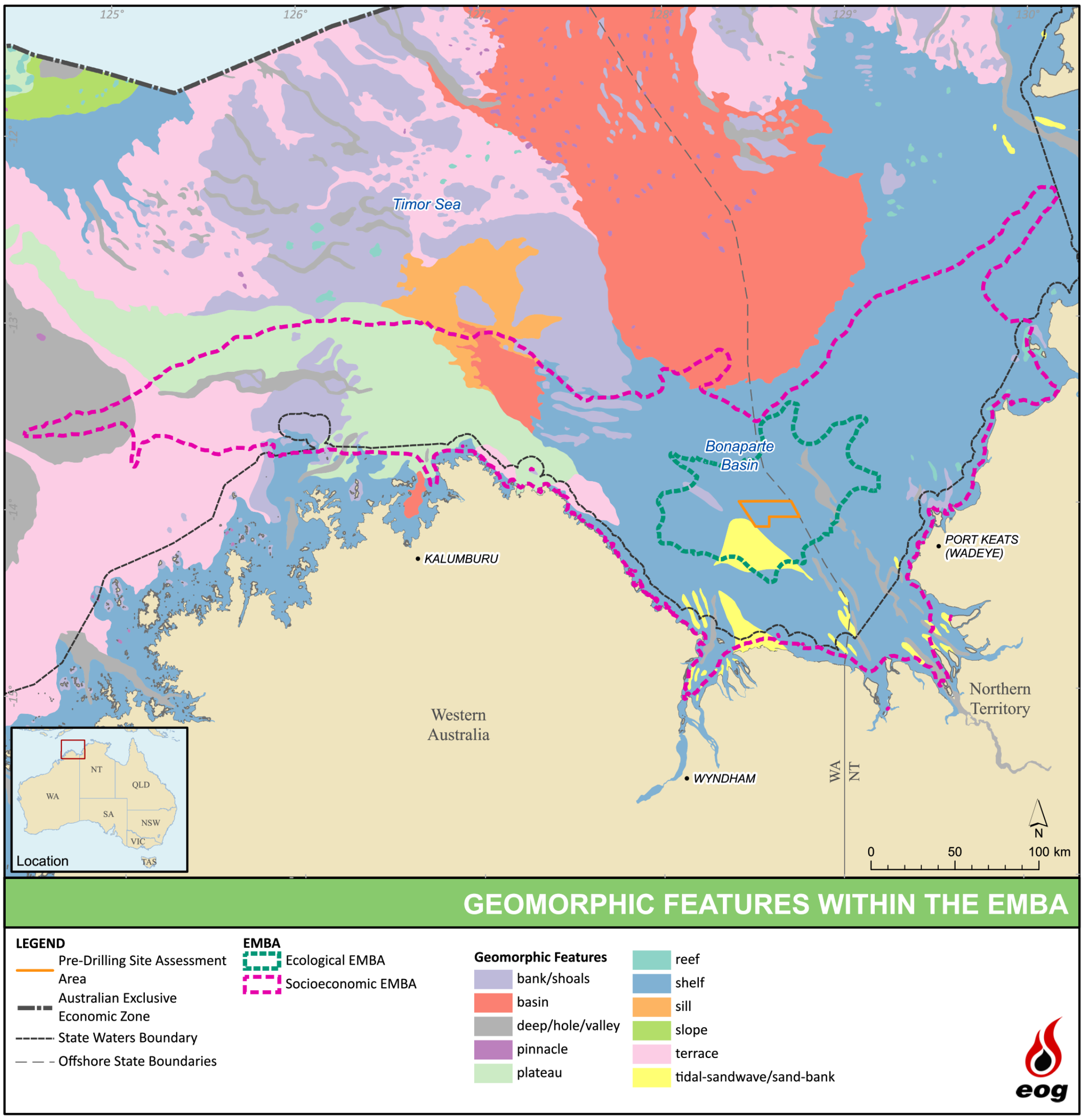


Figure 5.9. Geomorphic features of the activity area and EMBA

5.2. Coastal Environment

The physical coastal environment described in this section is defined by the potential extent of dispersion of low threshold entrained hydrocarbons predicted under the MDO spill scenario (the socio-economic EMBA), which stretches from the northern Kimberley coast in WA to the Daly River estuary in the NT (noting that the ecological EMBA does not intersect the shoreline and there is no accumulation of hydrocarbons on the shoreline at concentrations that may cause ecological harm).

5.2.1. Shoreline Habitats

Shoreline habitats are defined as those habitats that are adjacent to the water along the mainland and islands that occur above the Lowest Astronomical Tide (LAT), and most often in the intertidal zone. The following section broadly categorises shoreline habitats as the following biological communities that were identified to occur within the socio-economic EMBA: mangroves, sandy beaches, intertidal mud flats, rocky shores and islands.

Intertidal mud and sand flats

The socio-economic EMBA intersects intertidal mud and sand flats on the southern coastline of the JBG, approximately 127 km southeast of the activity area. Mudflats are comprised of layers of fine mud due to the ongoing deposition of estuarine silts, which combines with deposition of fine sands by tidal movements. These areas provide important habitat for mud and sand-dwelling invertebrates such as crabs, prawns, shells and worms and sheltered habitat for larval and juvenile fishes. Due to the diversity of infauna, they are also an important foraging habitat for various shorebird species including egrets, plovers and oystercatchers.

Sandy beaches

Using satellite imagery, sand beaches are the dominant shoreline type on the eastern coast of the JBG with only occasional rocky headlands and river estuaries leading to the ocean. These environments are highly remote and are unlikely to have any significant anthropogenic presence. The beaches may provide roosting and nesting habitat for sand nesting bird species, such as plovers.

Rocky shores

Using satellite imagery, rocky shorelines are the dominant shoreline type on the western coast of the JBG that is intersected by the socio-economic EMBA. While there are some stretches of sand beaches on the western coast, they are confined to the sheltered bays and inlets. The exposed rocky shores would be exposed to wave action from the JBG and as such are likely to provide habitat for intertidal algae and shell species.

Mangroves

Mangroves commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes (Kathiresan and Bingham, 2001). Mangroves are found wherever suitable conditions are present including wave-dominated settings of deltas, beach/dune coasts, limestone barrier islands and ria/archipelago shores (Semeniuk, 1993).

Mangroves are important primary producers and have a number of ecological and economic values, including reducing coastal erosion and providing habitat for a variety of epibenthic, infaunal and meiofaunal invertebrates (Kathiresan and Bingham, 2001). Crustaceans known to inhabit the mud in mangrove systems include fiddler crabs, mud crabs, shrimps and barnacles, while water channels of the system support various finfish. Mangroves and their associated invertebrate-rich mudflats are also an important habitat for migratory shorebirds from the northern hemisphere, as well as some avifauna that are restricted to mangroves as their sole habitat (Garnet and Crowley, 2000).

Using satellite imagery, mangrove habitat intersected by the socio-economic EMBA typically occur along the banks of the major rivers and estuarine environments of the southern JBG including at Quoin Island (119 km southeast) and Clump Island (126 km southeast) and along the southern coastline of Dorcherty Island (80 km east).

Islands

No islands or emergent reef systems are located within the activity area or the ecological EMBA. However, several rocky and sandy islands are located within the socio-economic EMBA that provide intertidal and shoreline habitats for a variety of marine fauna and ecological communities, including many small islands along the north Kimberley coast. The most significant islands to the activity area are Pelican Island (76 km south), Kanggurryu Island (70 km south), Dorcherty Island (80 km east) and Lacrosse Island (71 km southwest).

5.3. Biological Environment

The sources listed at the start of this chapter have been used in the preparation of this section. Additionally, biologically important areas (BIAs) are identified for those species that may occur within the activity area and spill 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, 2021a). The BIAs do not represent a species' full distribution range.

5.3.1. Benthic Assemblages

The benthic environment of the JBG is linked to its geomorphic features, with the majority of the area characterised by infaunal plains, with some localised reefs and outcrops supporting sponge gardens. Przeslawski et al (2011) provides an overview of the benthic environment associated with the different geomorphic features within the EMBA, which are presented in Figure 5.10:

- Shelf – sediment plains that are swept by strong tidal currents and are subject to large influxes of suspended sediment and freshwater, particularly during the wet season. Support diverse infaunal communities that play a key ecological role by contributing to nutrient cycling and sediment turnover (bioturbation) at the local scale. Low abundance of crustaceans, echinoderms and sessile epifauna are expected.
- Banks/shoals - elevated features with a relatively high proportion of hard substrate that support patches of moderately dense octocoral and sponge gardens which in turn provide habitat for other epifauna and cryptofauna. Banks support high numbers of epifaunal species. Infaunal species richness is moderately high in bank sediments. Very few macroalgae (including *Halimeda*) or reef-forming hard corals were recorded.
- Basin - low-relief expanses of unconsolidated sediment, and the available biological data suggests that these habitats are dominated by infauna with limited epifauna.
- Deep/hole/valley - dominated by flat soft sediment expanses. Support low-moderate numbers of epifaunal species and include many debris-swept channels, which in places expose small patches of underlying rock that support moderate densities of sessile animals.
- Tidal-sandwave/sand bank – high disturbance, soft substrate, limited biota.

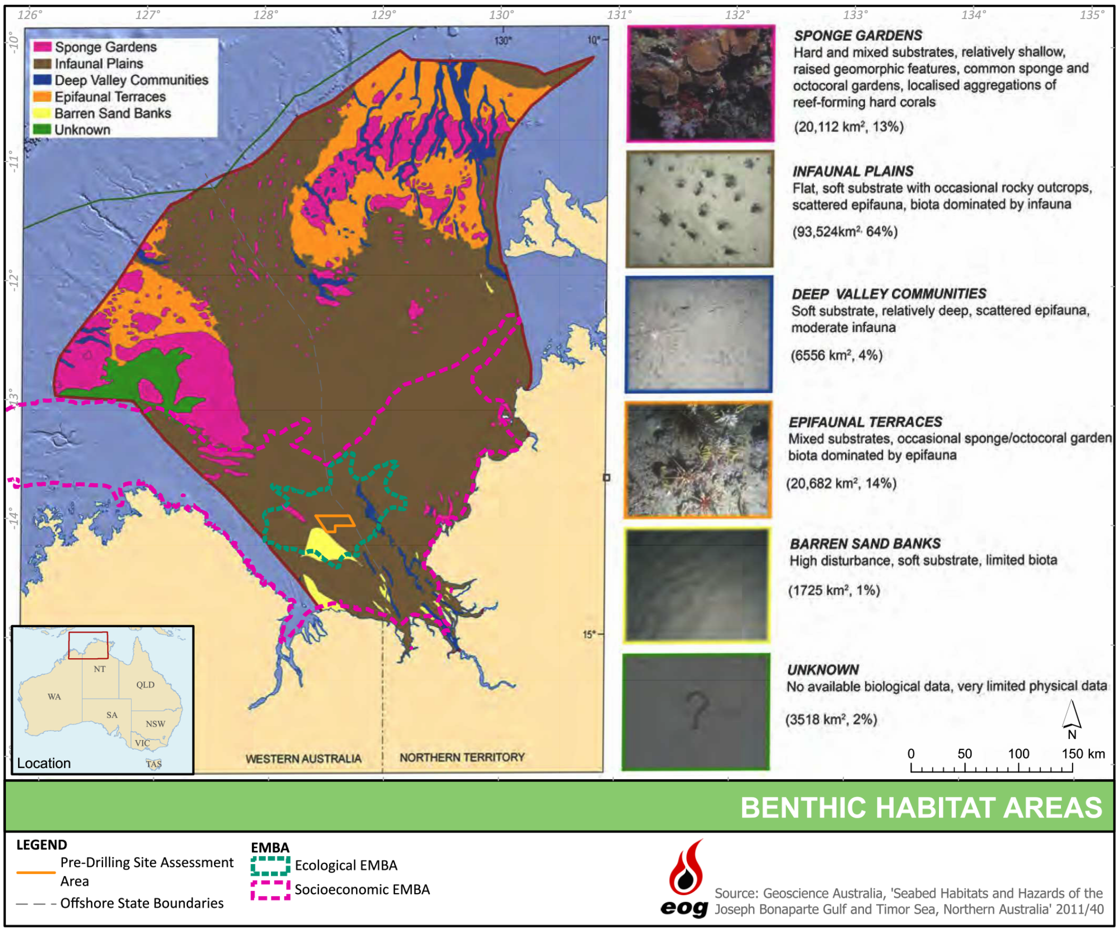


Figure 5.10. Generalised habitat map showing likely distribution of habitats and biological communities in the activity area and EMBA

Based on Figure 5.10, the main habitat type in the activity area and EMBA is infaunal plains, which are primarily characterised by flat soft substrate with occasional rocky outcrops, scattered epifauna and biota dominated by infauna (Przeslawski *et al*., 2011).

Infaunal communities

Studies conducted on the infauna within the Blacktip Project area (the closest sampling station, located approximately 10 km northwest from the activity area) found infauna to be diverse and abundant, with two major phyla, Arthropoda (crustaceans) and Annelida (polychaete worms), contributing over 80% of the total number of individuals (Woodside, 2004). Recorded Arthropoda species include tanaids (shrimps), brachyurans (crabs) and grammarid amphipods. The Annelida were diverse comprising of 36 families, with the most abundant families being Terebellidae, Spionidae, Onphidae, Maldanidae and Ampharetidae. Members of these families are mainly tube-dwelling worms that feed on detrital material on the surface or in the surface sediments. Other abundant infauna are the Cnidaria (hydroids, soft corals), Mollusca (mainly bivalves) and Echinodermata (brittle stars, sea urchins).

The Blacktip baseline studies found that infauna species richness and abundance in the JBG was related to sediment particle size. Richness and species abundance increased with distance from the mouth of the Victoria River (approximately 125 km southeast of the activity area), which coincided with an increasing proportion of fine particles in the sediment (Woodside, 2004). Sites near the Victoria River mouth generally had coarser sediments and lower species richness and abundance. The Blacktip sampling sites supported a richer assemblage than sites closer to the Victoria River mouth (Woodside, 2004).

During this survey, 135 nominal species were identified. However, faunal abundance was low with only 528 individuals recorded and only 14 species recording more than 10 individuals across all the offshore samples. The composition of the infaunal community was somewhat unusual. Continental shelf infauna is generally dominated by polychaete worms. However, nearly three times as many crustaceans were collected as polychaetes. Bryozoans and hydroids were the next most abundant group after the crustaceans, and nearly as many molluscs and echinoderms were collected as polychaetes. The most abundant species was a porcelain crab followed by a brittle star (Woodside, 2004).

The study also observed that sites near the Victoria River mouth, which generally had coarser sediments, had a greater proportional abundance of crustaceans and cnidarians (hydroids and soft corals) compared to sites further offshore, which supported a predominantly detritus feeding infauna (Woodside, 2004).

Crustaceans

In a study of prawn trawl bycatch in the JBG, which included sampling locations within the EMBA and approximately 10 km from the activity area, Tonks et al (2008) found that four crustacean species dominated the invertebrate component of the bycatch: *Charybdis callianassa* (Portunidae); *Trachypenaeus gonospinifer* (Penaeidae); *Metapenaeopsis novaeguineae* (Penaeidae); and *Solenocera australiana* (Solenoceridae).

The dominant prawn species of the JBG are the penaeid species, namely tiger prawn (*Penaeus esculentus*), banana prawn (*P. merguiensis*) and red-legged banana prawn (*P. indicus*). These species occur in coastal waters to depths of approximately 200 m and are widely distributed through sub-tropical and tropical waters from Western Australia to New South Wales (Jones and Morgan, 1994). Shallower inshore waters act as nursery grounds for juveniles, such as the river and tidal creek systems of the JBG. Small numbers of prawns can also be found in mangrove habitats. More is known about the distribution and abundance of prawns in the JBG compared to other crustaceans due to their commercial significance.

As discussed in detail in Section 5.7.1, prawns are commercially caught in areas of the JBG, mainly in the west of the gulf and in Fog Bay, NT to the northeast of the activity area. The juvenile prawns that migrate offshore to the fishery come from mangrove nursery habitats from the Victoria River in the east of the Gulf, to the Ord River and Cambridge Gulf in the west, forming a very extensive migration throughout the lower region of the JBG. This migration is likely to be from February to April and October to December. Migration of the juveniles is thought to be triggered by rainfall and river discharge. The areas most intensely fished for prawns are located in the Gulf of Carpentaria (outside the EMBA).

Prawns

There are several prawn species present in the JBG that occupy benthic habitats and prey on micro-organisms, small shellfish, worms and decaying organic matter. Several of the species develop their juveniles in nearshore estuarine and mangrove habitat before moving further offshore in adulthood. A description of the major prawn species is provided here.

Banana prawns live in tropical and sub-tropical coastal waters and are found over muddy and sandy bottoms in coastal waters and estuaries (AFMA, 2021). Juvenile banana prawns inhabit small creeks and rivers in sheltered mangrove environments (AFMA, 2021). Banana prawns reach reproductive maturity at approximately 6 months of age (AFMA, 2021).

White banana prawns can generally be found at depths of 16-25 m but can occur to depths of 45 m while red-legged banana prawns are found at depths of 35-90 m (AFMA, 2021).

Tiger prawns live in coastal waters to depths of 200 m (AFMA, 2021). Adult brown tiger prawns are found over coarse sediments and adult grooved tiger prawns are found in fine mud sediments (AFMA, 2021). Juvenile tiger prawns are found in shallow waters, often where seagrass beds are present, and sometimes on top of coral reef platforms (AFMA, 2021). For brown tiger prawns, spawning occurs throughout the year, in both inshore and offshore areas, while grooved tiger prawns spawn in offshore areas (AFMA, 2021). Brown tiger prawns have a spawning peak between July and October (AFMA, 2021). Grooved tiger prawns have a spawning peak in August-September, with a secondary peak in February (AFMA, 2021).

Endeavour prawns live in tropical coastal waters (AFMA, 2021). Blue endeavour prawns can be found over sandy or mud-sand substrates to depths of about 60 m while red endeavour prawns prefer muddy substrates and have been found to depths of 95 m (AFMA, 2021). Juvenile blue endeavour prawns are commonly associated with seagrass beds in shallow estuaries, while juvenile red endeavour prawns are more widely distributed across seagrass beds, mangrove banks, mud flats and open channels (AFMA, 2021). Spawning occurs throughout the year (AFMA, 2021). Blue endeavour prawns have spawning peaks in March and September, while red endeavour prawns have a spawning peak in September to December (AFMA, 2021). Based on the endeavour prawns spawning habitat preferences it is unlikely that they would spawn in the offshore area of the activity location.

Molluscs

The JBG has relatively low mollusc species diversity due to the restricted number of habitats available and silty conditions, with less than 100 species (mainly bivalves) recorded in the region (Walker *et al*., 1996). Many different types of molluscs are found in the mangroves, including clams (Walker *et al*., 1996). The soft sediment infaunal plains habitat that dominates the activity area does not provide extensive hard substrate for bivalve molluscs or other fixed invertebrates to attach and reproduce (Przeslawski *et al*., 2011).

Reefs, Shoals and Banks

Coral reefs are habitats with high diversity of corals, associated fish and other species of both commercial and conservation importance. No reef habitats have been identified within the activity area or the ecological EMBA; however, the socioeconomic EMBA does overlap with areas of coral reef habitats. The closest identified coral reef habitat is located within the Joseph Bonaparte Gulf Australian Marine Park (JBG AMP). Emu Reefs (located 85 km northeast of the activity area) was recently surveyed by traditional owners of the Thamarrur region in partnership with the Australian Institute of Marine Science (AIMS), Eni and Parks Australia. The survey deployed Baited Remote Underwater Video Systems (BRUVS) and captured a diversity of fish, sharks and crabs as well as the protected and culturally significant eyebrow wedgefish (*Rhynchobatus palpebratus*) (Parks Australia, 2021a).

Oceanic shoals and banks are abrupt geological features that rise from the deep continental shelf to within 15-20 m of the sea surface. These unique habitats contain submerged reefs that support a very high diversity of coral reef ecosystems (Heyward *et al*., 2017). It is likely that the open oceanic environment that the northwest banks and shoals are situated in contributes to their high species diversity and abundance as their exposure to oceanic influences may enhance productivity and in turn the diversity of species inhabiting them (Parks Australia, 2021a). There are no identified oceanic shoals or banks located within the activity area or the ecological EMBA, however, there are several identified shoals and banks in the western extent of the socio-economic EMBA including Holothuria Banks, Tait Bank, Penguin Shoal and Bassett-Smith Shoal

(RPS, 2021). Though there is a paucity of information relevant to these specific features, studies of similar nearby shoals not located in the EMBA have found a high diversity of free-living corals, sponges, gorgonian soft corals, hard corals, rhodoliths, tropical fish, rays and sharks (Heyward *et al*., 2017; Moore *et al*., 2017; Heyward *et al*., 2010). It is expected that the shoals and banks located in the western extent of the socio-economic EMBA may include a similar assemblage of species. Identified banks, reefs and shoals in relation to the activity area and EMBA are presented in Figure 5.11.

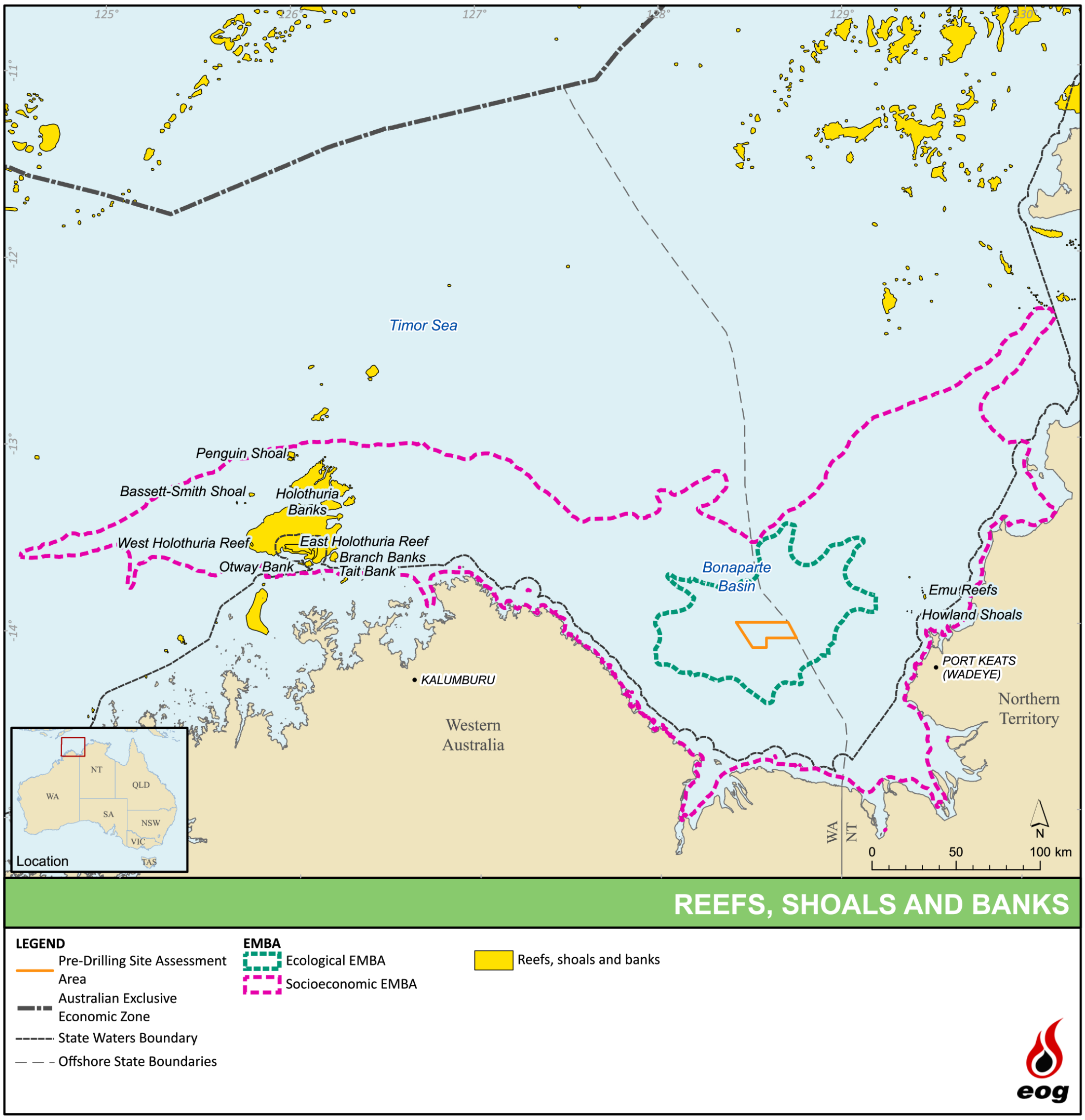


Figure 5.11. Reefs, shoals and banks in the EMBA

5.3.2. Flora

Mangroves

Mangroves provide nutrient to surrounding waters and are also important habitat and nursery areas for fish and invertebrates. The north Kimberley region contains some of the most species rich systems of mangroves in the world (DPaW, 2016). The mangroves and estuarine habitats of the north Kimberley support a range of threatened, protected and culturally important species including estuarine crocodiles, turtles, dolphins, sawfish, mud crabs, fish and specialist mangrove birds (DPaW, 2016).

In the JBG, mangroves occur in river estuaries. The mangroves surrounding the Ord River are notable in terms of their structural complexity and diversity. Fourteen species of mangroves have been identified within the Ord River alone (Pedretti & Paling, 2001). This diverse area is known to support significant habitats for saltwater crocodiles, migratory birds and supports populations of the commercially exploited species of red-legged banana prawn (*Penaeus indicus*) (Kenyon *et al*., 2004).

Seagrass Beds and Macroalgae

Seagrass beds and macroalgae communities are the primary food source for many marine species and provide important habitats and nursery grounds (Heck *et al*., 2003; Wilson *et al*., 2010). Within the north Kimberley marine region, seagrass and macroalgae communities are an important source of primary productivity. They provide vital habitat for juvenile fish, turtles and dugongs and can be found around Cape Londonderry, which is 165 km west of the activity area and within the socio-economic EMBA but outside of the ecological EMBA (DPAW, 2016).

5.3.3. Plankton

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

Phytoplankton

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 has the capacity to multiply rapidly in response to bursts of nutrient availability and are subsequently consumed by zooplankton that in turn are consumed by other marine fauna species.

Zooplankton

Zooplankton is the faunal component of plankton, comprising small crustaceans (such as krill), fish eggs and fish larvae. Zooplankton includes species that drift with the currents and also those that are motile. Nutrients and planktonic organisms (including many species of larval recruits) are transported to and from the JBG by the southerly movement of the Indonesian Throughflow and the southeast and northwest monsoonal wind-driven currents (Brewer *et al*., 2007).

The exact locations and timing of spawning and/or aggregations of fish and shark species are unknown, but the DPIRD provide an indication of species that may spawn within the North Coast bioregion, which includes the JBG (DoF, 2013a) (Table 5.5).

Table 5.5. Peak spawning/aggregation times for key commercial fish species in the North Coast Bioregion

Common name	Species name	Spawning / Aggregation times
Blacktip shark	*Carcharhinus tilstoni* & *C.limbatus*	November – December
Goldband snapper	*Pristipomoides multidens*	January – April
Pink snapper	*Pagrus auratus*	May – July
Rankin cod	*Epinephelus multiinotatus*	August – October

Common name	Species name	Spawning / Aggregation times
Red emperor	*Lutjanus sebae*	October, January, March
Sandbar shark	*Carcharhinus plumbeus*	October – January
Spanish mackerel	*Scomberomorus commerson*	August – November

Based on information from the NPFI, commercial prawn species such as banana, tiger and endeavour prawns may spawn within the activity area during the warmer months of the year. Banana prawns spawn offshore throughout the year with two spawning peaks: the late dry season (September-November) and the late wet season (March-May).

Endeavour prawns spawn throughout the year, with blue endeavour prawns having spawning peaks in March and September and red endeavour prawns have a spawning peak in September to December. Based on the endeavour prawn spawning habitat preferences it is unlikely that they would spawn in the activity area.

Brown tiger prawns peak spawning period is between July and October. A twelve-month-old female prawn can produce hundreds of thousands of eggs at a single spawning and may spawn more than once in a season. The eggs sink to the bottom after release, where they hatch into larvae within about 24 hours. Less than 1% of these offspring survive the two-to-four-week planktonic larval phase to reach suitable coastal nursery habitats where they may settle. After one to three months on the nursery grounds, the young prawns move offshore onto the fishing grounds. See Section 5.6.1 for more information.

During stakeholder engagement for the Santos Fishburn 3D MSS, the PPA noted that there would most likely be a variable distribution of silver lipped pearl oyster (*Pinctada maxima*) at the proposed depths where that survey took place within the JBG. Silver lipped pearl oysters are known to be sparsely distributed in the JBG out to the 100 m isobath. Primary spawning occurs from the middle of October to December, with a smaller secondary spawning occurring in February and March (Hart *et al*., 2015).

5.3.4. Finfish, Sharks and Rays

There are 47 fish species listed under the EPBC Act with potential to occur in the spill EMBA (Table 5.6) (DAWE, 2021a). This includes six species listed as threatened, six species listed as migratory and a further 35 listed marine species, all of which are Sygnathiformes (seahorses, pipefishes and their relatives). Figure 5.12 illustrates the likely temporal presence and absence of these fish species in the activity area and EMBA. The species listed as threatened or migratory are described in this section.

Table 5.6. EPBC Act-listed finfish, sharks and rays that may occur in the activity area and EMBA

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Anoxypristis cuspidate	Narrow sawfish	-	Yes	-	✓	✓	✓	No	No	-
Carcharodon carcharias	Great white shark	V	Yes	-	✓	✓	✓	No	No	RP
Carcharhinus longimanus	Oceanic whitetip shark	-	Yes		✓	✓	✓	No	No	-
Glyphis garricki	Northern river shark	E	-	-	✓	✓	✓	No	No	CA, RP
Isurus oxyrinchus	Shortfin mako	-	Yes	-	✓	✓	✓	No	No	-
Isurus paucus	Longfin mako	-	Yes	-	✓	✓	✓	No	No	-
Manta alfredi	Reef manta ray	-	Yes	-	✓	✓	✓	No	No	-
Manta birostris	Giant manta ray	-	Yes	-	✓	✓	✓	No	No	-
Pristis clavata	Dwarf sawfish	V	Yes	-	✓	✓	✓	No	No	CA, RP
Pristis pristis	Largetooth sawfish	V	Yes	-	✓	✓	✓	No	No	CA, RP
Pristis zijsron	Green sawfish	V	Yes	-	✓	✓	✓	No	No	CA, RP
Rhincodon typus	Whale shark	V	Yes	-	✓	✓	✓	No	No	CA
Seahorses, pipefish and pipehorses										

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Bhanotia fasciolata	Corrugated pipefish	-	-	Yes	-	-	✓	No	No	-
Campichthys tricarinatus	Three-keel pipefish	-	-	Yes	✓	✓	✓	No	No	-
Choeroichthys brachysoma	Pacific short-bodied pipefish	-	-	Yes	✓	✓	✓	No	No	-
Choeroichthys suillus	Pig-snouted pipefish	-	-	Yes	✓	✓	✓	No	No	-
Corythoichthys amplexus	Fijian banded pipefish	-	-	Yes	✓	✓	✓	No	No	-
Corythoichthys flavofasciatus	Reticulate pipefish	-	-	Yes	✓	✓	✓	No	No	-
Corythoichthys haematopterus	Reef-top pipefish	-	-	Yes	-	✓	✓	No	No	-
Corythoichthys intestinalis	Australian messmate pipefish	-	-	Yes	-	-	✓	No	No	-
Corythoichthys schultzi	Schultz's pipefish	-	-	Yes	✓	✓	✓	No	No	-
Cosmocampus banneri	Roughridge pipefish	-	-	Yes	-	-	✓	No	No	-
Doryrhamphus dactyliophorus	Banded pipefish	-	-	Yes	-	-	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Doryrhamphus excisus	Bluestripe pipefish	-	-	Yes	✓	✓	✓	No	No	-
Doryrhamphus janssi	Cleaner pipefish	-	-	Yes	✓	✓	✓	No	No	-
Festucalex cinctus	Girdled pipefish	-	-	Yes	-	✓	✓	No	No	-
Filicampus tigris	Tiger pipefish	-	-	Yes	-	-	✓	No	No	-
Halicampus brocki	Brock's pipefish	-	-	Yes	✓	✓	✓	No	No	-
Halicampus dunckeri	Red-hair pipefish	-	-	Yes	-	-	✓	No	No	-
Halicampus grayi	Mud pipefish	-	-	Yes	✓	✓	✓	No	No	-
Halicampus spinirostris	Spiny-snout pipefish	-	-	Yes	✓	✓	✓	No	No	-
Haliichthys taeniophorus	Ribboned pipehorse	-	-	Yes	✓	✓	✓	No	No	-
Hippichthys cyanospilos	Blue-speckled pipefish	-	-	Yes	-	✓	✓	No	No	-
Hippichthys parvicarinatus	Short-keel pipefish	-	-	Yes	-	✓	✓	No	No	-
Hippichthys penicillus	Beady pipefish	-	-	Yes	✓	✓	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Hippocampus angustus	Western spiny seahorse	-	-	Yes	-	-	✓	No	No	-
Hippocampus histrix	Spiny seahorse	-	-	Yes	✓	✓	✓	No	No	-
Hippocampus kuda	Spotted seahorse	-	-	Yes	✓	✓	✓	No	No	-
Hippocampus planifrons	Flat-face seahorse	-	-	Yes	✓	✓	✓	No	No	-
Hippocampus spinosissimus	Hedgehog seahorse	-	-	Yes	✓	✓	✓	No	No	-
Micrognathus micronotopterus	Tidepool pipefish	-	-	Yes	✓	✓	✓	No	No	-
Solegnathus hardwickii	Pallid pipehorse	-	-	Yes	✓	✓	✓	No	No	-
Solegnathus lettiensis	Gunther's pipehorse	-	-	Yes	✓	✓	✓	No	No	-
Solenostomus cyanopterus	Robust ghost pipefish	-	-	Yes	✓	✓	✓	No	No	-
Syngnathoides biaculeatus	Double-end pipehorse	-	-	Yes	✓	✓	✓	No	No	-
Trachyrhamphus bicoarctatus	Bentstick pipefish	-	-	Yes	✓	✓	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Trachyrhamphus longirostris	Straightstick pipefish	-	-	Yes	-	✓	✓	No	No	-

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*.

Key

EPBC status (@ December 2021)	V	Vulnerable
	E	Endangered
	CE	Critically endangered
BIA	A	Aggregation
	D	Distribution (i.e., presence only)
	F	Foraging
	M	Migration

Recovery plans (under the EPBC Act 1999)	CA	Conservation Advice
	CMP	Conservation Management Plan
	RP	Recovery Plan

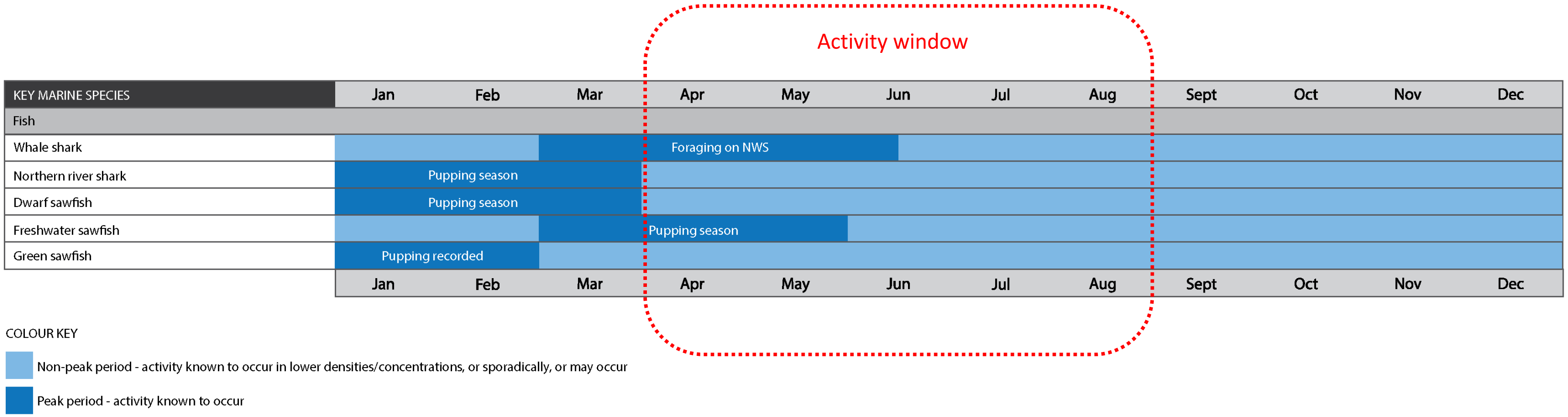


Figure 5.12. Likely temporal presence and absence of EPBC Act-listed fish species in the activity area and spill EMBA

Great white shark (EPBC Act: Vulnerable, Listed migratory)

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 NT (DAWE, 2021b). Studies of the great white shark indicates that they appear to be largely transient, with a few longer-term residents; however, individuals are known to return to feeding grounds on a seasonal basis (Klimey and Anderson, 1996). Observations of adult white sharks are more frequent around fur-seal and sea lion colonies whilst juveniles are known to congregate in certain key areas.

There are no biologically important aggregation, breeding or foraging areas intersected by the activity area or spill EMBA; however, it is likely that individuals may transit through the spill EMBA.

Shortfin mako shark (EPBC Act: Listed migratory)

The shortfin mako (*Isurus oxyrinchus*) is a pelagic species with a circumglobal, wide ranging oceanic distribution in tropical and temperate seas (Mollet *et al*., 2000). It is widespread in Australian waters, recorded in offshore waters all around the continent's coastline with exception of the Arafura Sea, the Gulf of Carpentaria and Torres Strait (DAWE, 2021b). Shortfin makos are also highly migratory and travel large distances (DAWE, 2021b).

Due to their widespread distribution in Australian waters, their presence in the activity area and spill EMBA is likely to be limited to transiting individuals.

Longfin mako shark (EPBC Act: Listed migratory)

The longfin mako is widely distributed; however, it is rarely encountered and can be found along the WA coastline as a far south as Geraldton (Last and Stevens, 2009). There is limited research into the species within Australian waters; however, Sepulveda et al (2004) recorded southern Californian juveniles favoured surface waters, while larger adults were frequently observed at depths of up to 250 m. Whilst assumed to be a deep-dwelling shark, sightings on the ocean surface, and the species' diet, suggest a greater depth range (Reardon *et al*., 2006).

Though there is limited information about the longfin mako, their presence in the activity area and spill EMBA is likely to be limited to transiting individuals.

Whale shark (EPBC Act: Vulnerable, listed migratory)

The whale shark (*Rhincodon typus*) is a filter-feeding shark and is the largest known species of fish in the world (DAWE, 2021b). It is considered to be an oceanic and coastal species, commonly seen far offshore but also closer inshore near coral atolls (DAWE, 2021b). Whale sharks generally prefer tropical to warm temperate waters where surface sea temperature ranges from 21° to 25 °C (DAWE, 2021b). In Australian waters the whale shark is commonly seen in waters off northern WA, NT and Queensland with only very occasional sightings off Victoria and South Australia (Last and Stevens, 1994). The movements of whale sharks are not well documented; however, they are known to seasonally aggregate (March and April) in shallow tropical waters off the North West Cape in WA (DAWE, 2021b).

Whale sharks may occur within the activity area and spill EMBA. A foraging BIA is intersected by the socio-economic EMBA (Figure 5.13) and hence, individuals may forage in the far western extent of the EMBA.

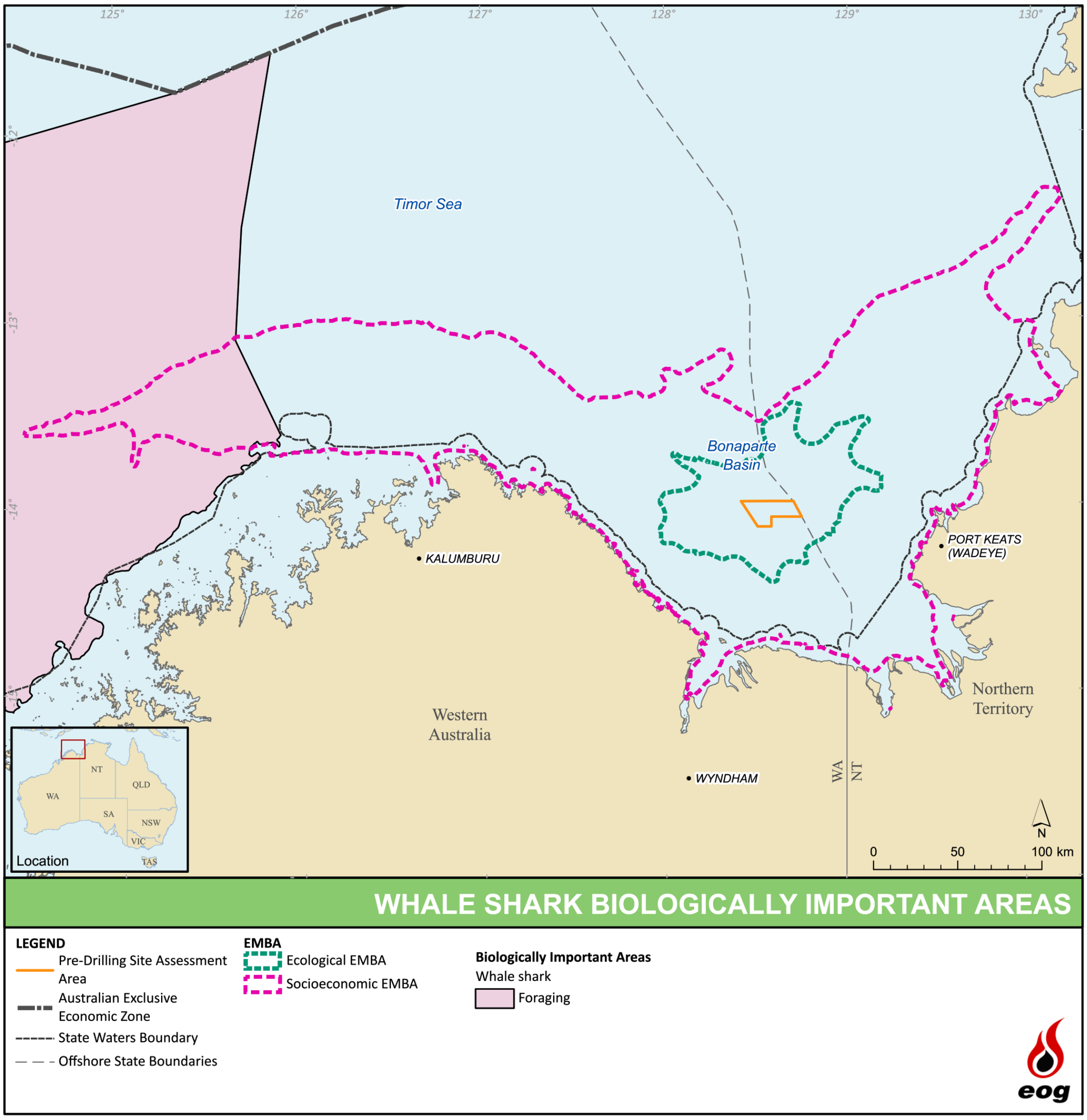


Figure 5.13. Whale shark BIA intersected by the spill EMBA

Northern river shark (EPBC Act: Endangered)

The northern river shark (*Glyphis garricki*) is an elasmobranch capable of living and moving between freshwater and seawater. The species utilises rivers, tidal sections of large tropical estuarine systems, macro tidal embayments, inshore and offshore marine habitats. The species is listed as endangered under the EPBC Act, based partly on its limited geographic distribution (TSSC, 2014a). Within Australia, the northern river shark is known to occur in WA and the NT, occupying both marine and freshwater environments including the JBG, Daly River, Adelaide River and the South and East Alligator Rivers (TSSC, 2014a) (Figure 5.14). Whilst northern river sharks have been observed well offshore, the extent to which this occurs is unknown (TSSC, 2014a).

Individuals may be present within the activity area or nearshore areas of the spill EMBA.

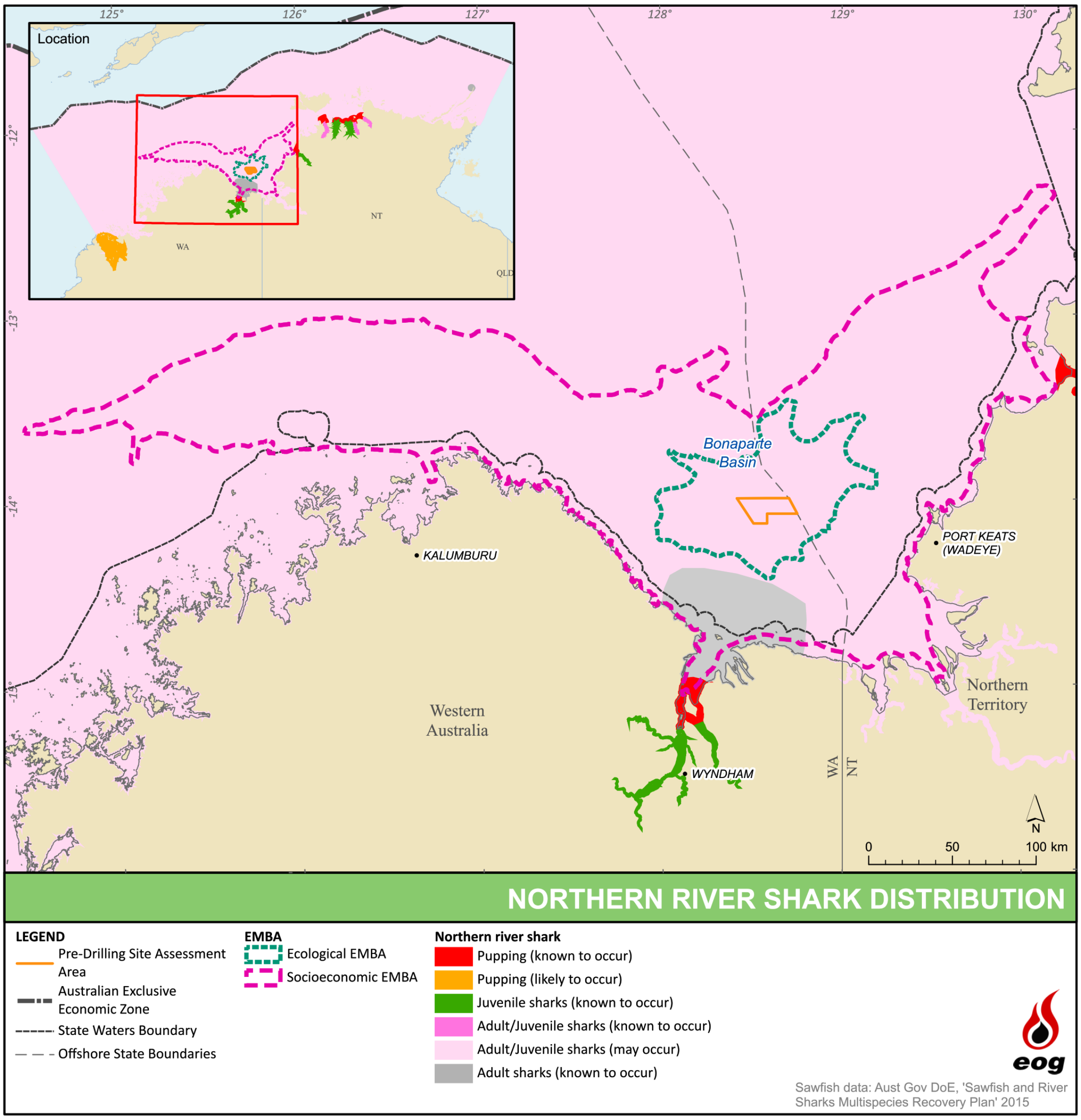


Figure 5.14. Northern river shark presence in the activity area and spill EMBA

Oceanic whitetip shark (EPBC Act: Listed migratory)

Within Australian waters, the oceanic whitetip shark (*Carcharhinus longimanus*) is found from Cape Leeuwin, WA, through parts of the NT and down the east coast of Queensland and New South Wales (NSW) to Sydney (Last and Stevens, 2009). It has not been recorded within the Gulf of Carpentaria or the Arafura Sea. The oceanic whitetip shark is a circumglobal deep-water pelagic species inhabiting tropical to warm-temperate waters (Compagno, 1984). Oceanic whitetip sharks prefer water temperatures above 20°C and can reach depths of >180 m (Castro *et al*., 1999).

Given the species distribution in deep offshore waters, the presence of the species within the activity area and EMBA is expected to be low.

Reef manta ray (EPBC Act: Listed migratory)

The reef manta ray (*Manta alfredi*) has a circum-global range in tropical and sub-tropical waters with sightings between waters off Perth, all along the northern coastline of Australia to the waters off the Solitary Islands, NSW (Marshall *et al*., 2011a). While this species tends to inhabit nearshore environments, it is known to occurs in waters as deep as 300 m and has been sighted around offshore coral reefs, rocky reefs and seamounts (Marshall *et al*., 2011a). In addition, it makes seasonal migrations of several hundred kilometres (Marshall *et al*., 2011a).

Despite there being no known aggregation sites within close proximity to the EMBA, reef manta rays may be present in the activity area and EMBA as transiting individuals.

Giant manta ray (EPBC Act: Listed migratory)

The giant manta ray (*Manta birostris*) has a widespread distribution along the coast of Australia and is known to seasonally migrate between aggregation sites (Marshall *et al*., 2011b). The giant manta ray is commonly sighted along productive coastlines with regular upwelling, oceanic island groups and particularly offshore pinnacles and seamounts (Marshall *et al*., 2011b).

This species has also been recorded within the Oceanic Shoals Marine Park, which is located 143 km north of the activity area and outside the EMBA (Nichol *et al*., 2013). Despite there being no known aggregation sites within close proximity to the activity area, giant manta rays may be present in the activity area and EMBA as transiting individuals.

Narrow sawfish (EPBC Act: Listed migratory)

The narrow sawfish lives in coastal and estuarine habitats across northern Australia and is generally restricted to shallow waters (less than 40 m) (D'Anastasi *et al*., 2013). The species is known to occur in the Gulf of Carpentaria but its distribution and migration is largely unknown. The narrow sawfish has the potential to occur within the activity area and spill EMBA because it has been caught as bycatch by the NPF in these areas (Tonks *et al*., 2008).

Dwarf sawfish (EPBC Act: Vulnerable, Listed migratory)

The dwarf sawfish (*Pristis clavata*) usually inhabits shallow (2–3 m deep) coastal waters and estuarine habitats. Its distribution is considered to extend north from Cairns around the Cape York Peninsula in Queensland, across northern Australian waters to the Pilbara coast in WA (DAWE, 2021b). The dwarf sawfish uses its rostrum to stun schooling fish by sideswiping or threshing while swimming through a school. The main prey species is popeye mullet (*Rhinomugil nasutus*). The main threats to dwarf sawfish are habitat loss and entanglement in fishing nets.

Adult dwarf sawfish are known to occur in the activity area and the nearshore areas of the spill EMBA (Figure 5.15).

Largetooth sawfish (EPBC Act: Vulnerable, Listed migratory)

Largetooth sawfish (*Pristis pristis*) utilise both freshwater (juvenile) and marine (adult) environments during the different stages of its lifecycle (TSSC, 2014b). Within Australia, largetooth sawfish have been recorded in numerous drainage systems across northern WA, NT and northern Queensland (TSSC, 2014b). The freshwater sawfish feeds on fishes and benthic invertebrates. The saw is used to stun schooling fish, such as mullet, and for extracting molluscs and small crustaceans from the benthic sediment.

The activity area and the spill EMBA overlap areas where adult largetooth sawfish are known to occur (Figure 5.16).

Green sawfish (EPBC Act: Vulnerable, Listed migratory)

The green sawfish (*Pristis zijsron*) occurs in both inshore and offshore marine coastal waters of northern Australia. Its current known distribution stretches from Broome, WA around northern Australia and down the east coast as far as Jervis Bay, NSW (DAWE, 2021b). The main threats to green sawfish are habitat loss and entanglement in fishing nets. The EMBA overlaps areas where both adult and juvenile sawfish are known to occur and is adjacent to the inner waters of the southern JBG where pupping of this species is likely to occur (Figure 5.17). It has also been caught as bycatch from the NPF in the area overlapped by the activity area and spill EMBA and therefore is likely to be present in both (Tonks *et al*., 2008).

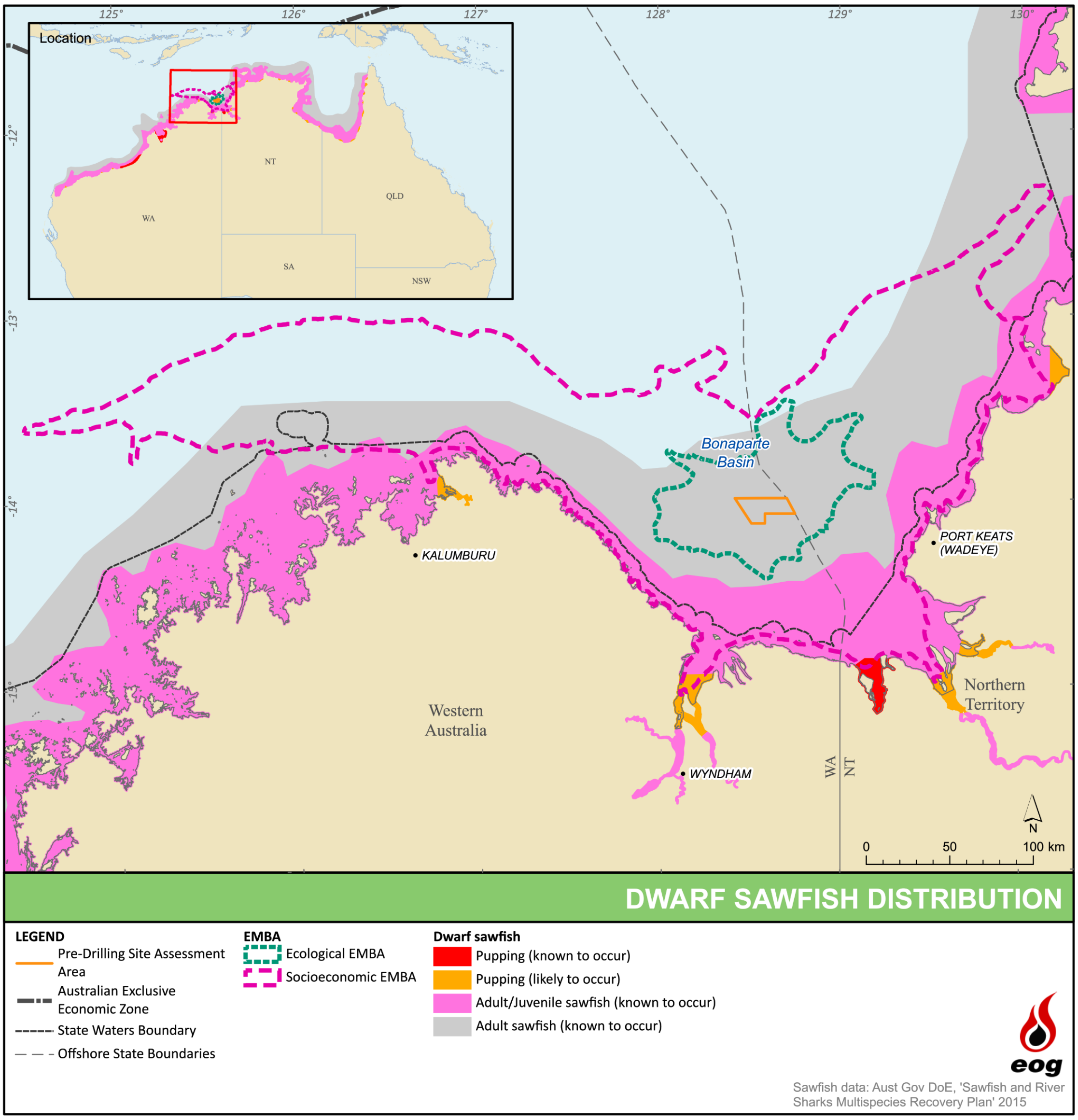


Figure 5.15. Dwarf sawfish presence in the activity area and spill EMBA

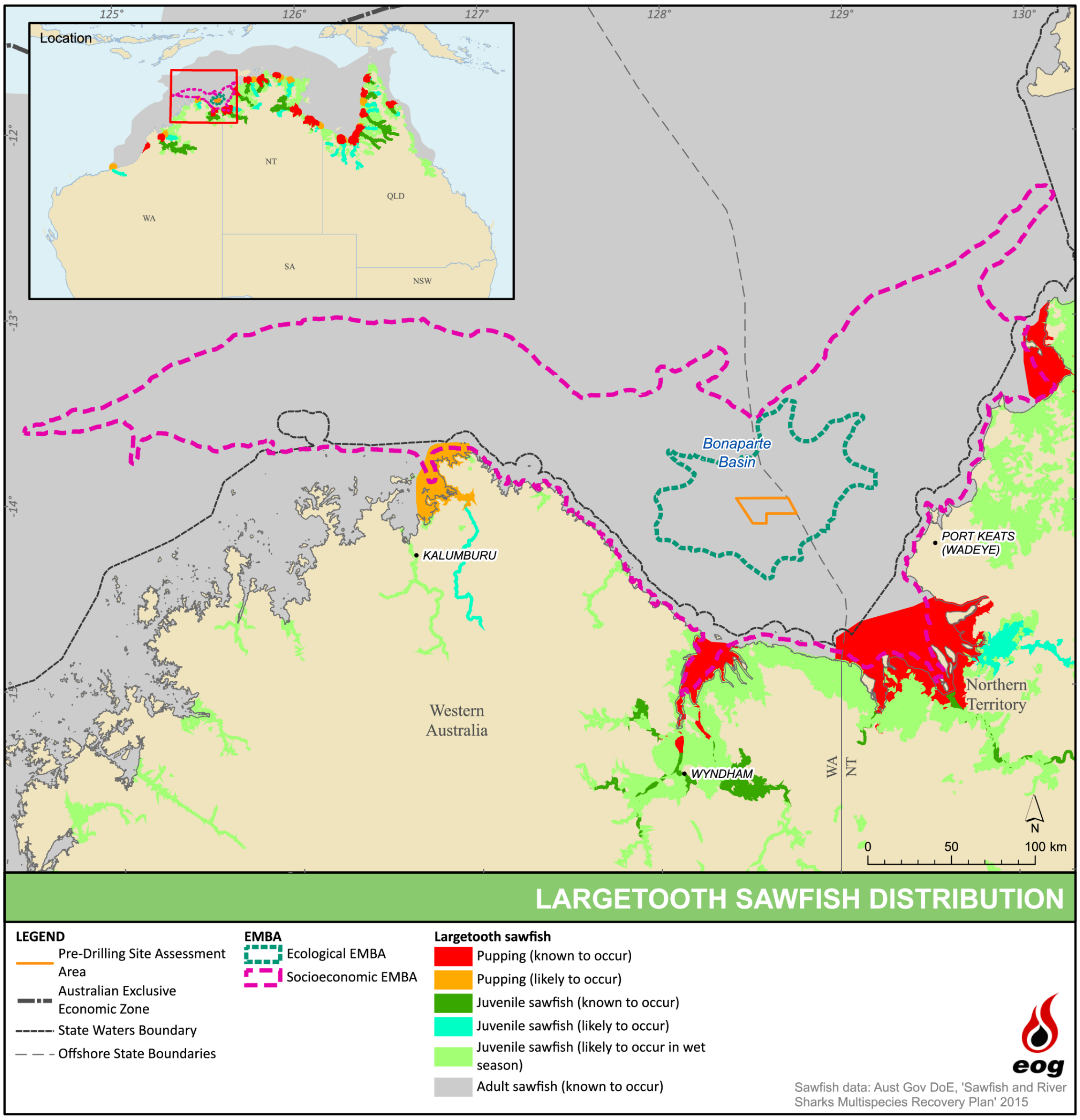


Figure 5.16. Largetooth sawfish presence in the activity area and spill EMBA

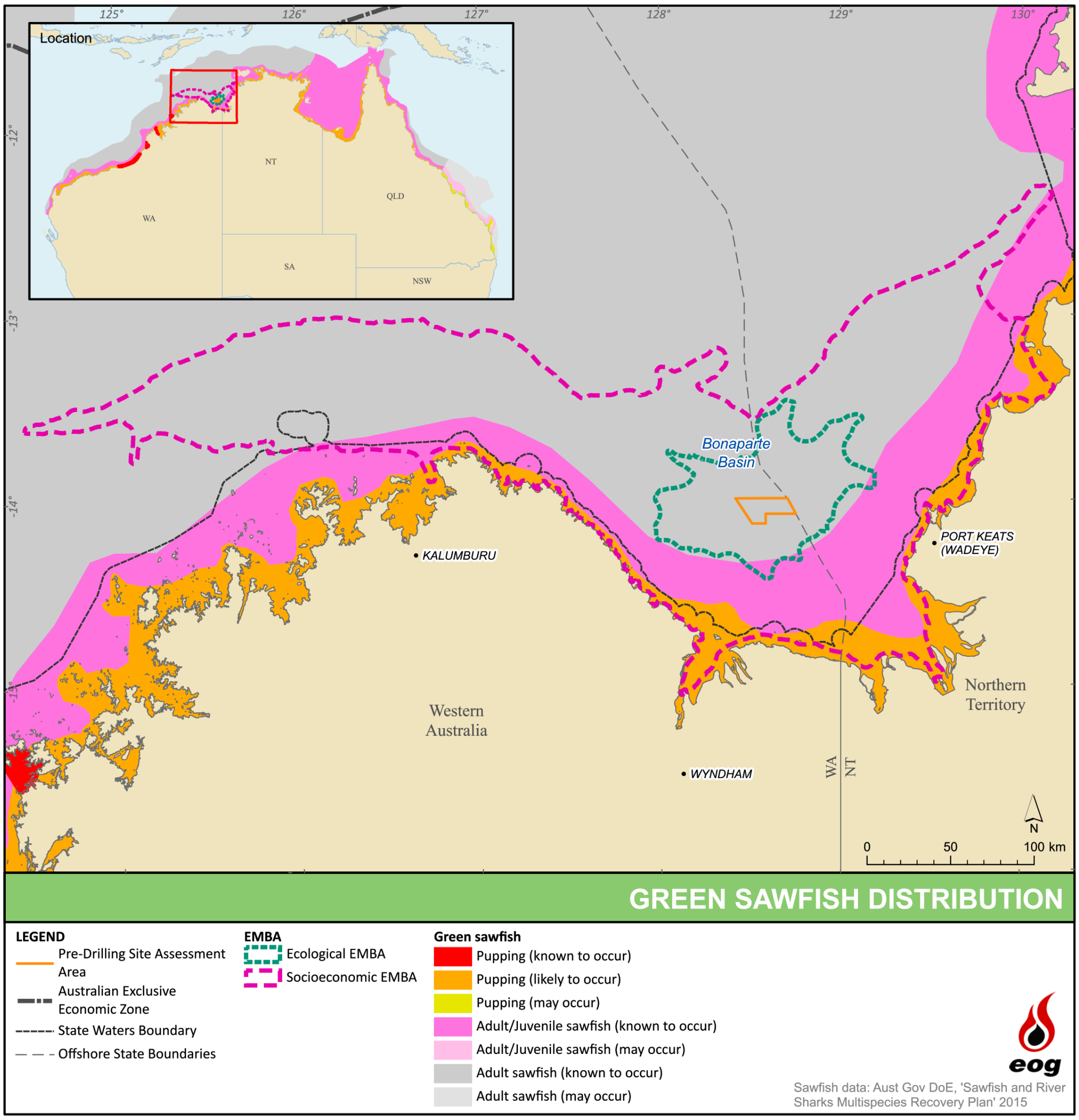


Figure 5.17. Green sawfish presence in the activity area and spill EMBA

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

Thirty-five (35) of the 47 marine ray-finned fish species identified in the EPBC Act PMST (74%) are sygnathiformes, which includes seahorses, seadragon, pipehorse and pipefish. The majority of these fish species are associated with seagrass meadows, macroalgal seabed habitats, reefs and sponge gardens located in shallow, inshore waters (e.g., protected coastal bays, harbours and jetties) less than 50 m deep. 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 unlikely that sygnathid species in the deeper waters of the activity area though they are likely to occur in the inshore areas of the spill EMBA.

The PMST species profile and threats profiles indicate that the sygnathiforme species listed for the EMBA are widely distributed throughout northern and north-western Australian waters. The diverse range of ecological niches afforded by reef sites would be expected to provide suitable habitat for these listed species. The likely absence of reef and seagrass habitat within the activity area would suggest the diversity and abundance of these species would be far less in the activity area.

5.3.5. Marine Mammals

The PMST indicates that nine whale species and 15 dolphin species may reside within or migrate through the activity area and spill EMBA (DAWE, 2021a). These species are presented in Table 5.7 and a description focused on threatened species follows. Figure 5.18 illustrates the likely temporal presence and absence of cetaceans in the activity area and EMBA. The species listed as threatened or migratory are described in this section.

Table 5.7. EPBC Act-listed cetaceans that may occur in the activity area and EMBA

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Whales										
Balaenoptera borealis	Sei whale	V	Yes	Yes	✓	✓	✓	No	No	CA
Balaenoptera edeni	Bryde's whale	-	Yes	Yes	✓	✓	✓	No	No	-
Balaenoptera musculus	Blue whale	E	Yes	Yes	✓	✓	✓	No	No	CMP
Balaenoptera physalus	Fin whale	V	Yes	Yes	✓	✓	✓	No	No	CA
Kogia breviceps	Pygmy sperm whale	-	-	Yes	-	-	✓	No	No	-
Kogia simus	Dwarf Sperm Whale	-	-	Yes	-	-	✓	No	No	-
Megaptera novaeangliae	Humpback whale	V	Yes	Yes	✓	✓	✓	No	No	CA
Physeter macrocephalus	Sperm whale	-	Yes	Yes	-	-	✓	No	No	-
Ziphius cavirostris	Cuvier's beaked whale	-	-	Yes	-	-	✓	No	No	-
Dolphins										
Delphinus delphis	Common dolphin	-	-	Yes	✓	✓	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Feresa attenuata	Pygmy killer whale	-	-	Yes	-	-	✓	No	No	-
Globicephala macrorhynchus	Short-finned pilot whale	-	-	Yes	-	-	✓	No	No	-
Grampus griseus	Risso's dolphin	-	-	Yes	✓	✓	✓	No	No	-
Orcaella brevirostris	Australian snubfin dolphin	-	Yes	Yes	-	-	✓	No	No	-
Orcinus orca	Killer whale	-	Yes	Yes	✓	✓	✓	No	No	-
Peponocephala electra	Melon-headed whale	-	-	Yes	-	-	✓	No	No	-
Pseudorca crassidens	False killer whale	-	-	Yes	✓	✓	✓	No	No	-
Sousa sahulensis	Australian humpback dolphin	-	Yes	Yes	-	✓	✓	No	No	-
Stenella attenuata	Spotted dolphin	-	-	Yes	✓	✓	✓	No	No	-
Stenella coeruleoalba	Striped dolphin	-	-	Yes	-	-	✓	No	No	-
Stenella longirostris	Long-snouted spinner dolphin	-	-	Yes	-	-	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Steno bredanensis	Rough-toothed dolphin	-	-	Yes	-	-	✓	No	No	-
Tursiops aduncus	Indian Ocean bottlenose dolphin	-	-	Yes	✓	✓	✓	No	No	-
Tursiops truncatus	Bottlenose dolphin	-	-	Yes	✓	✓	✓	No	No	-
Dugong										
Dugong dugon	Dugong	-	Yes	Yes	✓	✓	✓	No	No	-

Same key as per Table 5.6.

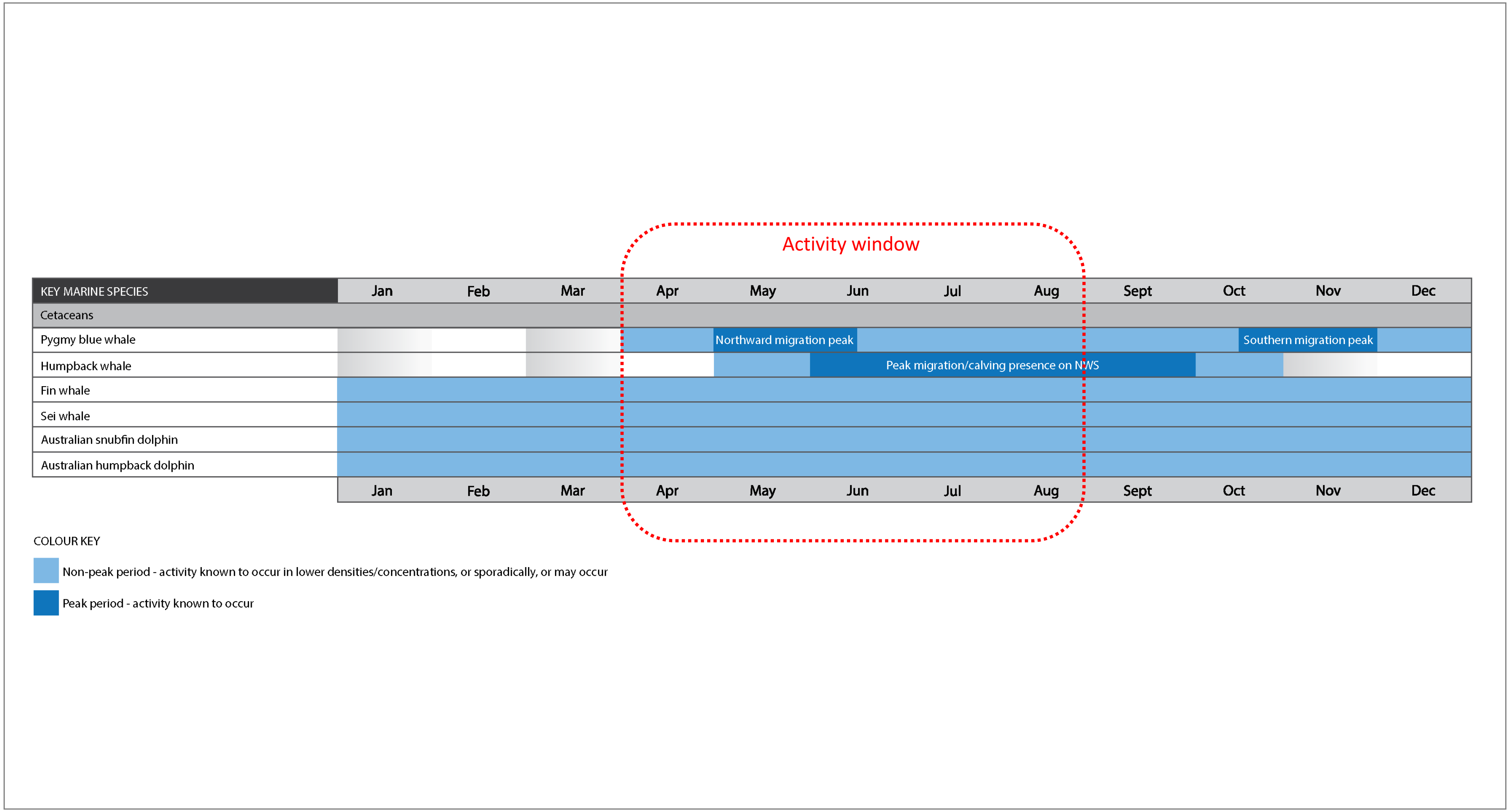


Figure 5.18. Likely temporal presence and absence of EPBC Act-listed cetacean species in the activity area and EMBA

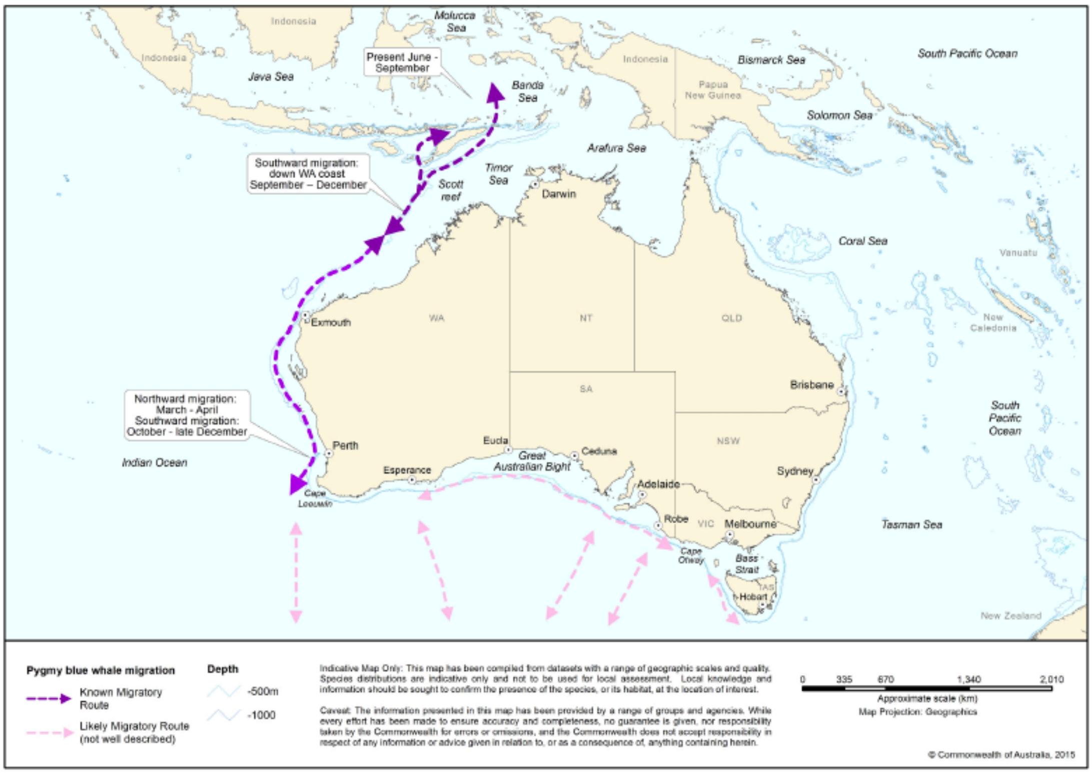
Pygmy blue whale (EPBC Act: Endangered, Listed migratory)

Blue whales (*Balaenoptera musculus*) are the largest living animals, growing to a length of over 30 m and weighing up to 180 tonnes (DoE, 2015a). In Australia, there are two recognised sub-species of blue whale; the Antarctic blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*B. m. brevicauda*).

Blue whales have a worldwide distribution but tend to move between warm water (low latitudes) for breeding and cold water (high latitudes) for feeding. Pygmy blue whales are thought to migrate from Australian feeding areas to breeding grounds that include Indonesia (based on sightings in Indonesia in the austral winter), while Antarctic blue whale winter migratory destinations include lower latitudes of the Pacific and Indian Oceans (DoE, 2015a). Thus, the pygmy blue whale is more likely to be encountered in tropical waters and hence the information provided herein is based on the pygmy blue whale.

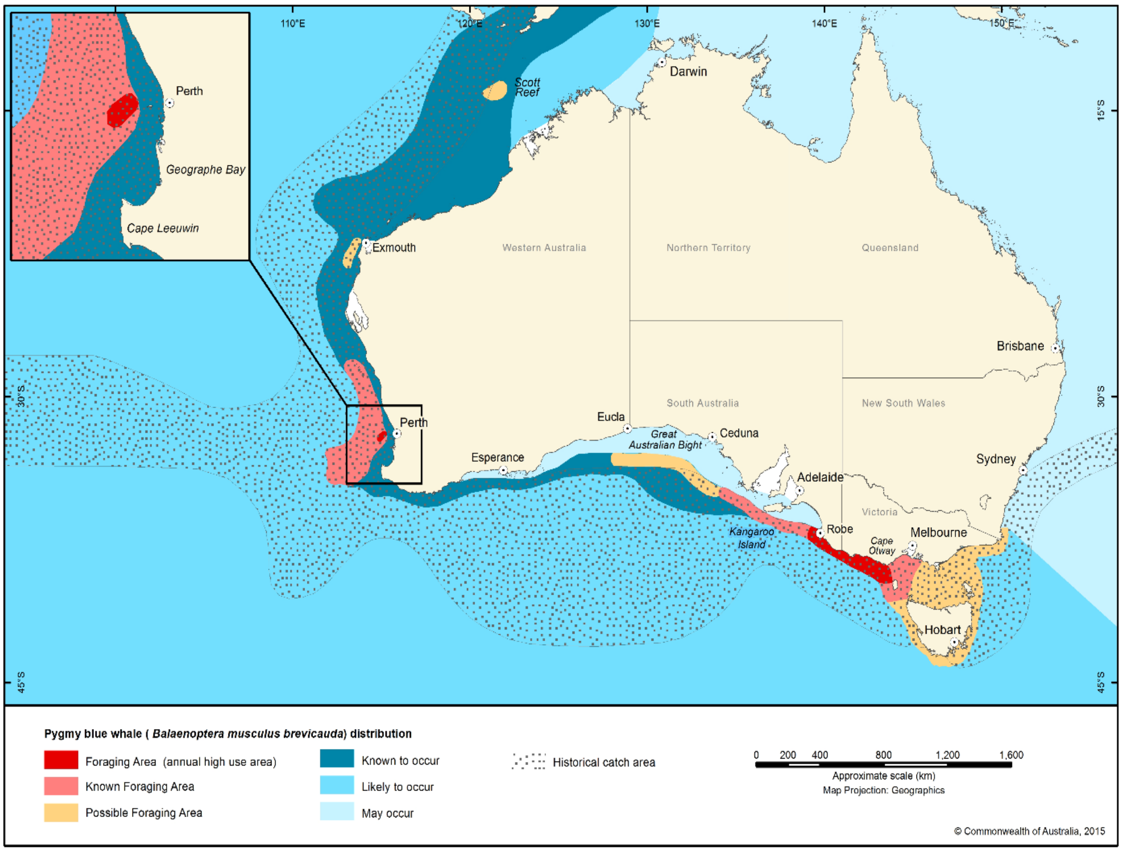
Tracking of pygmy blue whales identified that they migrate north from the Perth Canyon (known feeding area) in March/April reaching Indonesia by June where they remain until at least September (DoE, 2015a). Southern migration from Indonesia may occur from September and finish by December after which the animals may make their way slowly northwards towards the Perth Canyon by March/April (Double *et al*., 2014). Blue whale migration is thought to follow deep oceanic routes, and a tagging study by Double et al (2014) identified that the shallowest waters occupied was ~1,300 m. Figure 5.19 shows the distribution of pygmy blue whale around Australia. There is a foraging, migration and distribution BIA located off the Northwest Shelf (Figure 5.20), which is not intersected by the spill EMBA or the activity area.

Though there are no BIAs that are intersected by the activity area or EMBA, the activity area and EMBA are considered within the 'likely' distribution of the species and therefore pygmy blue whales may be present in the region (DoE, 2015a).



Source: DoE (2015a).

Figure 5.19. Pygmy blue whale migration routes



Source: DoE (2015a).

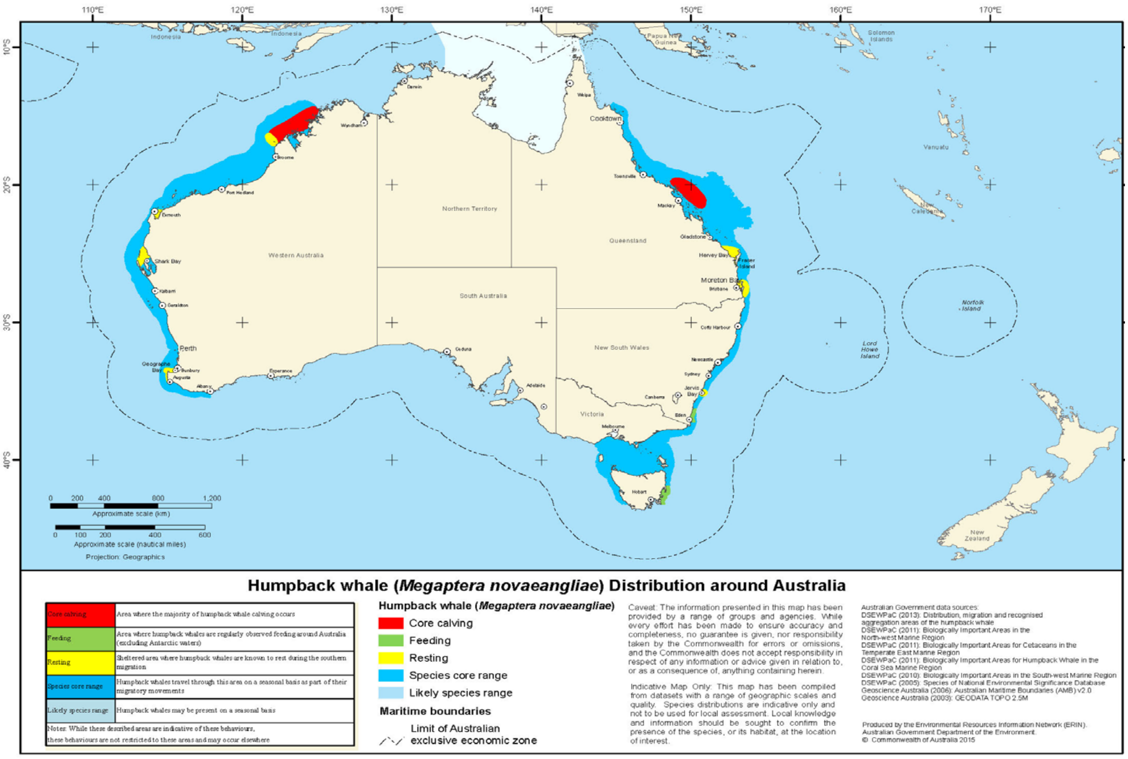
Figure 5.20. Pygmy blue whale BIAs

Humpback whale (EPBC Act: Vulnerable, Listed migratory)

Humpback whales (*Megaptera novaeangliae*) in the southern hemisphere undertake an annual migration during the austral winter from Antarctic feeding areas to tropical calving grounds (DAWE, 2021b). Figure 5.21 shows the distribution of humpback whales around Australia.

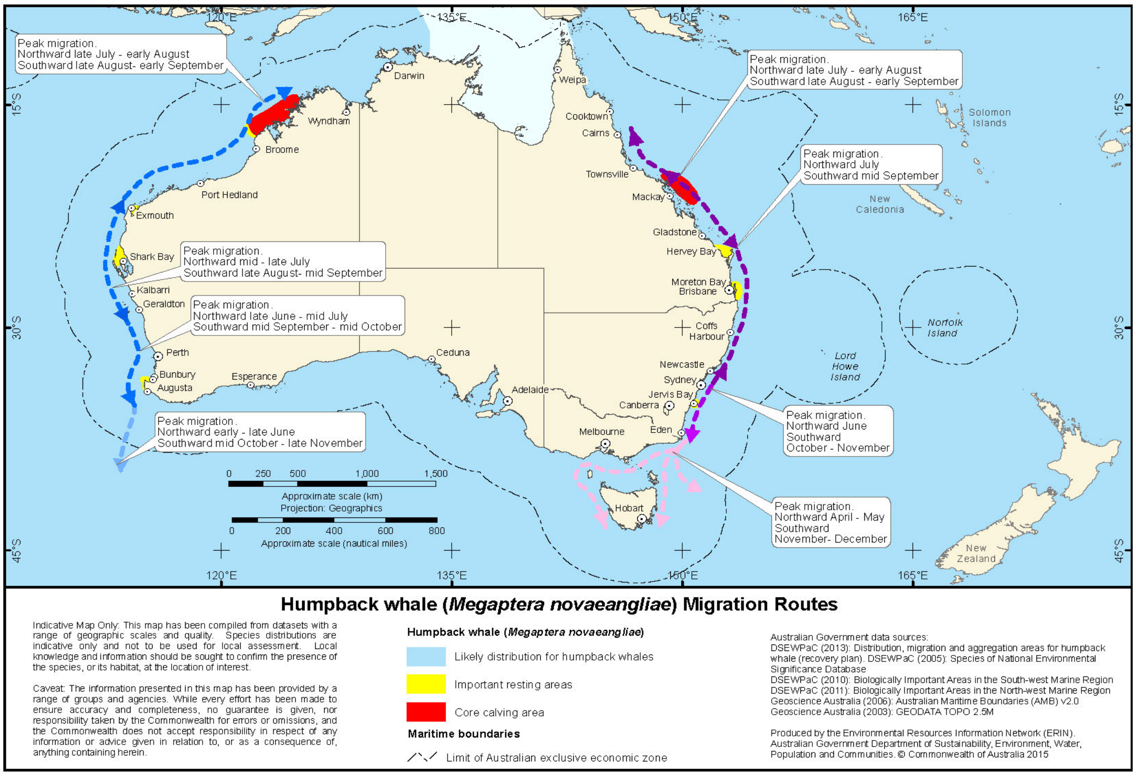
In the NWMR, humpback whales are known to have breeding and foraging grounds between Broome and the northern end of Camden Sound (460 km southwest of the activity area and over 195 km south from the closest extent of the EMBA), with the highest concentrations occurring between June and September (DEWHA, 2008b). Camden Sound appears to be the northern most limit for the majority of the west coast whales (Figure 5.22) (Jenner *et al*., 2001).

The breeding and calving BIA for humpbacks off the west Kimberley coastline extends as far as Bigge Island (107 km south of the EMBA). Therefore, humpback whales are unlikely to be present in the activity area though may be present in the spill EMBA during the period of peak presence in north western Australia (June – September).



Source: TSSC (2015a).

Figure 5.21. Distribution of the humpback whale around Australia



Source: TSSC (2015a).

Figure 5.22. Migration routes of humpback whales around Australia

Sei whale (EPBC Act: Vulnerable, Listed migratory)

Sei whales (*B. 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 (TSSC, 2015b).

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, 2015b).

These whales are thought to complete long annual seasonal migrations from subpolar summer feeding grounds to lower latitude winter breeding grounds (TSSC, 2015b); 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, NT and WA (TSSC, 2015b).

Based upon the species preference for deep offshore waters, and the small number of sei whale sightings in Australia, it is considered unlikely that this species occurs within the activity area or EMBA.

Fin whale (EPBC Act: Vulnerable, Listed migratory)

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, 2015c). 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, 2015c).

Fin whales are generally thought to undertake long annual migrations from higher latitude summer feeding grounds to lower latitude winter breeding grounds (TSSC, 2015c). It is likely they migrate in November - May 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, 2015c). Migration patterns are not well understood. It is though the species may breeding deeper waters of the Indonesian Archipelago, using north western Australia as a migration route.

The conservation advice (TSSC, 2015c) 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 the JBG, it is considered unlikely that this species occurs within the activity area or the spill EMBA.

Sperm whale (EPBC Act: Vulnerable, listed migratory)

Sperm whales (*Physeter macrocephalus*) are the largest of the toothed whales and are generally found in pods of up to 50 individuals (DAWE, 2021b). Sperm whales have a global distribution. They generally inhabit deeper oceanic waters, although they have been located closer to coastlines at depths of approximately 200 m.

The PMST indicates that the species is not predicted to occur within the activity area, but is known to occur within the EMBA. No BIAs for the species are recorded in the activity area or spill EMBA.

It is possible that sperm whales may transit through the activity area and spill EMBA, but they are not expected to be present in significant numbers.

Bryde's whale (EPBC Act: Listed migratory)

The Bryde's whale (*Balaenoptera edeni*) is restricted to tropical and temperate waters and has been recorded off all Australian states with exception of the NT (Bannister *et al*., 1996). Bryde's whales can be found in both oceanic (500 to 1,000 m isobath) and inshore waters (<200 m isobath) (DAWE, 2021b). Population estimates are not available for Bryde's whales, globally or in Australia, and no migration patterns have been documented in Australian waters (DAWE, 2021b). Bryde's whale is considered to be a fairly opportunistic feeder and it appears that the coastal and offshore forms may be distinguished by their prey preferences, with the smaller coastal form feeding on schooling fishes, such as pilchard, anchovy, sardine, mackerel, herring and others. In contrast, the larger offshore form appears to feed on small crustaceans, such as euphausids, copepods, pelagic red crabs and cephalopods.

The PMST indicates that the species may occur within the activity area and the EMBA. There are no BIAs within the activity area or EMBA.

Omura's whale (EPBC Act: not listed)

Omura's whale (*Balaenoptera omurai*) may occur in and around the activity area and EMBA but is not listed under the EPBC Act. It is understood that DAWE is considering listing this species and as such, it is described briefly here. It is listed under the IUCN Red list as 'data deficient.'

Omura's whale was first described in 2003 and is morphologically similar to but genetically distinct from the Bryde's and sei whales (Cerchio *et al*., 2019). This species is widely distributed in tropical and warm-temperate locations in all ocean basins except the central and eastern Pacific Ocean. Field research indicates Omura's whale has a strong preference for shallow water, on-shelf habitat, with only short ventures into adjacent deep waters (Cerchio *et al*., 2019).

Cerchio et al (2019) report that there have been several accounts of Omura's whale along Australia's northwest coast, from Exmouth (WA) into the Timor Sea. McPherson et al (2016) recorded Omura's whale calls around the Barossa and Caldita gas fields (460-490 km northeast of the activity area) in 2014-15 as part of the monitoring undertaken for ConocoPhillips Australia's Barossa Development proposal. The calls were primarily observed from May to August, with no detection of the species' calls from November to late December.

Given the limited information available for this species, it is assumed that it may migrate through the operational area.

Killer whale (EPBC Act: Listed migratory)

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 (outside the EMBA) (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, 2021b). The breeding season is variable, and the species moves seasonally to areas of food supply (Bannister *et al*., 1996; Morrice *et al*., 2004). The activity area and EMBA are unlikely to represent important habitat for this species. Therefore, killer whales are unlikely to be present in the activity area or EMBA.

Australian humpback dolphin (EPBC Act: Listed migratory)

Australian humpback dolphins (*Sousa sahulensis*) are found primarily in coastal waters and feed mainly on fish associated with coastal-estuarine waters (DAWE, 2021b). In Queensland and the NT, Australian humpback dolphins are mainly found in water less than 20 km from the nearest river mouth, and in water less than 15–20 m deep (DAWE, 2021b). They are generally found in river mouths, mangroves, seagrass beds, tidal channels and inshore reefs. They are known to have resident groups that forage, feed, breed and calve in state and territory waters. Calves may be born throughout the year, but peaks in summer and spring have been reported.

The PMST indicates that the species is not predicted to occur within the activity area, but is known to occur within the EMBA. The coastal area of the socio-economic EMBA comes within 10 km of intersecting the significant habitat BIA for this species but does not overlap (Figure 5.23). Therefore, the species is unlikely to be present in the activity area and likely to be present in the western extent of the spill EMBA.

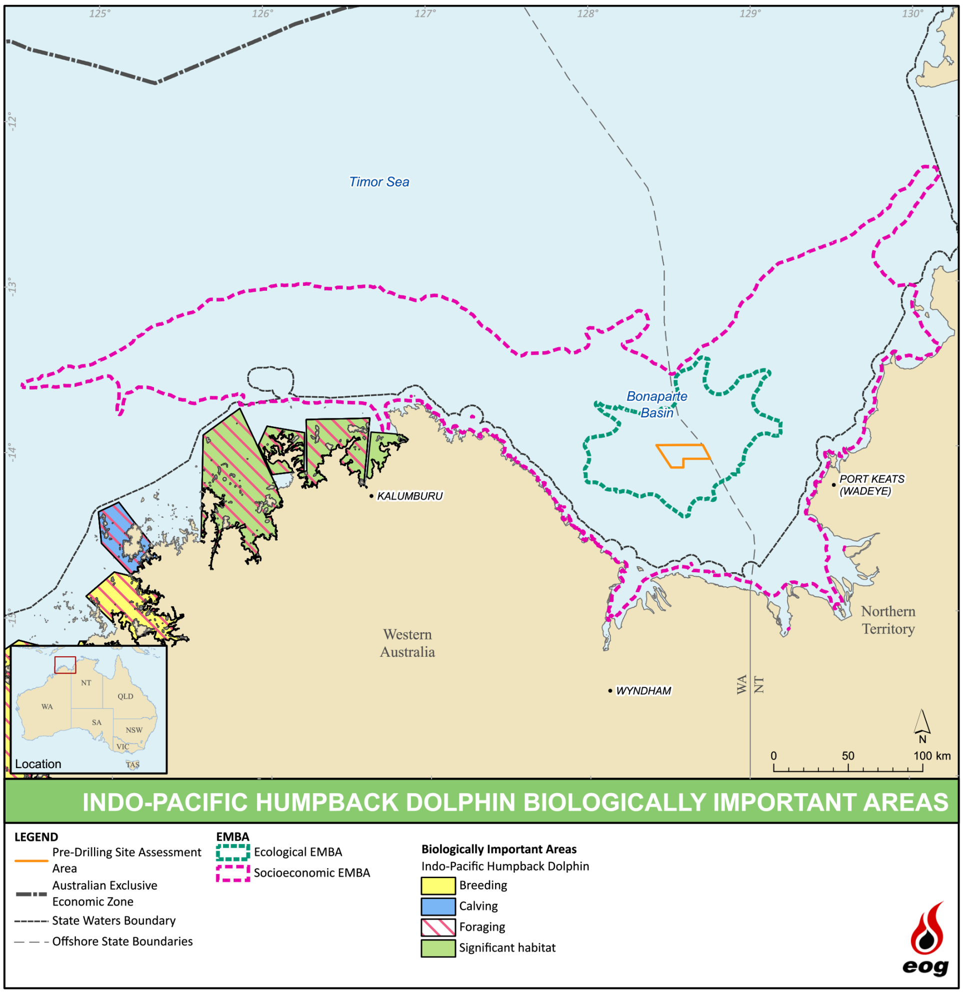


Figure 5.23. Australian humpback dolphin BIA intersected by the spill EMBA

Australian snubfin dolphin (EPBC Act: Listed migratory)

Australian snubfin dolphins (*Orcaella brevirostris*) occur mostly in protected shallow waters close to the coast, and close to river and creek mouths, including the shallow coastal waters and estuaries along the Kimberley coast and Cambridge Gulf (DAWE, 2021b). Within Australian waters, Australian snubfin dolphins have been recorded almost exclusively in coastal and estuarine waters (DAWE, 2021b). All available data on the distribution and habitat preferences of Australian snubfin dolphins indicate that they mainly occur in one location: shallow coastal and estuarine waters of Queensland, NT and northern WA (DAWE, 2021b). Australian snubfin dolphins share similar habitat preference with Australian humpback dolphins, with these two species potentially occurring in the same area through most of their Australian range (DAWE, 2021b).

Feeding primarily occurs in shallow waters (less than 20 m) close to river mouths and creeks (DAWE, 2021b). This includes a variety of habitats, from mangroves to sandy bottom estuaries and embayments, to rock and/or coral reefs. Prey for this species includes fish of the families Engraulidae, Clupeidae, Chirocentridae, Anguillidae, Hemirhampidae, Leiognathidae, Apogonidae, Pomadasydae, Terapontidae and Sillaginidae, typically associated with shallow coastal waters and estuaries in tropical regions (DAWE, 2021b).

Off the WA Kimberley coast, the development of infrastructure, mostly associated with the petroleum industry and iron ore activities, and seismic surveys and petroleum explorations are of concern and are suspected to have an impact at the local level at all affected sites. This threat to Australian snubfin dolphins is considered likely to continue into the future, with the potential to increase its impact as habitat degradation and loss increase with increased human population requirements (DAWE, 2021b).

The PMST indicates that the species is not predicted to occur within the activity area, but is known to occur within the EMBA. The EMBA overlaps with the resting, foraging, calving and breeding BIA for this species (Figure 5.24).

Dugong (EPBC Act: Listed marine, migratory)

Dugongs (*Dugong dugon*) inhabit protected shallow coastal areas, such as wide shallow bays and mangrove channels. They feed on seagrass, and major concentrations of dugongs tend to coincide with sizeable seagrass beds. Research undertaken in the NT, including aerial surveys, has focused on dugong populations in the Gulf of Carpentaria and in the northern parts of the NT, such as the Tiwi Islands and Coburg Peninsula. No surveys have been undertaken in the JBG, therefore little is known about the distribution of dugongs in the Gulf. However, as high turbidity in the JBG limits the development of seagrass beds, dugongs are not expected to be abundant (Woodside, 2004).

Though not abundant in the JBG, dugongs have been reported to occur along the coastline from Cape Hay (83 km east of the activity area) to Pearce Point (290 km northeast of the activity area), with the main populations concentrated around Dorcherty Island (80 km east of the activity area) (Woodside, 2004). Therefore, dugongs are unlikely to be present in the activity area but may be present in the nearshore areas of the spill EMBA.

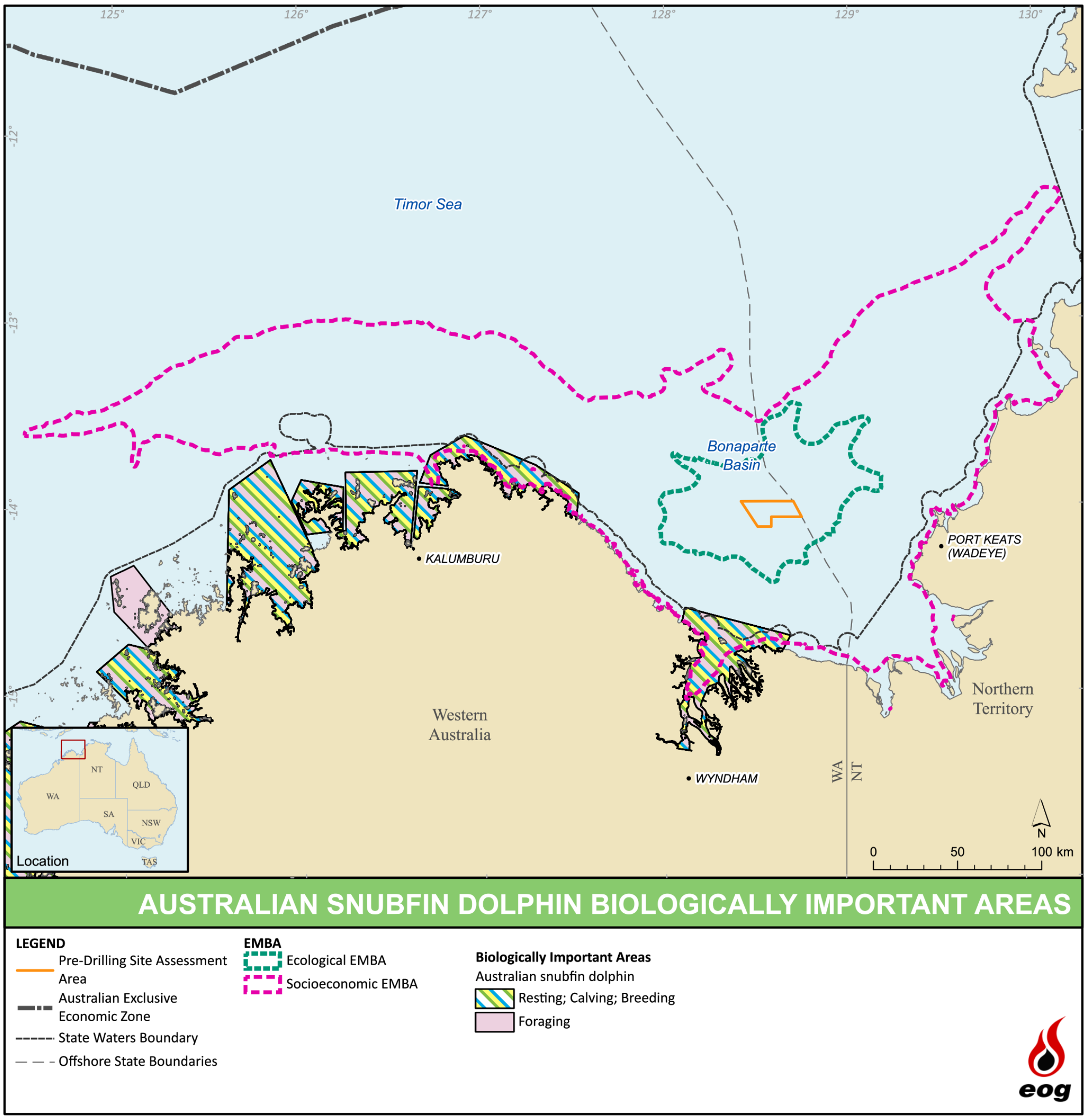


Figure 5.24. Australian snubfin dolphin BIA intersected by the spill EMBA

5.3.6. Reptiles

Six species of marine turtle are listed under the EPBC Act as potentially occurring in the EMBA, as listed in Table 5.8 (DAWE, 2021a). Three of the turtle species are listed as endangered with the other three listed as vulnerable. Additionally, 22 species of seasnake were identified as potentially occurring in the EMBA (two of which are listed as critically endangered). Two species of crocodile were also identified.

Ecological stages and temporal occupation of the turtle species is presented in Figure 5.25.

Table 5.8 EPBC Act-listed marine reptiles that may occur in the activity area and EMBA

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Turtles										
Caretta caretta	Loggerhead turtle	E	Yes	Yes	✓	✓	✓	No	No	F
Chelonia mydas	Green turtle	V	Yes	Yes	✓	✓	✓	Yes	Yes	I, F
Dermochelys coriacea	Leatherback turtle	E	Yes	Yes	✓	✓	✓	No	No	-
Eretmochelys imbricate	Hawksbill turtle	V	Yes	Yes	✓	✓	✓	No	No	-
Lepidochelys olivacea	Olive ridley turtle	E	Yes	Yes	✓	✓	✓	Yes	Yes	I, F
Natator depressus	Flatback turtle	V	Yes	Yes	✓	✓	✓	Yes	Yes	I, F
Seasnakes										
Acalyptophis peronii	Horned seasnake	-	-	Yes	✓	✓	✓	No	No	-
Aipysurus apraefrontalis	Short-nosed seasnake	CE	-	Yes	-	-	✓	No	No	CA
Aipysurus duboisii	Dubois' seasnake	-	-	Yes	✓	✓	✓	No	No	-
Aipysurus eydouxii	Spine-tailed seasnake	-	-	Yes	✓	✓	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Aipysurus foliosquama	Leaf-scaled seasnake	CE	-	Yes	-	-	✓	No	No	CA
Aipysurus laevis	Olive seasnake	-	-	Yes	✓	✓	✓	No	No	-
Astrotia stokesii	Stokes' seasnake	-	-	Yes	✓	✓	✓	No	No	-
Disteira kingii	Spectacled seasnake	-	-	Yes	✓	✓	✓	No	No	-
Disteira major	Olive-headed seasnake	-	-	Yes	✓	✓	✓	No	No	-
Emydocephalus annulatus	Turtle-headed seasnake	-	-	Yes	-	-	✓	No	No	-
Enhydrina schistosa	Beaked seasnake	-	-	Yes	✓	✓	✓	No	No	-
Hydrelaps darwiniensis	Black-ringed seasnake	-	-	Yes	✓	✓	✓	No	No	-
Hydrophis atriceps	Black-headed seasnake	-	-	Yes	✓	✓	✓	No	No	-
Hydrophis coggeri	Slender-necked seasnake	-	-	Yes	-	-	✓	No	No	-
Hydrophis elegans	Elegant seasnake	-	-	Yes	✓	✓	✓	No	No	-
Hydrophis inornatus	Plain seasnake	-	-	Yes	-	✓	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Hydrophis mcdowelli	Small-headed seasnake	-	-	Yes	✓	✓	✓	No	No	-
Hydrophis ornatus	Spotted seasnake	-	-	Yes	✓	✓	✓	No	No	-
Hydrophis pacificus	Large-headed seasnake	-	-	Yes	-	✓	✓	No	No	-
Lapemis hardwickii	Spine-bellied seasnake	-	-	Yes	✓	✓	✓	No	No	-
Parahydrophis mertoni	Northern mangrove seasnake	-	-	Yes	-	-	✓	No	No	-
Pelamis platurus	Yellow-bellied seasnake	-	-	Yes	✓	✓	✓	No	No	-
Crocodiles										
Crocodylus johnstoni	Freshwater crocodile	-	-	Yes	-	-	✓	No	No	-
Crocodylus porosus	Salt-water crocodile	-	Yes	Yes	✓	✓	✓	No	No	-

Same key as per Table 5.6.

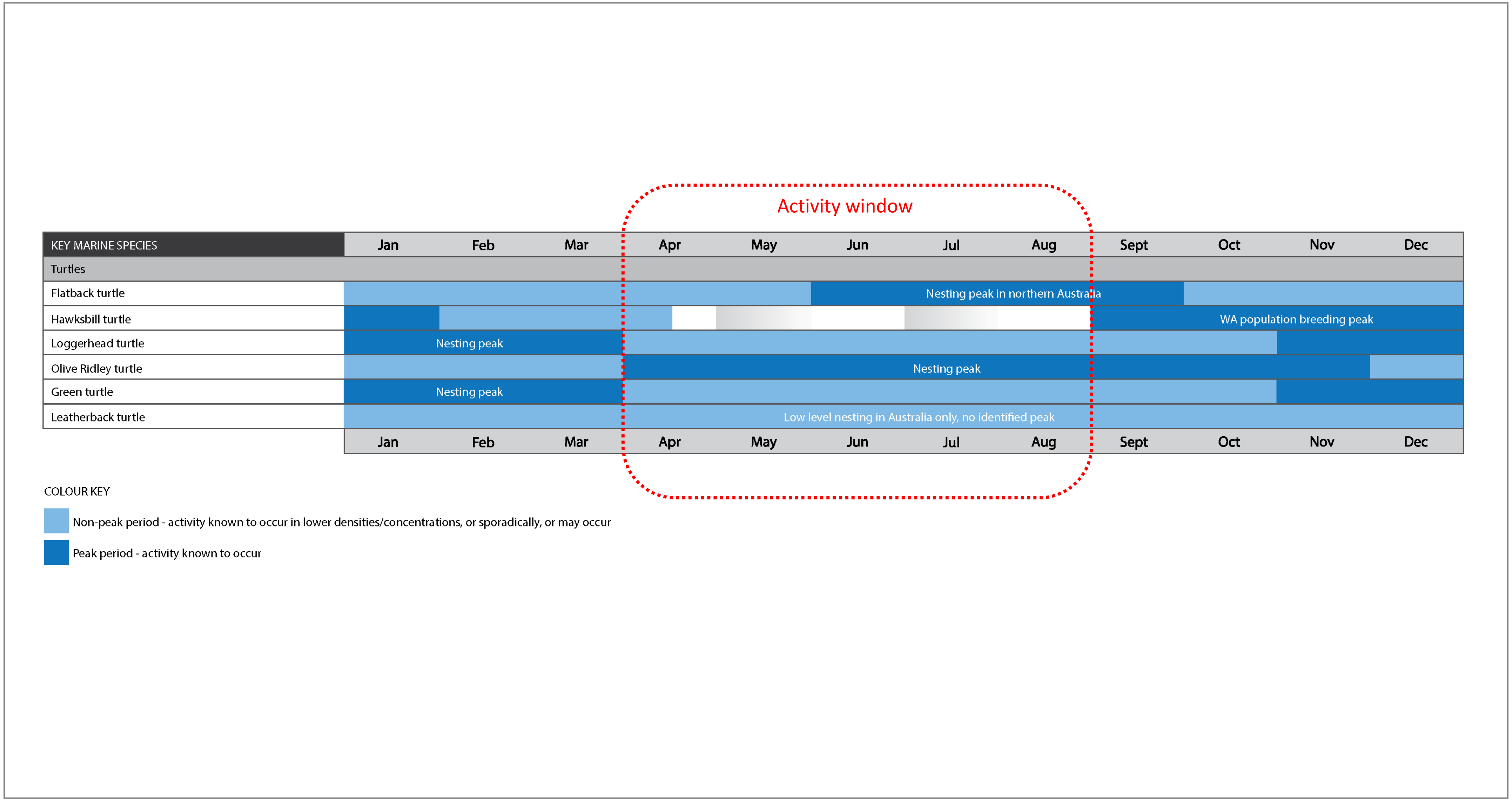


Figure 5.25. Likely temporal presence and absence of EPBC Act-listed turtle species in the activity area and EMBA

Loggerhead turtle (EPBC Act: Endangered, listed migratory)

The loggerhead turtle (*Caretta caretta*) has a global distribution throughout tropical, sub-tropical and temperate waters. In Australia, the loggerhead turtle occurs in waters of coral and rocky reefs, seagrass beds, and muddy bays throughout eastern, northern and western Australia (DAWE, 2021b).

While nesting is mainly concentrated on sub-tropical beaches in southern Queensland and from Shark Bay to the North West Cape in WA between November and March, foraging is more widespread. Loggerhead turtles show fidelity to both their foraging and breeding areas and can migrate over 2,600 km between the two (DAWE, 2021b). The WA stock forage from Shark Bay through to Arnhem Land, NT (DAWE, 2021b).

Juveniles feed on algae, pelagic crustaceans, molluscs and flotsam, whilst as an adult the species feeds on gastropod molluscs, clams, jellyfish, starfish, coral, crabs and fish (DAWE, 2021b). Loggerhead turtles are known to forage around the pinnacles of the Bonaparte Basin and the carbonate bank and terrace system of the Sahul Shelf KEFs. The foraging BIA for the loggerhead turtle is intersected by the socio-economic EMBA and is presented in Figure 5.26. Given the proximity of the foraging BIA, it is likely that loggerhead turtles are present in the activity area and EMBA.

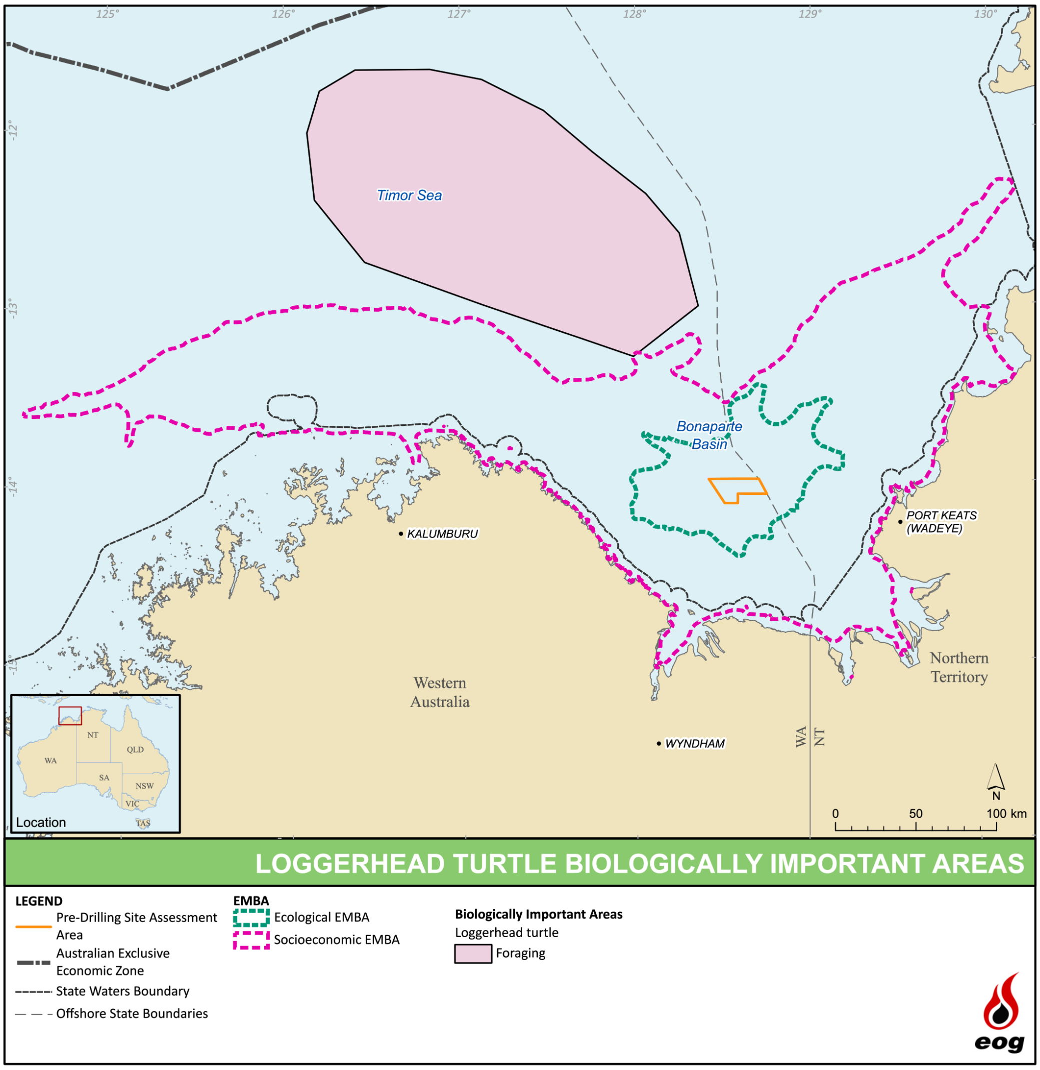


Figure 5.26. Loggerhead turtle BIA intersected by the spill EMBA

Green turtle (EPBC Act: Vulnerable, listed migratory)

Green turtles (*Chelonia mydas*) nest, forage and migrate across tropical northern Australia (DAWE, 2021b) and are commonly found foraging and nesting in the Gulf of Carpentaria (DSEWPaC, 2012). In WA, nesting is between November and March and green turtles can migrate over 2,600 km between their feeding and nesting grounds (DAWE, 2021b). The pinnacles of the Bonaparte Basin are thought to be a key ecological feature where green turtles move between foraging and nesting grounds (DSEWPaC, 2012). The species primarily forages in shallow benthic habitats (<10 m) such as tropical tidal and subtidal coral and rocky reef habitat or inshore seagrass beds, feeding on seagrass beds or algae mats (Hazel *et al*., 2009; DAWE, 2021b). Large feeding aggregations of green turtles are present at Ashmore Reef (located outside the EMBA) and is the only reef recorded on the Sahul Shelf, where such large numbers of green turtles gather to feed.

The NCVA identifies that the activity area and EMBA overlap with a foraging BIA for this species (Figure 5.27). As such, green turtles are likely to occur in the activity area and EMBA. The closest nesting and interesting BIAs are located 286 km west of the activity area and are not intersected by the EMBA. Within foraging areas, adult green turtles feed on seagrass, sponges and algae (DAWE, 2021b).

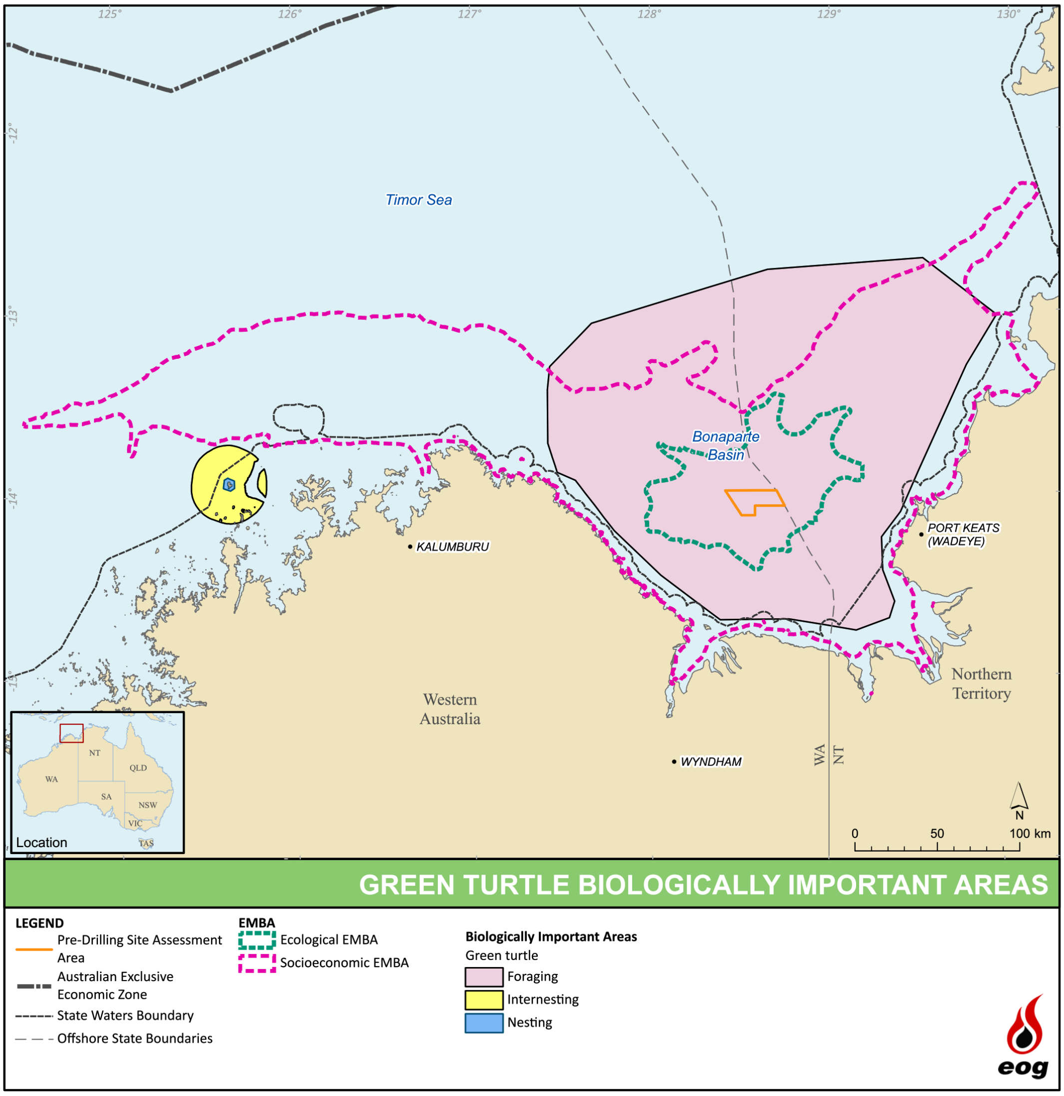


Figure 5.27. Green turtle BIA intersected by the activity area and spill EMBA

Flatback turtle (EPBC Act: Vulnerable, listed migratory)

The flatback turtle (*Natador depressus*) is only found in Australian waters and some nearby waters in Indonesia and Papua New Guinea. It is commonly found in the NWMR and NMR, nesting in northern Australia and foraging in the region.

Breeding occurs all year round; however, in northern Australia most nesting occurs between June and August (DAWE, 2021b). Flatback turtle nesting is widespread across the islands and mainland beaches east of Dampier Peninsula in winter, with Cape Domett reported to support the highest density (Whiting *et al*., 2008). Flatback turtles nest at Cape Domett throughout the year. The Recovery Plan for Marine Turtles in Australia 2017 -2027 (DoEE, 2017c) notes that the peak nesting period at Cape Domett is July to September. The Cape Domett nesting population appears to be one of the largest known nesting populations of this species, with an estimated yearly population in the order of several thousand turtles (Whiting *et al*., 2008).

The 60 km inter-nesting buffer for flatback turtles in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) is based primarily on the movements of tagged inter-nesting flatback turtles along the Northwest Shelf reported by Whittock et al (2014), which found that flatback turtles may demonstrate inter-nesting displacement distances up to 62 km from nesting beaches. However, these movements were confined to longshore movements in nearshore coastal waters or travel between island rookeries and the adjacent mainland (Whittock *et al*., 2014). There is no evidence to date to indicate flatback turtles swim out into deep offshore waters during the inter-nesting period. Flatback turtle hatchlings do not have an offshore pelagic phase. Instead, hatchlings grow to maturity in shallow coastal waters thought to be close to their natal beaches (DoEE, 2017c). Flatback turtle hatchlings do not undertake oceanic migrations like the juveniles of other turtle species do, but spend their juvenile life phase within continental shelf waters. The activity area and EMBA intersects an inter-nesting BIA, as illustrated in Figure 5.28.

Adult flatback turtles are primarily carnivorous, feeding on soft-bodied invertebrates. Juveniles eat gastropod molluscs, squid, siphonophores, and limited data indicate that cuttlefish, hydroids, soft corals, crinoids, molluscs and jellyfish are also eaten (DAWE, 2021b). The species has been recorded foraging in depths less than 10 m to over 40 m on the carbonate bank and terrace system of the Sahul Shelf KEF and around the pinnacles of the Bonaparte Basin KEF. The EMBA intersects a foraging BIA located in the Bonaparte Basin, as illustrated in Figure 5.28.

The NCVA identifies the area out to 60 km offshore from Cape Domett and Lacrosse Island in the Cambridge Gulf as an inter-nesting BIA for flatback turtles, which is intersected by the EMBA and part of the activity area. Hence, it is likely that flatback turtles will be present in the activity area and EMBA.

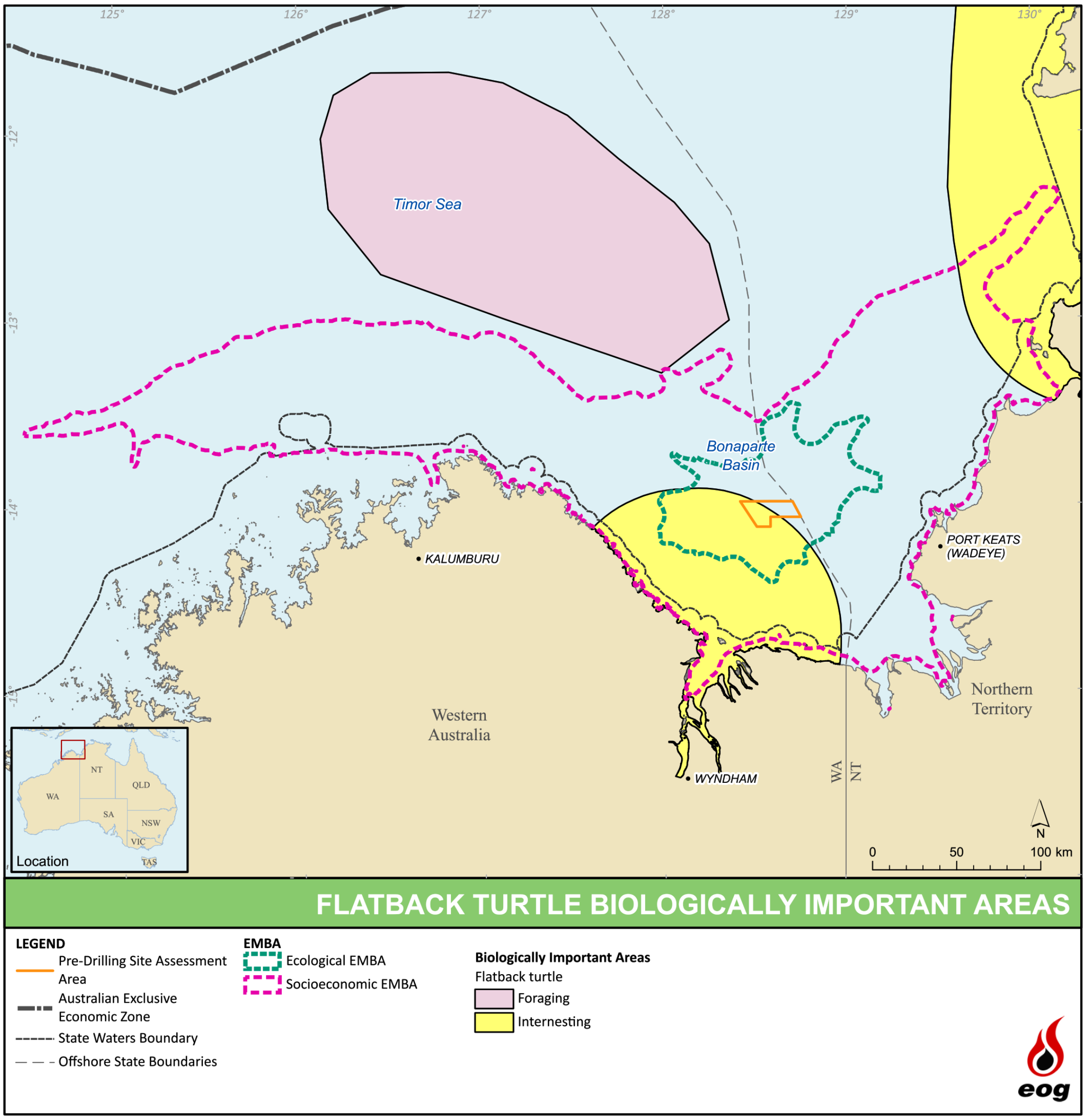


Figure 5.28. Flatback turtle BIA intersected by the activity area and spill EMBA

Olive Ridley turtle (EPBC Act: Endangered, listed migratory)

The olive ridley turtle (*Lepidochelys olivacea*) has a worldwide tropical and sub-tropical distribution and is known to occur in both WA and the NT (DSEWPC, 2012c). While nesting has been recorded in WA, it is far more common in the NT (DSEWPC, 2012).

Although olive ridley turtles nest all year round, nesting activity peaks around April to November, with the majority of nesting occurring from the Arnhem Land coast (including Bathurst Island, outside the EMBA) to the northwest coast of Cape York Peninsula (outside of the EMBA) (DSEWPC, 2012). After nesting, Olive Ridley turtles are known to migrate up to 1,050 km to various foraging areas (DAWE, 2021b), including the pinnacles of the Bonaparte Basin and the carbonate bank and terrace system of the Sahul Shelf KEF (DSEWPC, 2012).

The olive ridley turtle is known to primarily forage in soft-bottom habitats ranging in depths from 6 – 35 m, though they are also known to forage in pelagic waters (DEWHA 2008a). Adult turtles forage for crabs, shrimp, tunicates, jellyfish, salps and algae in depths ranging from several metres to over 100 m (DAWE, 2021b). The NCVA identifies that the activity area and EMBA overlap with a foraging BIA for this species (Figure 5.29); hence it is possible that individuals could be encountered in the activity area or EMBA, though nesting is unlikely to occur in the coastal sections of the EMBA.

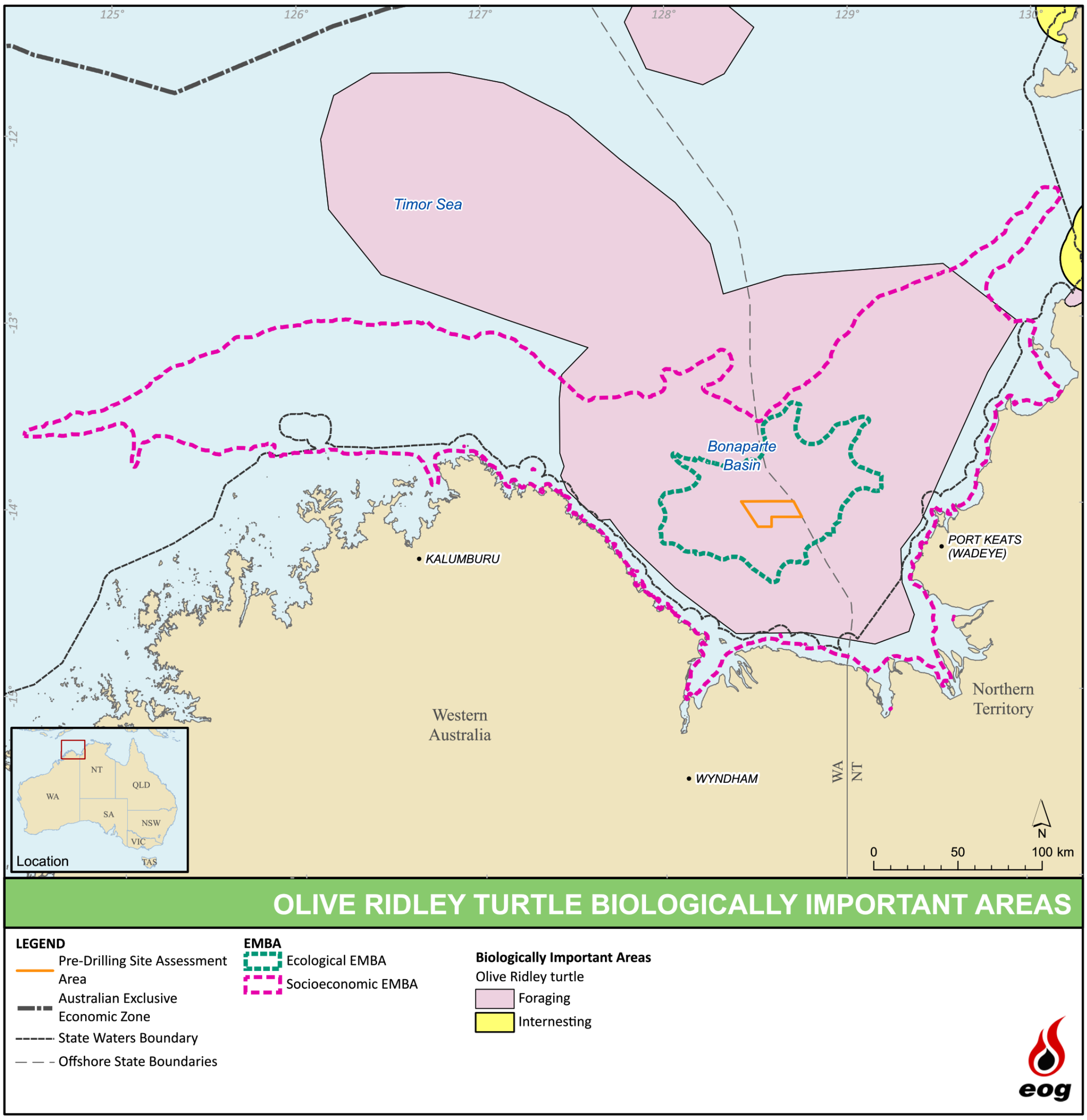


Figure 5.29. Olive Ridley turtle BIA intersected by the activity area and spill EMBA

Hawksbill turtle (EPBC Act: Vulnerable, listed migratory)

Hawksbill turtles (*Eretmochelys imbricate*) are found in tropical, sub-tropical and temperate waters in all the oceans of the world (DoEE, 2019e). The hawksbill turtle is commonly found in the NWMR and NMR, nesting extensively along the coasts and foraging in the region.

As a juvenile, the hawksbill turtle feeds on plankton in the open ocean and then feeds on sponges, hydroids, cephalopods, gastropods, jellyfish, seagrass and algae as an adult (DAWE, 2021b). The species is also highly migratory, moving up to 2,400 km between foraging and breeding areas (DSEWPC, 2012). Due to genetic variability, Australia's population is considered to comprise of two distinct stocks; one in WA and the other in the northeast of Australia (DSEWPC, 2012). These distinct populations are also known to have significantly different breeding seasons.

Hawksbill turtles forage in waters ranging from 1.5 m to 84 m deep, and Fossette et al (2021) report that 17% of satellite tagged turtles (total n=42) foraged in waters greater than 20 m. Fossette et al (2021) reported less than a quarter of foraging area overlapped with designated foraging BIAs for hawksbill turtles (none of which are intersected by the activity area or EMBA) and/or Commonwealth and State-managed protected areas.

The northeast sub-population breeds throughout the year with a peak nesting period during July to October (DSEWPaC, 2012), while in the WA population breeding peaks around October to January. There are no BIAs for the species located within the activity area or spill EMBA. The species may be encountered in the activity area and EMBA as transient individuals.

Leatherback turtle (EPBC Act; Endangered, listed migratory)

The leatherback turtle (*Dermochelys coriacea*) is a pelagic feeder found in tropical, sub-tropical, and temperate waters throughout the world. Whilst it is less abundant off the northern Australian continental shelf, it is occasionally sighted in the Gulf of Carpentaria and near the Cobourg Peninsula (460 km northeast of the activity area and outside the EMBA) (DSEWPaC, 2012).

No major nesting has been recorded in Australia, with isolated nesting recorded in Queensland and the NT (DSEWPaC, 2012). The closest confirmed inter-nesting site for the leatherback turtle is at Cobourg Peninsula (outside the EMBA) (DAWE, 2021b).

Leatherback turtles forage on pelagic soft bodied creatures (such as jellyfish, squid, salps, siphonophores and tunicates) all year round in Australian waters (DAWE, 2021b). The species may be present in the activity area and EMBA, though is unlikely to nest within the coastal areas of the EMBA.

Short-nosed seasnake (EPBC Act: Critically Endangered)

The short-nosed seasnake (*Aipysurus apraefrontalis*) is endemic to WA and occurs throughout the Northwest Shelf and eastern Indian Ocean. This fully aquatic species can grow up to 90 cm in length and prefers shallow coastal reef habitats.

Given the shallow water distribution of the species it is unlikely the species will occur within the activity area, however the species and species habitat may occur in the spill EMBA. Cartier Island and Ashmore Reef are internationally significant sites for their abundance and diversity of seasnakes, both of which are located outside the EMBA.

Leaf-scaled seasnake (EPBC Act: Critically Endangered)

The only known populations of the leaf-scaled seasnake (*Aipysurus foliosquama*) species inhabit the shallow reef habitats of the Sahul Shelf and Ashmore Reef (Minton and Heatwole, 1975), which are both located outside the activity area and EMBA.

Given the shallow water distribution, it is unlikely the species will occur within the activity area, but the species and species habitat is known to occur in the EMBA.

Saltwater crocodile (EPBC Act: Listed migratory)

The saltwater crocodile (*Crocodylus porosus*) is distributed from King Sound, WA throughout coastal NT to Rockhampton in Queensland, where it can be found in coastal waters, estuaries, lakes, inland swamps and marshes up to 150 km inland from the coast (DAWE, 2021b).

Preferred nesting habitat of the saltwater crocodile includes elevated, isolated freshwater swamps that do not experience the influence of tidal movements. Floating rafts of vegetation also provide important nesting habitat. In the NT, most nest sites are found on the north-west banks of rivers (DAWE, 2021b). The species nest during the wet season with peak nesting during January and February. Whilst sightings of saltwater crocodiles far out to sea have been recorded, it is more likely to be encountered in the coastal areas of the socio-economic EMBA than in the activity area.

5.3.7. Avifauna

There are 36 bird species (13 seabirds and 23 shorebirds) listed under the EPBC Act with potential to occur in the spill EMBA (Table 5.9) (DAWE, 2021a). The majority of these are listed as migratory and marine species, with four listed as critically endangered, five as endangered and three as vulnerable. The PMST results includes terrestrial species of birds that are protected under the EPBC Act. Figure 5.30 illustrates the likely temporal presence and absence and ecological stages of these bird species in the activity area and EMBA. The species listed as threatened or with a BIA intersected by the activity area or EMBA are described in this section.

Many of the birds listed in Table 5.9 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 5.4.4).

Table 5.9. EPBC Act-listed bird species that may occur in the activity area and EMBA

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Seabirds										
Anous stolidus	Common noddy	-	Yes	Yes	✓	✓	✓	No	No	-
Anous tenuirostris melanops	Australian lesser noddy	V	-	Yes	-	-	✓	No	No	CA
Calonectris leucomelas	Streaked shearwater	-	Yes	Yes	✓	✓	✓	No	No	-
Fregata ariel	Lesser frigatebird	-	Yes	Yes	✓	✓	✓	No	No	-
Fregata minor	Greater frigatebird	-	Yes	Yes	✓	✓	✓	No	No	-
Haliaeetus leucogaster	White-bellied sea-eagle	-	-	Yes	-	-	✓	No	No	-
Onychoprion anaethetus	Bridled tern	-	Yes	Yes	-	-	✓	No	No	-
Pandion haliaetus	Osprey	-	Yes	Yes	✓	✓	✓	No	No	-
Papasula abbotti	Abbott's booby	E	-	Yes	-	-	✓	No	No	CA
Sterna bengalensis	Lesser crested tern	-	-	Yes	-	-	✓	No	Yes	-
Sterna dougallii	Roseate tern	-	Yes	Yes	-	-	✓	No	No	-
Sternula albifrons	Little tern	-	Yes	Yes	-	-	✓	No	No	-
Sula leucogaster	Brown booby	-	Yes	Yes	-	-	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Shorebirds										
Actitis hypoleucos	Common sandpiper	-	Yes	Yes	✓	✓	✓	No	No	-
Apus pacificus	Fork-tailed swift	-	Yes	Yes	-	-	✓	No	No	-
Arenaria interpres	Ruddy turnstone	-	Yes	Yes	-	-	✓	No	No	-
Calidris acuminata	Sharp-tailed sandpiper	-	Yes	Yes	✓	✓	✓	No	No	-
Calidris alba	Sanderling	-	Yes	Yes	-	-	✓	No	No	-
Calidris canutus	Red knot	E	Yes	Yes	✓	✓	✓	No	No	CA
Calidris ferruginea	Curlew sandpiper	CE	Yes	Yes	✓	✓	✓	No	No	CA
Calidris melanotos	Pectoral sandpiper	-	Yes	Yes	✓	✓	✓	No	No	-
Calidris tenuirostris	Great knot	CE	Yes	Yes	-	-	✓	No	No	CA
Charadrius leschenaultia	Greater sand plover	V	Yes	Yes	-	-	✓	No	No	CA
Charadrius mongolus	Lesser sand plover	E	Yes	Yes	-	-	✓	No	No	CA
Charadrius veredus	Oriental plover	-	Yes	Yes	-	-	✓	No	No	-
Larus novaehollandiae	Silver gull	-	-	Yes	-	-	✓	No	No	-

Scientific name	Common name	EPBC Act Status			Presence			BIA intersected by activity area?	BIA intersected by ecological EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine	Activity area	Ecological EMBA	Socio-economic EMBA			
Limnodromus semipalmatus	Asian dowitcher	-	Yes	Yes	-	-	✓	No	No	-
Limosa lapponica	Bar-tailed godwit	-	Yes	Yes	-	-	✓	No	No	-
Limosa lapponica baueri	Nunivak bar-tailed godwit	V	-	-	-	-	✓	No	No	CA
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	CE	-	-	-	-	✓	No	No	CA
Limosa limosa	Black-tailed godwit	-	Yes	Yes	-	-	✓	No	No	-
Numenius madagascariensis	Eastern curlew	CE	Yes	Yes	✓	✓	✓	No	No	CA
Numenius phaeopus	Whimbrel	-	Yes	Yes	-	-	✓	No	No	-
Pluvialis squatarola	Grey plover	-	Yes	Yes	-	-	✓	No	No	-
Rostratula australis	Australian painted snipe	E	-	Yes	-	-	✓	No	No	CA
Rostratula benghalensis (sensu lato)	Painted snipe	E	-	Yes	-	-	✓	No	No	CA

Same key as per Table 5.6.

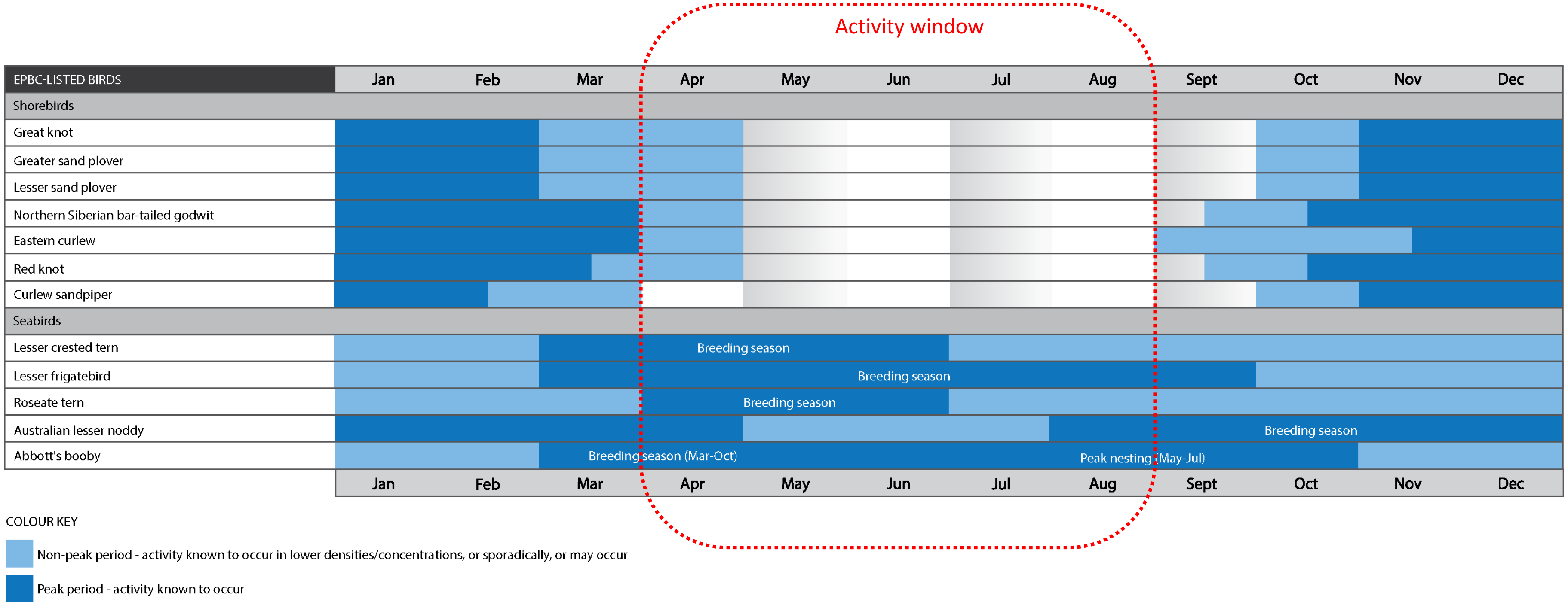


Figure 5.30. Likely temporal presence and absence of EPBC Act-listed seabird species in the activity area and EMBA

Seabirds

Roseate tern (EPBC Act: Listed Migratory)

The roseate tern (*Sterna dougallii*) occurs throughout various coastal habitats including beaches, reefs and sandy/coral islands. It is a specialist forager for small pelagic fish (DAWE, 2021b). The terns prefer nesting sites adjacent to clear shallow hunting areas. Nests are generally a bare scrape in sand, shingle or coral rubble. The species breeds in large mixed-species colonies from April to June, with breeding populations located around Ashmore Reef, Cartier Island and Scott Reef (none of which are located in the EMBA) (DEWHA, 2008). Little information is available about migratory movements or timing through the northwest of Australia.

A breeding BIA for the species is intersected by the EMBA at coastal islands off the north Kimberley coast (Figure 5.31). Foraging, feeding or related behaviours are likely to occur within the offshore and coastal areas of the EMBA but unlikely in the activity area due to its distance from the nearest breeding BIA (166 km west from the activity area). Therefore, the species is unlikely to be present in the activity area and likely to be present in the western extent of the EMBA.

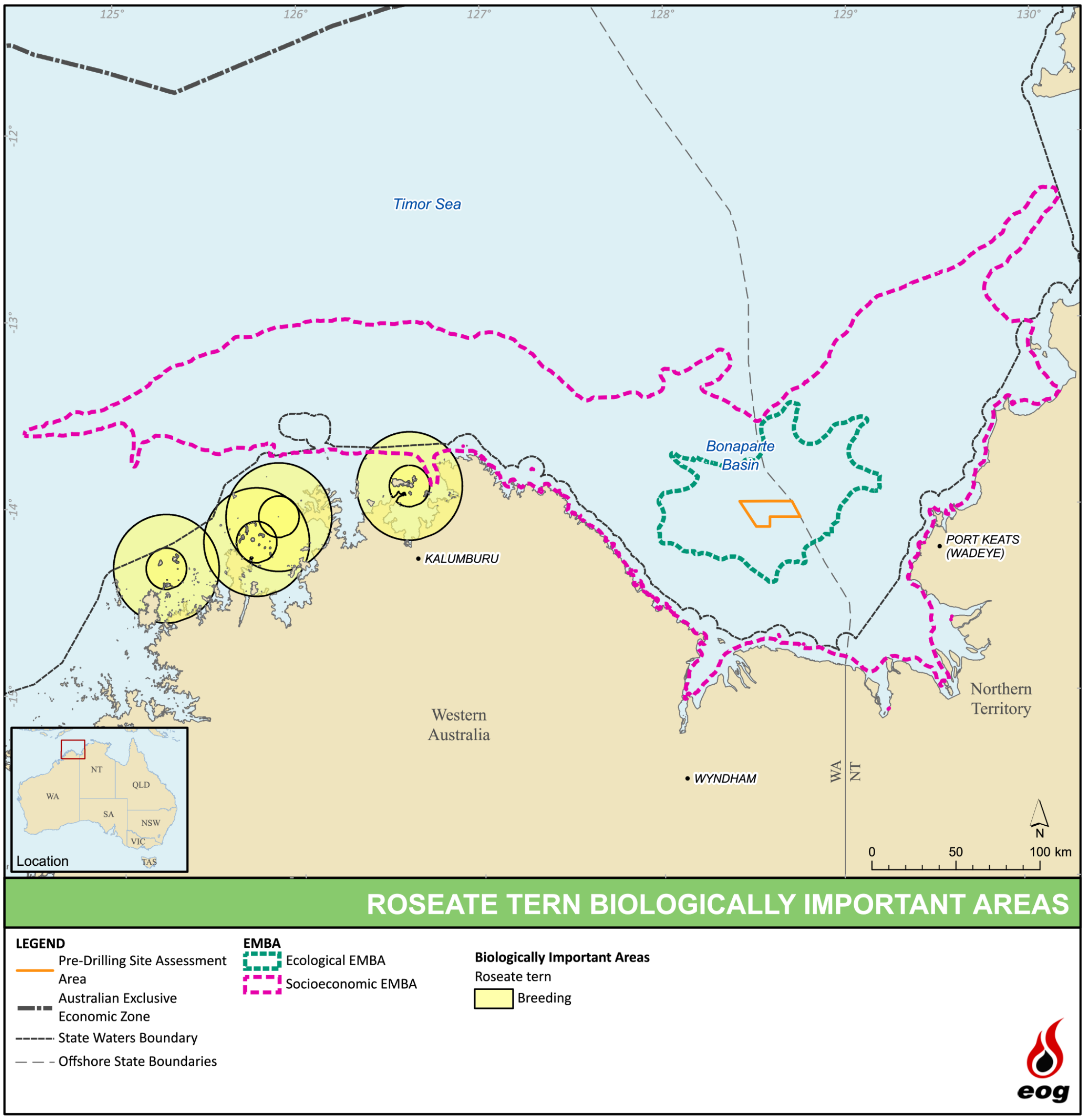


Figure 5.31. Roseate tern BIA intersected by the spill EMBA

Lesser frigatebird (EPBC Act: Listed Migratory)

Lesser frigatebirds (*Fregata ariel*) are usually observed in tropical waters around the coast of northern WA, NT, Queensland and NSW (DSEWPC, 2012d). They are often found foraging far offshore, especially during the non-breeding season where some large movements have been recorded (DSEWPC, 2012). During the breeding season (March - September), the lesser frigatebird's range remains close to the breeding colonies (DSEWPC, 2012).

The EMBA overlaps a breeding BIA for this species but the activity area does not (Figure 5.32). Hence, this species is unlikely to be in the activity area due to its distance from the breeding BIA (172 km west of the activity area) and may be present within the EMBA.

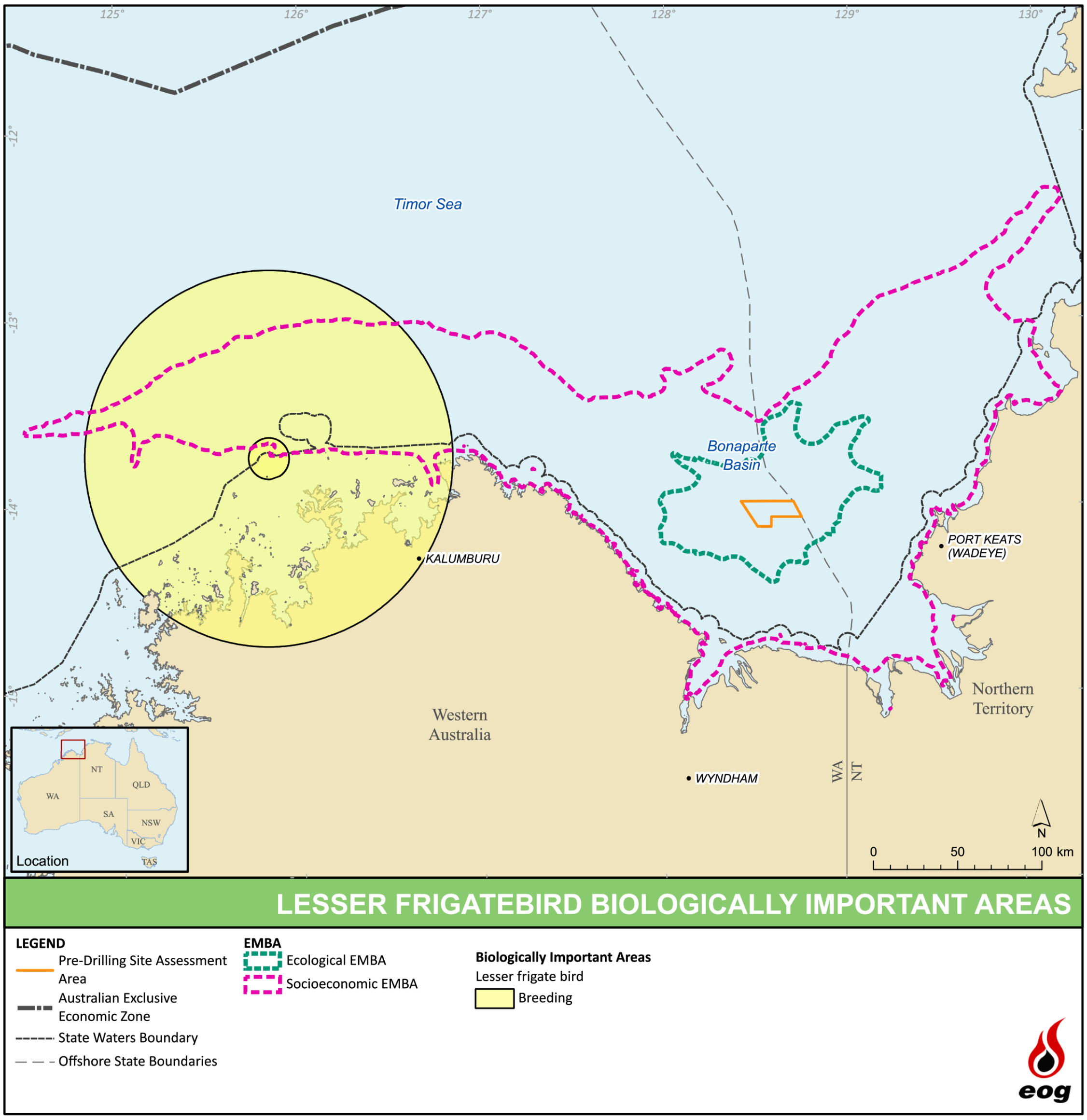


Figure 5.32. Lesser frigatebird BIA intersected by the spill EMBA

Lesser crested tern (EPBC Act: Listed Migratory)

The lesser crested tern (*Sterna bengalensis*) inhabits tropical and sub-tropical sandy and coral coasts and estuaries (DSEWPC 2012). In Australia, lesser crested terns are found on coasts and in coastal waters, primarily in northern Australia. The species occurs around most of the NT, with the highest density of confirmed sightings along the coast to the south-west of Darwin (DSEWPC 2012).

The species breeds on low-lying islands, coral flats, sandbanks and flat sandy beaches, and may move nesting sites from one year to the next (DSEWPC 2012). Lesser crested terns forage for small pelagic fish and shrimp in the surf and over offshore waters in areas of reef and deeper shelf waters (DSEWPC 2012). The spill EMBA partially overlaps with a lesser crested tern breeding BIA (Figure 5.33). There is no overlap between the activity area and the lesser crested tern breeding BIA.

Given these breeding areas are 44 km west from the activity area, there is a low likelihood of this species occurring in the activity area. Given the location of breeding grounds within the spill EMBA, this species is likely to be present in the spill EMBA.

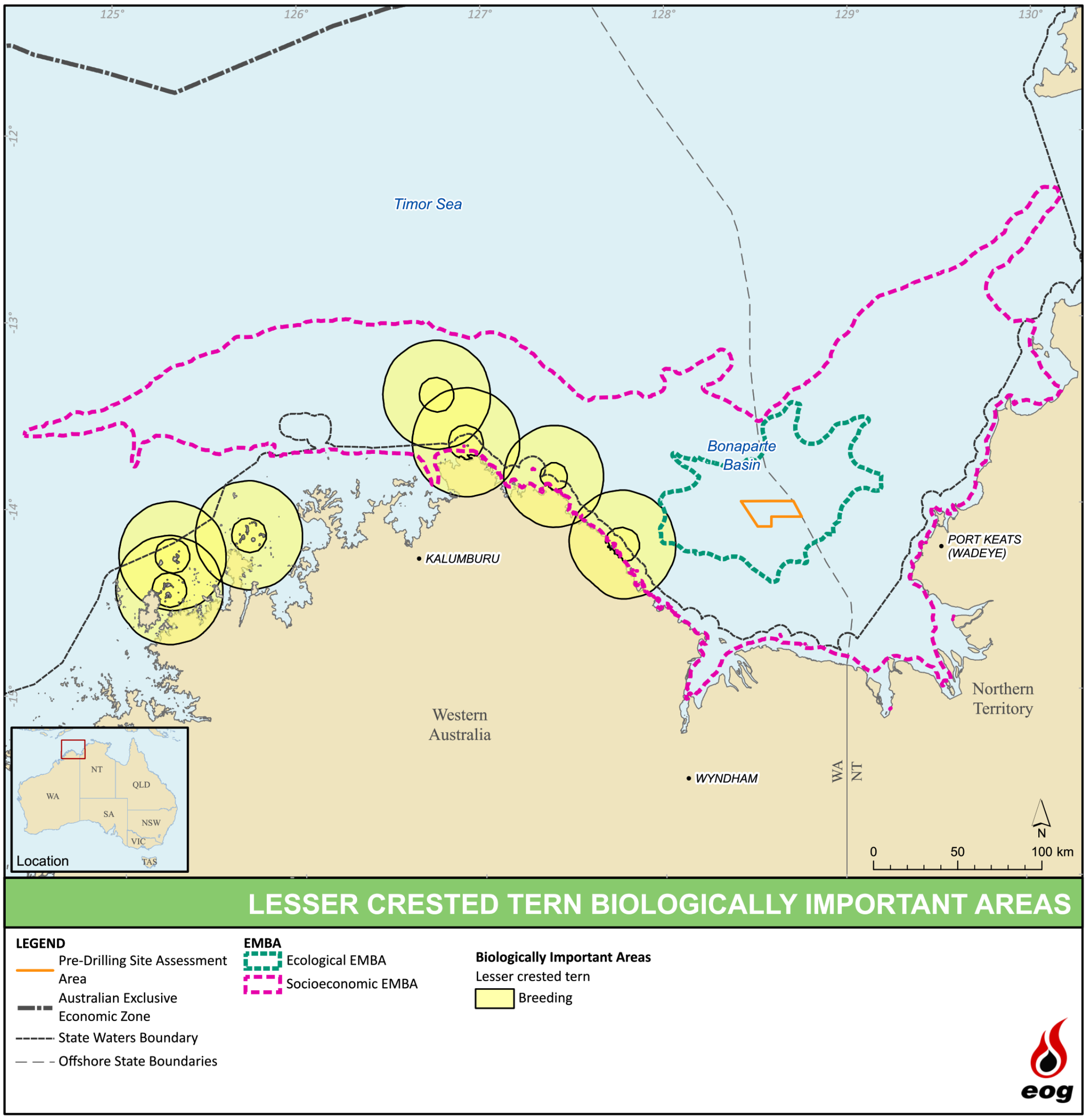


Figure 5.33. Lesser crested tern BIA intersected by the spill EMBA

Australian lesser noddy (EPBC Act: Vulnerable)

The Australian lesser noddy (*Anous tenuirostris melanops*) is endemic to Australia and nests on the Abrolhos Islands, Ashmore Reef and various other islands throughout tropical and sub-tropical northwest Australia (DAWE, 2021b). They may forage out to sea or close inshore to breeding islands, including outside fringing reefs, feeding on small squid and fish (DoEH, 2005). They roost mainly in mangroves, and sometimes rest on the beaches (DoEH, 2005).

The Australian lesser noddy is not predicted to occur in the activity area but may occur within the coastal areas of the EMBA.

Abbott's booby (EPBC Act: Endangered)

Abbott's booby (*Papasula abbotti*) spend much of their time at sea, but need to come ashore to breed (DAWE, 2021b). It is currently known to only breed on Christmas Island (outside the EMBA) during the months of March to October, with peak nesting May-July (DAWE, 2021b). The species nests in tall rainforest trees, laying a single egg clutch (DAWE, 2021b). Birds are known to travel up to 400 km from nesting locations to forage for fish and squid (DAWE, 2021b).

The species is not predicted to occur in the activity area but may occur in the EMBA.

Shorebirds

Curlew sandpiper (EPBC Act: Critically Endangered, Listed Migratory)

In Australia, the curlew sandpiper (*Calidris ferruginea*) occurs around the coasts and is also quite widespread inland, though in smaller numbers (DAWE, 2021b). They are rarely recorded in the northwest Kimberley, around Wyndham and Lake Argyle (DAWE, 2021b).

This species is unlikely to be present in the activity area due to its location offshore but given that the EMBA is adjacent to (without intersecting) critical habitat for this species (e.g., wetlands), it is possible that this species would be present in the coastal sections of the EMBA during the summer months.

Lesser sand plover (EPBC Act: Endangered, Listed Migratory)

The lesser sand plover (*Charadrius mongolus*) spends non-breeding periods in Australia. The species is widespread in coastal regions and has been recorded in all states within Australia but mainly occurs in northern and eastern Australia (DAWE, 2021b).

The species feeds mostly on extensive, freshly-exposed areas of intertidal sandflats and mudflats in estuaries or beaches, or in shallow ponds in saltworks (DAWE, 2021b). They also occasionally forage on coral reefs and on sandy or muddy river margins (DAWE, 2021b). The lesser sand plover roost near foraging areas, on beaches, banks and spits, banks of sand and shells, and occasionally on rocky spits, isles or reefs (DAWE, 2021b).

This species is not predicted to occur in the activity area due to its distance from shore but may occur within the coastal areas of the EMBA and in the Cambridge Gulf.

Eastern curlew (EPBC Act: Critically Endangered, Listed Migratory)

The eastern curlew (*Numenius madagascariensis*) has a primarily coastal distribution within Australia (DotE, 2015c). It does not breed in Australia and is found foraging on soft sheltered intertidal sandflats or mudflats, open and without vegetation or covered with seagrass, often near mangroves, on saltflats and in saltmarsh, rockpools and among rubble on coral reefs, and on ocean beaches near the tideline (DoE, 2015b).

This species is unlikely to be present in the activity area due to its location offshore but given that the EMBA is adjacent to (without overlapping) critical habitat for this species (e.g., wetlands), it is possible that this species occurs in the EMBA during the summer.

Nunivak bar-tailed godwit (EPBC Act: Vulnerable)

The Nunivak bar-tailed godwit (*Limosa lapponica baueri*) is a large wader recorded in coastal areas of all states and territories of Australia (DAWE, 2021b). The species is found in coastal habitats such as large intertidal sand and mudflats, banks, estuaries, harbours, bays and coastal lagoons where it forages when the tide is out (DAWE, 2021b). Their diet consists of worms, molluscs, crustaceans, insects and some plant material (DAWE, 2021b). This species breeds in the northern hemisphere and migrates south for the winter, arriving in northwest Australia from August and departs before the end of April (DAWE, 2021b).

This species is not predicted to occur in the activity area due to its offshore location but may be present in the coastal sections of the EMBA between August and April.

Northern Siberian bar-tailed godwit (EPBC Act: Critically Endangered)

The northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri*) is a large migratory shorebird (TSSC, 2016). The northern Siberian bar-tailed godwit spends non-breeding periods in Australia and is found in all Australian states and territories (TSSC, 2016). Populations have been recorded in northern Australia, from Darwin east to the Gulf of Carpentaria. The species forages near the edge of water or in shallow water, mainly on muddy coastlines, estuaries, inlets and mangroves feeding on worms, molluscs, crustacean, insects and plant material (TSSC, 2016).

It is unlikely that this species would be present in the activity area due to its offshore location but this species may be present within the coastal sections of the EMBA.

Great knot (EPBC Act: Critically Endangered, Listed Migratory)

The great knot (*Calidris tenuirostris*) has been recorded around the entire Australian coast and spends non-breeding periods in Australia (DAWE, 2021b). The greatest numbers of this species are found in northern Australia, and most commonly on the coast of the Pilbara and Kimberley, from the Dampier Archipelago to the NT border, and in the NT from Darwin and Melville Island, through Arnhem Land to the southeast Gulf of Carpentaria (DAWE, 2021b). This species typically prefers sheltered coastal habitats with large intertidal mudflats or sandflats (DAWE, 2021b). The great knot feeds on snails, worms and crustaceans, and forages on intertidal mudflats, estuaries, and in mangroves.

This species is not predicted to be encountered in the activity area due to its habitat preferences, although it is expected in parts of the coastal areas of the EMBA where its preferred habitat is available.

Red knot (EPBC Act: Endangered, Listed Migratory)

The red knot (*Calidris canutus*) is common in all the main suitable habitats around the coast of Australia (DAWE, 2021b), and very large numbers are regularly recorded in northwest Australia, with Eighty Mile Beach and Roebuck Bay being particular strongholds (both outside the EMBA). In WA, it is widespread on the coast from Ningaloo Reef and Barrow Island to the southwest Kimberley coastline. In the NT it is mainly recorded in Darwin.

The red knot is not predicted to occur within the activity area due to its habitat preferences, but is likely to be present in parts of the coastal areas of the EMBA.

Australian painted snipe (EPBC Act: Endangered)

The Australian painted snipe (*Rostratula australis*) is a wader and is found in wetlands throughout all Australian states and territories (DAWE, 2021b). The species generally inhabits freshwater wetlands, although can inhabit brackish water, saltmarshes and claypans (DAWE, 2021b). It feeds on vegetation, seeds, insects, worms, molluscs, crustaceans and other invertebrates (DAWE, 2021b). The Australian painted-snipe is not predicted to occur within the activity area, but is likely to be present in the EMBA.

Greater sand plover (EPBC Act: Vulnerable, Listed Migratory)

The greater sand plover (*Charadrius leschenaultia*) occurs in coastal areas throughout Australia with the greatest populations between the NW Cape and Roebuck Bay (DAWE, 2021b) (both outside the EMBA). The plover spends almost all its time in coastal habitats. Their diet consists mainly of molluscs, worms, crustaceans and insects (DAWE, 2021b). The species breeds in the northern hemisphere and migrates south for the boreal winter (DAWE, 2021b). The greater sand plover is one of the first migratory waders to return to northwest Australia, usually arriving in late July and departing in mid to late April (DAWE, 2021b).

The species is not predicted to occur in the activity area due to its habitat preferences, but may occur within the coastal areas of the EMBA from July to April.

5.3.8. 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).

The Marine Pests Interactive Map (DAFF, 2021) indicates that the major port likely to be used to support the activity (e.g., Darwin) is not known to harbour any marine pests. However, Department of Agriculture, Fisheries and Forestry (DAFF) (2021) notes that the following species are listed to keep watch for in the Port of Darwin due to their high potential for accidental introduction:

- Asian green mussel (*Perna viridis*) – typically inhabits soft sediment bottoms from the low tide mark to shallow waters up to 42 m deep. Juveniles are bright green than turn brown in adults.
- American slipper limpet (*Crepidula fornicate*) – competes with native species for food and space and may alter sediment characteristics by removing suspended sediments from the water column. Its likely habitat includes mud, rocks and sand within shores and shall waters.
- Black striped false mussel (*Mytilopsis sallei*) – affects the productivity of commercial fisheries and aquaculture by competing with native species for food and space. The species usually inhabits shallow waters up to a few metres deep.
- Charru mussel (*Mytella charruana*) – successful invasive species globally due to its great dispersal ability and tolerance for a wide variety of habitats. Typically found on rocky or hard substrates in shallow waters.

5.4. Conservation Values and Sensitivities

The conservation values and sensitivities within the EMBA are described in this section, with Table 5.10 providing an outline of the conservation categories described.

Table 5.10. Conservation values in the EMBA

Category	Conservation classification	Section
MNES under the EPBC Act	Australian Marine Parks (AMP)	Section 5.4.1
	World Heritage-listed properties	Section 5.4.2
	National Heritage-listed places	Section 5.4.3
	Wetlands of international importance	Section 5.4.4
	Nationally threatened species and threatened ecological communities	Throughout Section 5.3 and Section 5.4.5
	Migratory species	Throughout Section 5.3
	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 5.4.6
	Key Ecological Features (KEF)	Section 5.4.7
	Nationally important wetlands (NIW)	Section 5.4.8
State protected areas	State/territory protected areas	Section 5.4.9

5.4.1. Australian Marine Parks

The activity area does not intersect any AMPs. The closest AMPs to the activity area that are intersected by the EMBA are the JBG AMP (located 30 km south of the activity area) and the Kimberley AMP (located 219 km west of the activity area), described herein. AMPs in the EMBA are illustrated in Figure 5.34.

Joseph Bonaparte Gulf AMP

The JBG AMP covers an area of 8,597 km^2 and water depths within the AMP range from less than 15 m to 75 m (Galaiduk *et al*., 2018). The JBG AMP is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Transition provincial bioregion and the Oceanic Shoals meso-scale bioregion (Galaiduk *et al*., 2018). The AMP contains a number of prominent shallow seafloor features including an emergent reef system, shoals and sand banks (Galaiduk *et al*., 2018). It also includes one key ecological feature, the Carbonate Bank and Terrace System of the Sahul Shelf, which is valued as a unique seafloor feature with ecological properties of regional significance (AMP, 2019a). The Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija and Balangarra people have responsibilities for sea country in this AMP (DNP, 2018a).

Kimberley AMP

The Kimberley AMP is located approximately 100 km north of Broome, WA and the central part of the Kimberley AMP is adjacent to the WA Camden Sound State Marine Park. It covers 74,469 km^2, with depths from less than 15 m to 800 m.

The Kimberley AMP is characterised by:

- High numbers of marine mammals such as dolphins, whales and dugong. The humpback whale breeds and calves in the Kimberley AMP annually after undertaking an extensive migration from Antarctica. Three dolphin species (Australian snubfin dolphin, Australian humpback dolphin and spotted bottlenose dolphin) use the Kimberley AMP to forage within and travel to coastal waters to calve and raise their young in inshore, protected waters.
- Important foraging rounds for seabirds and shorebirds known to breed on Adele Island (outside of the EMBA), including critically endangered eastern curlews and curlew sandpipers.
- Sea country within the AMP is valued for Indigenous cultural identity, health and wellbeing.
- Tourism, commercial fishing, mining, recreation (including fishing) and traditional use are important activities in the AMP.

There are no KEFs within the Kimberley AMP.

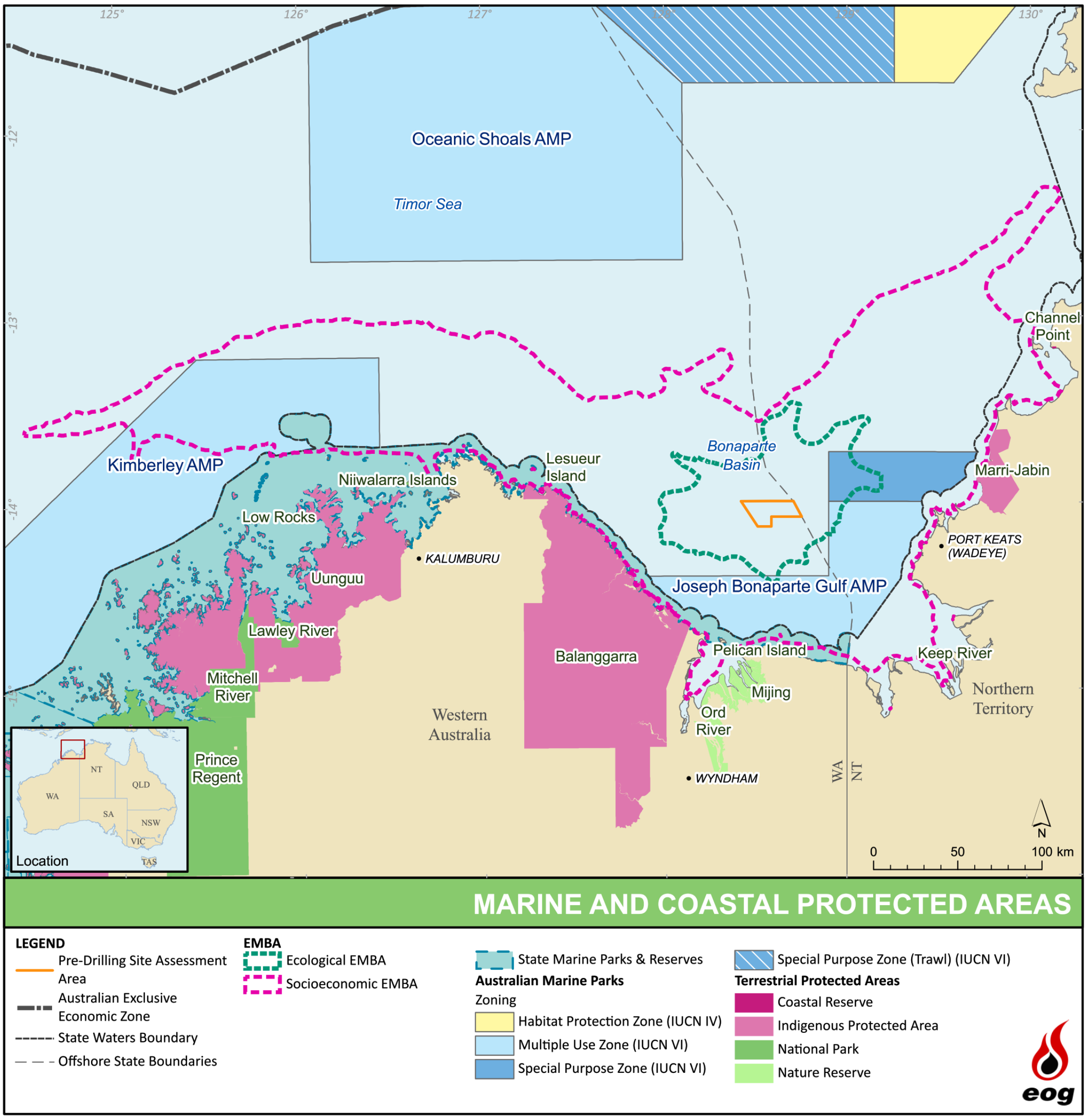


Figure 5.34. Protected areas intersected by the spill EMBA

Section 2.4 of the North Marine Parks Network Management Plan 2018 (DNP, 2018a) and Section 2.4 of the North-west Marine Parks Network Management Plan 2018 (DNP, 2018b) identify pressures relevant to the marine park networks. Pressures are defined as human-driven processes, events and activities that may detrimentally affect the values of the reserves network. Table 5.11 summarises the pressures and sources of pressure on the conservation values of the of the NMR and NWMR Reserves Network.

Table 5.11. Summary of environmental pressures in the NWMR and NMR

Pressure	Description
Climate change	Climate change impacts on marine environments are complex and interrelated and may include changes in sea temperature, sea level, ocean acidification, sea currents, increased storm frequency and intensity and species range extension or local extinction. Examples of features and species vulnerable to climate change impacts include submerged coral reefs, sawfish, sharks, dolphins, seabirds and marine turtles.
Changes in hydrology	Coastal developments and agriculture have the potential to discharge increased sediment loads and pollutants to rivers, estuaries and nearshore coastal environments. This can result in increased turbidity and siltation, which in turn impacts species that spawn or inhabit coastal, nearshore or offshore waters. Habitats and species vulnerable to changes in hydrology include seagrass meadows, reefs, sawfish, shark and dugong.
Extraction of living resources	Sustainable fishing as well as illegal or unregulated fishing can modify natural populations and disproportionately target select valuable species. Species vulnerable to extraction include shark, sawfish, turtles, seasnakes, fish and dugong.
Habitat modification	Offshore infrastructure developments can impact habitat within marine parks through physical disturbance and indirectly through the physical presence of infrastructure. Benthic habitats may be impacted by direct discharges to the seabed resulting in smothering or a reduction in the quantity of light reaching the seabed. Habitats and species vulnerable to habitat modification include reefs, shoals and pinnacle habitats, turtles, fish, seasnakes, dolphins and dugong.
Human presence	Wildlife watching, camping, boating, diving and snorkelling are drawcard activities for people to the region and have the potential to impact natural wildlife behaviour or result in damage to fragile marine environments. Habitats and species vulnerable to these impacts include reefs, turtles and seabirds.
Invasive species	Accidental introduction and establishment of invasive species can have potentially debilitating impacts on island, reef or shallow-water marine ecosystems. Direct impacts from predation or damage to important habitat and indirect impacts from competition for food resources can affect native populations. Habitats and species vulnerable to invasive species include reefs, turtles, seabirds and saltwater crocodiles.
Marine pollution	Land-based and marine activities that result in pollution have the potential to impact marine park values. Discharges of emissions including light, marine debris, noise, oil and chemicals can be detrimental to marine life and cause contamination of ecosystems and entanglement of marine fauna. Habitats and species vulnerable to marine pollution include islands, reefs, shallow-water habitats, dolphins, whales, turtles, sawfish, sharks and seabirds.

5.4.2. 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, 2021d). In Australia, these properties are protected under Chapter 5, Part 15 of the EPBC Act.

There are no World Heritage Properties within or adjacent to the activity area or the EMBA. The closest World Heritage Property is Kakadu National Park (onshore), which is located over 400 km northeast of the activity area.

5.4.3. 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, 2021e). These places are protected under Chapter 5, Part 15 of the EPBC Act.

There are no National Heritage-listed places intersected by the activity area. The socio-economic EMBA intersects the West Kimberley National Heritage Place. This National Heritage-listed place is described below and presented in Figure 5.35.

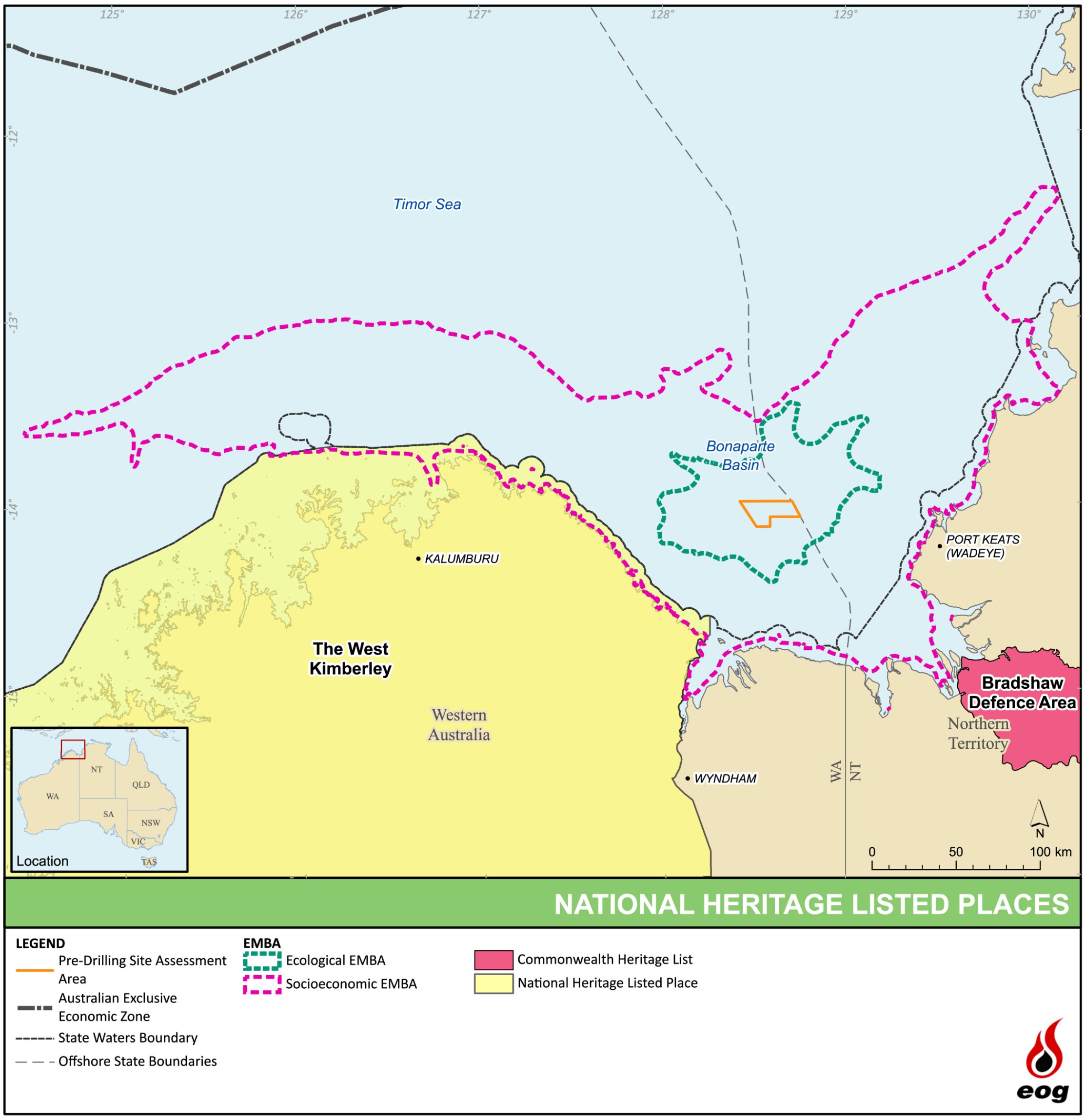


Figure 5.35. National Heritage-Listed Places intersected by the spill EMBA

West Kimberley National Heritage Place

The West Kimberley was included on the National Heritage List in 2011 and has numerous values which contribute to the significance of the property, including indigenous, historic, aesthetic, cultural and natural heritage values (DAWE, 2021b). The West Kimberley National Heritage place covers a vast area that is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands.

The values most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds (Roebuck Bay does not fall within the EMBA).

5.4.4. Wetlands of International Importance

Australia has 66 wetlands of international importance (‘Ramsar wetlands’) that cover more than 8.3 million hectares (as of September 2021) (DAWE, 2021f). 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 no Ramsar wetlands intersected by the activity area or the EMBA (Figure 5.36). However, the Ord River Floodplain Ramsar wetland is within 10 km of the boundary of the EMBA and so is described here.

Ord River Floodplain

The Ord River Floodplain Ramsar site is a floodplain and estuarine wetland system. North of the lagoons, the site includes the Ord River Estuary leading into the Cambridge Gulf while the northeast end of the site heads around the coast to include a series of extensive intertidal creeks and flats known as the False Mouths of the Ord. The upstream portion of the floodplain and river tends to be freshwater and becomes more saline as the river approaches the Cambridge Gulf and falls under tidal influence (DAWE, 2021b).

Mangroves are the most common vegetation in the site, extending from the False Mouths of the Ord to the upstream sections of the estuary. The mangroves form narrow fringes along the intertidal areas, with saltmarsh on higher ground. The intertidal mangroves support many species of birds and bats and are a breeding area for banana prawns (DAWE, 2021b).

Over 200 species of birds have been recorded within the site including waterfowl, migratory shorebirds, mangrove birds and terrestrial species. The site supports the nationally threatened Australian painted snipe. The wetlands are habitat for many fish species that require migration between marine and more freshwater environments during their life, including the nationally threatened species largetooth sawfish, green sawfish and northern river shark. Reptiles that use the site include the freshwater crocodile and saltwater crocodile (DAWE, 2021b).

The Ord River Floodplain Ramsar site lies within the boundaries of six Indigenous language groups: Miriuwung, Gajerrong, Dulbung, Guluwaring, Djangade and Biambarr. The site contains Indigenous burial sites, artefact scatters, quarries, paintings and ceremonial sites (DAWE, 2021b). The Ord River Nature Reserve is gazetted for the conservation of flora and fauna. The Lower Ord River and the False Mouths of the Ord are popular destinations for locals and visitors for recreational fishing, crabbing and boating (DAWE, 2021b).

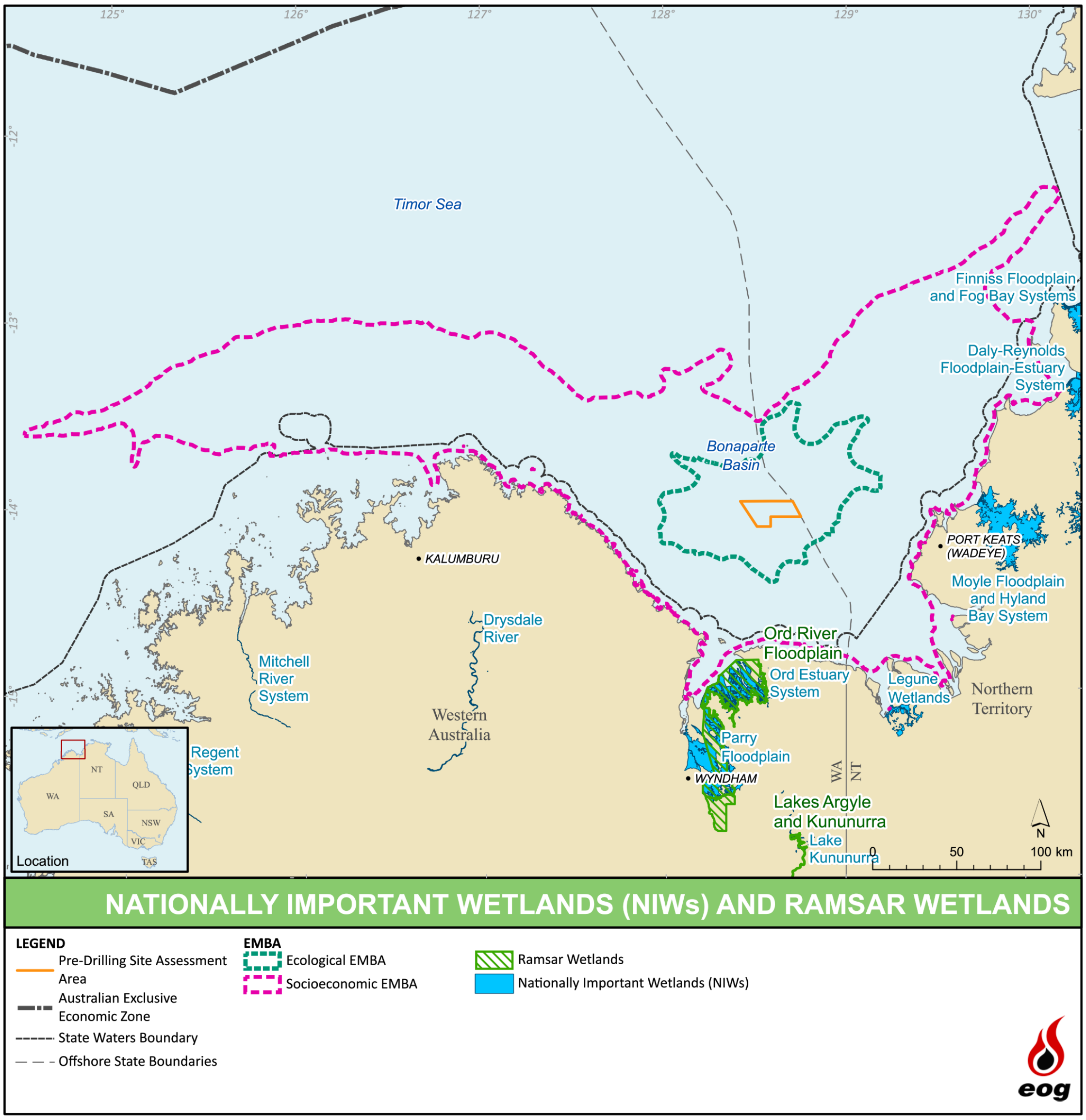


Figure 5.36. Ramsar wetlands and NIWs intersected by the spill EMBA

5.4.5. 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).

There are no TECs identified in the spill EMBA or activity area.

5.4.6. Commonwealth Heritage-listed Places

Commonwealth Heritage-listed places are natural, indigenous and historic heritage places owned or controlled by the Commonwealth (DAWE, 2021g). 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 activity area. The EMBA is located within 10 km of the Bradshaw Defence Area, which is described below.

Bradshaw Defence Area

The Bradshaw Defence Area is bounded by the Fitzmaurice and Victoria Rivers on the shores of the JBG. The Bradshaw Defence Field Training Area comprises a vast and rugged habitat endowed with a diverse array of plants and animals. The place demonstrates to a high degree the interplay of erosional terrains associated with coastal and fluvial environments. Coastal mudflats, associated tidal creek networks and mangal stands are prominent along the coastal margins. In places, the mudflats are 'interrupted' by bedrock outcrop, while in other locations, bedrock forms small islands rimmed by mudflats and associated mangrove belts. There is a substantial rainfall gradient within the place, so that species characteristic of both the wetter coastal forests and drier inland woodlands of north western Australia are represented (DAWE, 2021b).

5.4.7. Key Ecological Features

KEFs are components of the marine ecosystem that are considered to be important for biodiversity or ecosystem function and integrity of the Commonwealth Marine Area.

The activity area does not overlap with any KEFs, however the EMBA overlaps with the ‘Carbonate bank and terrace system of the Sahul Shelf’ KEF. At its closest point, the activity area is located 12 km east of this KEF (Figure 5.37). This KEF is described below.

Carbonate bank and terrace system of the Sahul Shelf

The carbonate bank and terrace system of the Sahul Shelf KEF is located in the western JBG and to the north of Cape Bougainville and Cape Londonderry. The carbonate banks and terrace system of the Sahul Shelf is defined as a KEF for its role in enhancing biodiversity and local productivity relative to its surrounds as it is a unique seafloor feature supporting relatively high species diversity, making it regionally significant.

The KEF provides areas of hard substrate in an otherwise soft sediment environment, which is important for sessile species. Banks rise from depths of approximately 80 m to within 30 m of the surface. Banks that rise to within 45 m water depth support more biodiversity, such as communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans and bryozoans (Brewer *et al*., 2007; Nichol *et al*., 2013). Brewer et al (2007) also noted that banks within the KEF support aggregations of demersal fish species such as snappers, emperors and groupers.

The banks are recognised as a biodiversity hotspot for sponges with more species and different communities than the surrounding seafloor (NERP MBH, 2014). The KEF is also known as a foraging area for flatback, olive ridley and loggerhead turtles (DSEWPC, 2012).

Threats to the KEF include changes in sea temperature and ocean acidification, both resulting from climate change, as well as extraction of living sources from illegal, unreported and unregulated fishing (Brewer *et al*., 2007; Nichol *et al*., 2013).

5.4.8. 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, 2021h).

There are no NIWs that are intersected by the activity area or the EMBA (see Figure 5.36).

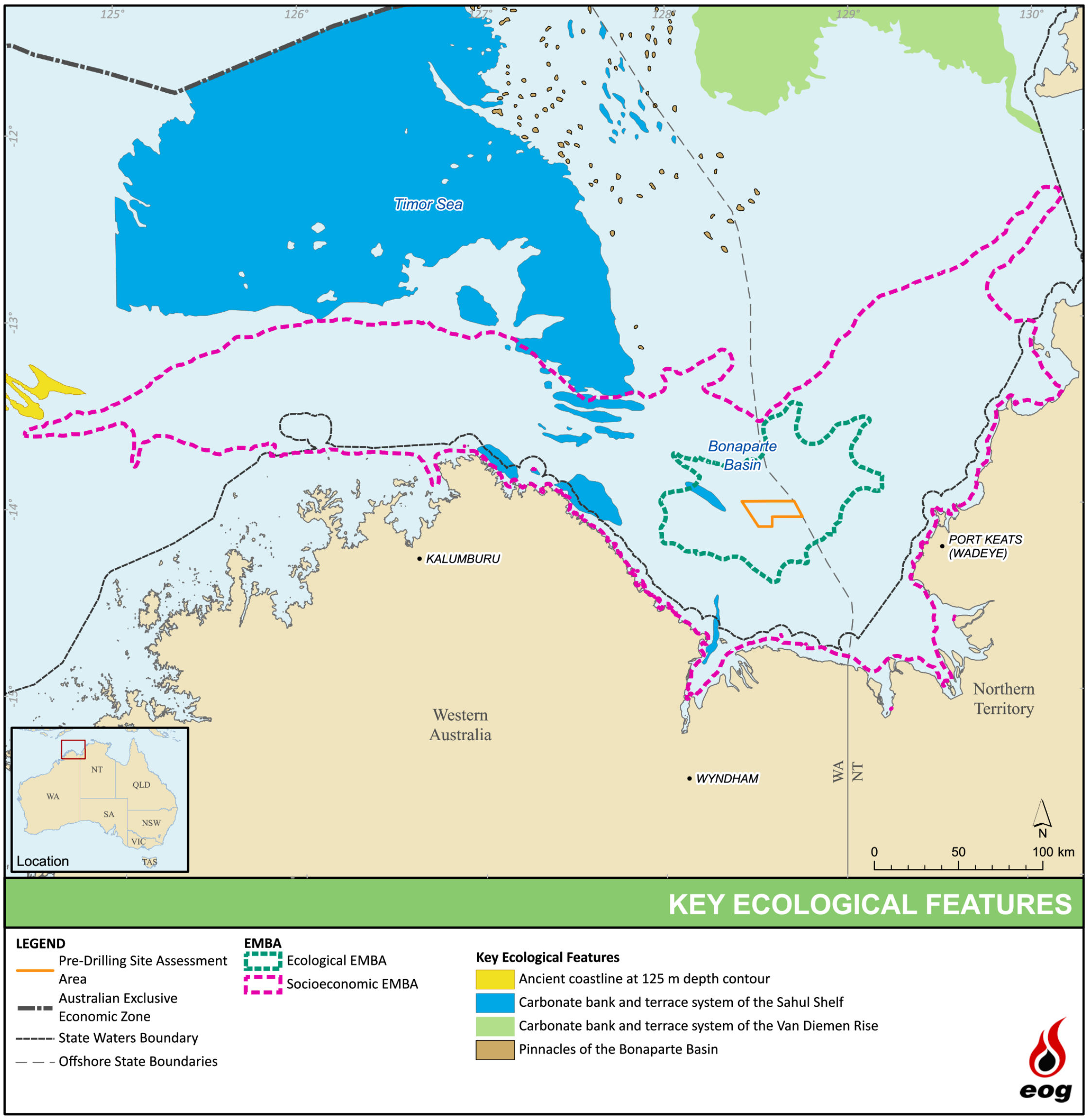


Figure 5.37. KEFs intersected by the spill EMBA

5.4.9. State/Territory Protected Areas

The activity area does not intersect any State- or Territory-managed protected areas.

There is one WA-managed marine protected area intersected by the EMBA (see Figure 5.34) and described in Table 5.12. There are no NT-managed marine protected areas intersected by the EMBA.

Table 5.12. WA marine protected areas in the spill EMBA

Name	Distance and direction from activity area	Description
North Kimberley Marine Park	59 km southwest of the activity area	The North Kimberley Marine Park is the largest state marine park in WA, covering an area of approximately 18,450 km^2. The park is located in state waters and extends from York Sound to Cape Londonderry, to the JBG and up to the WA/NT border (DPW, 2016). The park is part of a joint management plan between the Department of Parks and Wildlife and the Uunguu, Balangarra, Miriuwung Gajerrong and Wilinggin traditional owners (DPW, 2016). The North Kimberley Marine Park covers a large variety of marine habitats including coral reefs, seagrass, mangroves and macroalgal communities. More than 1,000 islands and associated intertidal and subtidal habitats are contained within its boundaries. Seagrass beds found around Cape Londonderry (164 km west of the activity area) provide foraging areas for dugong and marine turtles (DPW, 2016). The marine park surrounds thousands of islands with diverse and rich habitats. Marine turtle nesting sites and breeding sites for seabirds and migratory shorebirds have been identified within the marine park, and fringing reefs line the shores of almost all of the islands (DPAW, 2016). The productive deep waters that surround the islands and open sea reefs provide foraging habitat for marine mammals and pelagic fish, such as mackerel (DPW, 2016). The complex coastline of the mainland also creates a variety of habitats and communities, including important areas for dugongs, Australian snubfin dolphins and Australian humpback dolphins (DPW, 2016). The marine park also contains many places of cultural and spiritual importance to traditional owners (DPW, 2016).

5.5. 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 Indigenous and non-Indigenous (maritime archaeology).

5.5.1. Aboriginal Heritage

Indigenous Australian people have a strong continuing connection with the area that extends back some 50,000 years. The existence of any unknown Aboriginal sites or artefacts of significance within the offshore waters of northern Australia is considered highly unlikely.

A search of the WA Department of Aboriginal Affairs’ Aboriginal Heritage Inquiry System (AHIS) does not identify any registered Aboriginal heritage sites, other heritage sites or Aboriginal heritage survey areas within the activity area.

There are seven Registered Aboriginal Sites (Burrunungu, Ganggarryu, Ngarrmu/Ngarrmiyu, Balu-Gunanjarr Complex, Pelican Islet 1, Reveley Island Midden and Berkeley River Dunes) listed along the coast offshore Wyndham and the east Kimberley that fall within the EMBA.

5.5.2. Maritime Archaeological Heritage

Historic shipwrecks are recognised and protected under the *Underwater Cultural Heritage Act* 2018, which aims to protect historic wrecks and associated relics. Under the Act, all wrecks more than 75 years old are protected, together with their associated relics regardless of whether their actual locations are known.

A search of the National Shipwreck and Relic database identified no shipwrecks within the activity area. Five shipwrecks are identified in the coastal parts of the EMBA (Figure 5.38) and are briefly described below.

- Phoenix (Shipwreck ID 8241): Wrecked in 1950 but was never found. This is very little information regarding the vessel or wreck.
- Polype (Shipwreck ID 4673): Wrecked in 1913 but was never found. This is very little information regarding the vessel or wreck.
- Loellen (Shipwreck ID 3486): Wrecked in 1965 by heavy seas after unloading cargo on Tchindy Beach. No wreck has been found.
- Margaret Mary (Shipwreck ID 4450): Wrecked in 1965 but was never found. This is very little information regarding the vessel or wreck.
- Editha (Shipwreck ID 3996): Wrecked in 1963 and was originally constructed in 1903. Wrecked off Cape Hay, NT but was not found.

5.5.3. Native Title

A search of the NNTT Register did not identify any Native Title areas or any pending titles within the activity area.

There are four Native Title areas within the EMBA:

- Miriuwung Gajerrong - represented by the Miriuwung and Gajerrong Aboriginal Corporation (MG Corporation). The determination area extends to intertidal areas and sea country intersected by the EMBA in the Cambridge Gulf and eastern Kimberley region (Figure 5.39).
- Balanggarra - represented by the Balanggarra Aboriginal Corporation. The northern boundary of the area runs through sea country and encompasses a number of islands near the coast, including the Sir Graham Moore Islands, Adolphus Island and Reveley Island (Figure 5.40).
- Spirit Hills Pastoral Lease No.2 – located in the NT near the Keep River National Park and is held by the Miriuwung-Bindjen, Miriuwung-Nyawam Nyawam, Gajerrong-Gurrbjim, Gajerrong-Djarradjarranay, Gajerrong-Djandumi and Gajerrong-Wadanybang groups.
- Legune Pastoral Lease – located in the NT near the Keep River National Park Extension and is held by the Gajerrong-Wadanybang, Gajerrong-Gurrbjim and Gajerrong-Djarrajarrany groups.

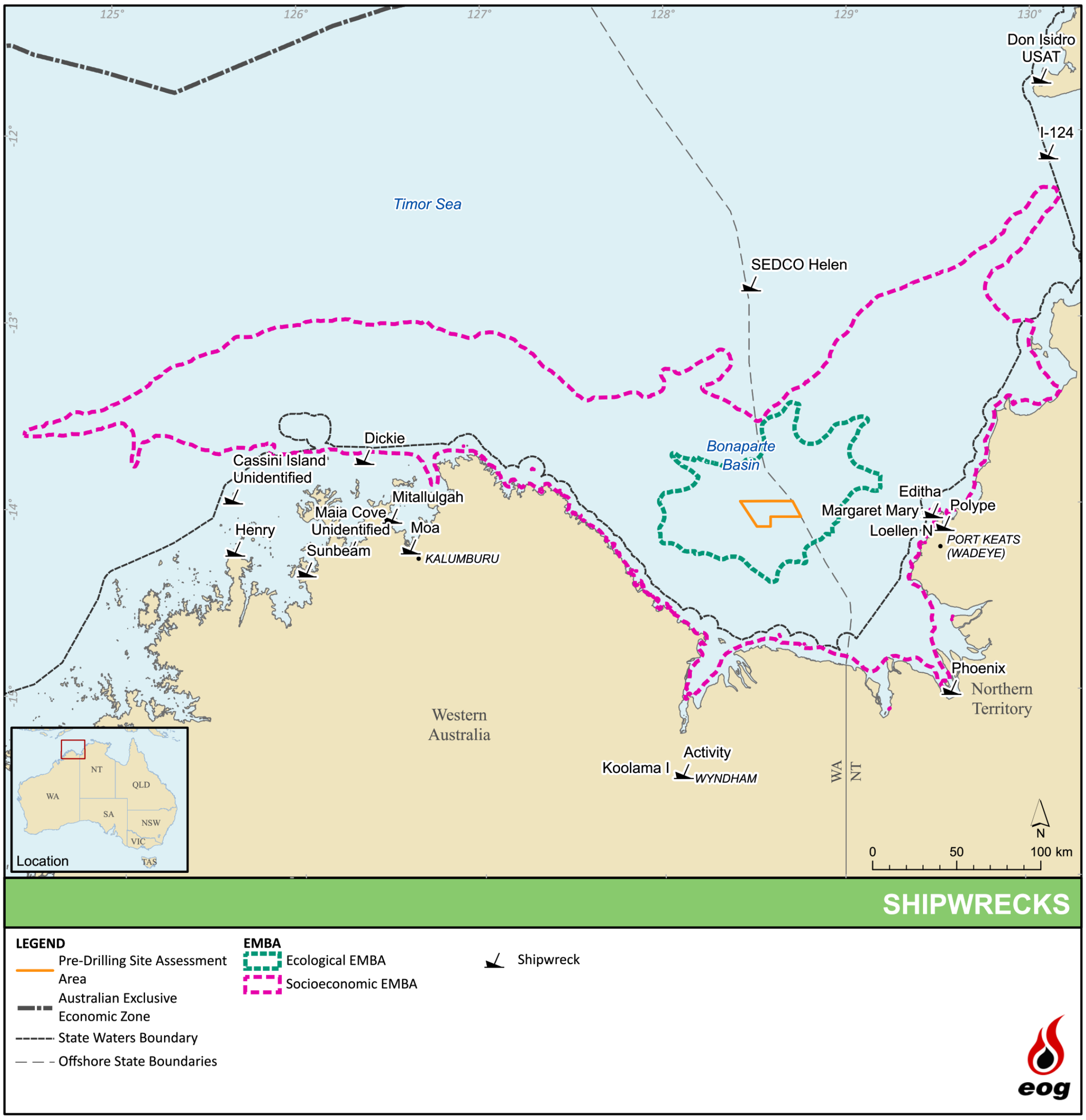


Figure 5.38. Shipwrecks intersected by the EMBA

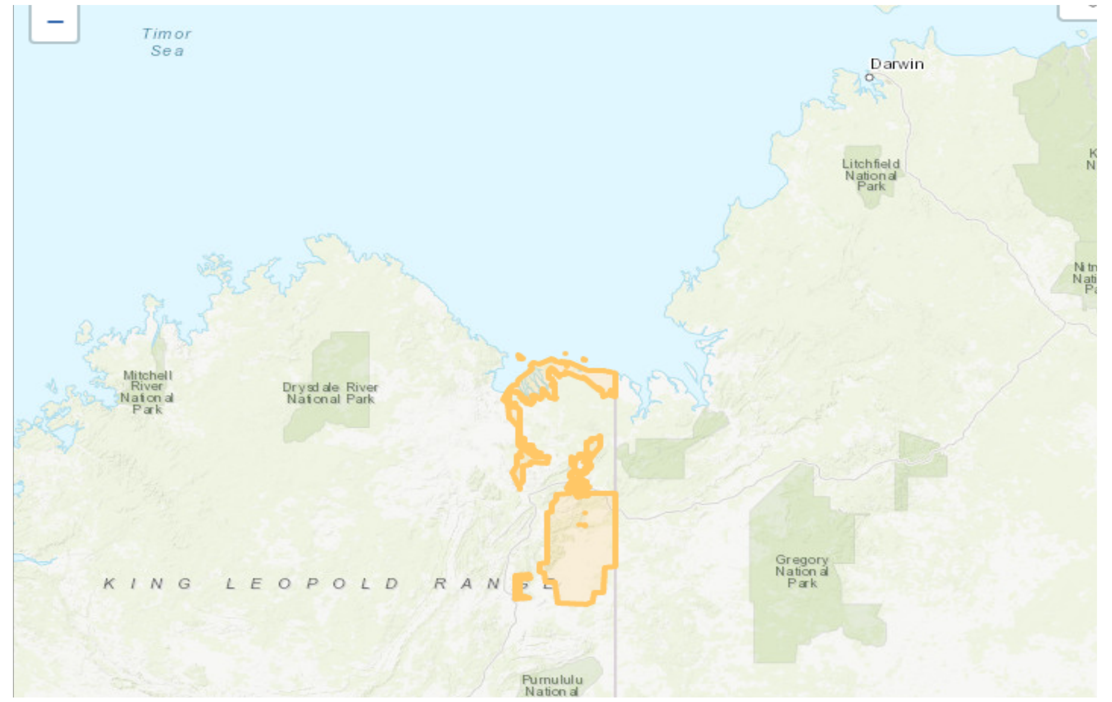


Figure 5.39. Miriuwung Gajerrong Native Title Determination Area

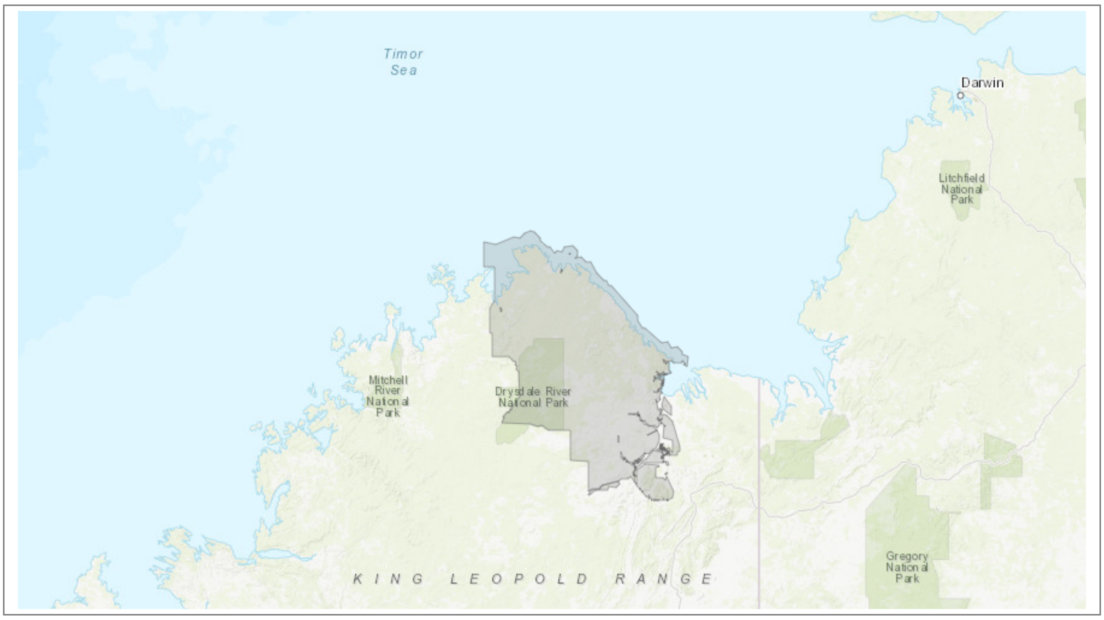


Figure 5.40. Balanggarra Native Title Determination Area

5.6. Socio-economic environment

This section describes the social and economic environment of the activity area and the EMBA.

5.6.1. Commercial Fishing

Several Commonwealth, WA and NT commercial fisheries are licensed to operate in and around the activity area and the EMBA. These are described in the following sections.

Commonwealth-managed Fisheries

Commonwealth fisheries are managed by 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 and activity area are the:

- Western Tuna and Billfish Fishery;
- Southern Bluefin Tuna Fishery;
- Northwest Slope Trawl Fishery;
- Western Skipjack Fishery; and
- Northern Prawn Fishery (NPF).

Of these fisheries, only the NPF has evidence of recent (within the last three years) fishing activity in the EMBA or activity area. Table 5.13 summarises the key facts and figures of the NPF.

Table 5.13. Commonwealth-managed commercial fisheries with jurisdictions to fish in and around the activity area and EMBA

Fishery	Target species	Does fishing activity intersect activity area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
NPF (Figure 5.41)	Redleg banana prawn (*Fenneropenaeus indicus),* white banana prawn (*F. merguiensis*), brown tiger prawn (*Penaeus esculentus*), grooved tiger prawn (*P. semisulcatus*), blue endeavour prawn (*Metapenaeus endeavouri*) and red endeavour prawn (*M. ensis*)	**Activity area?** **Yes** **Spill EMBA?** **Yes**	The NPF operates in two seasons; • First – April to June, when banana prawns are the key catch species. • Second – August - November, when tiger prawns are the key catch species.	Otter trawl is the primary fishing method. In the 2020 fishing season, there were 52 fishing vessels and 52 active vessels in the fishery. The numbers were the same in 2019. The primary landing ports are Darwin (NT), Cairns and Karumba (Qld).	Catch data and economic value available for the last five years: • 2020 – 4,767 tonnes valued at $84.9 million. • 2019 – 8,581 tonnes valued at $117.1 million. • 2018 – 6,778 tonnes valued at $98.2 million. • 2017 – 6,602 tonnes valued at $118.1 million. • 2016 – 5,794 tonnes valued at $126.1 million.

Sources: Patterson et al (2021; 2020; 2019; 2018; 2017).

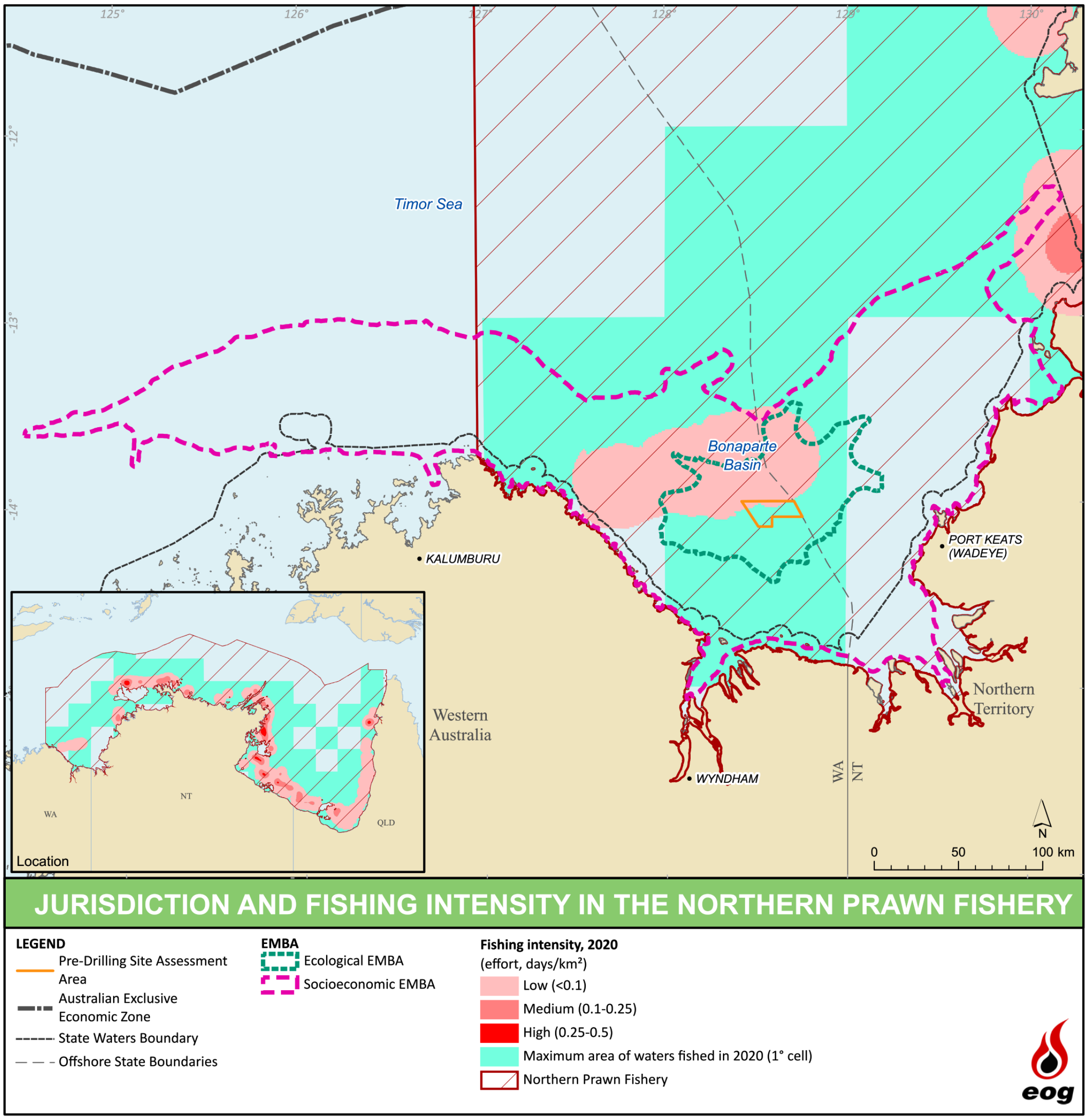


Figure 5.41a. NPF fishing intensity in the EMBA (2020)

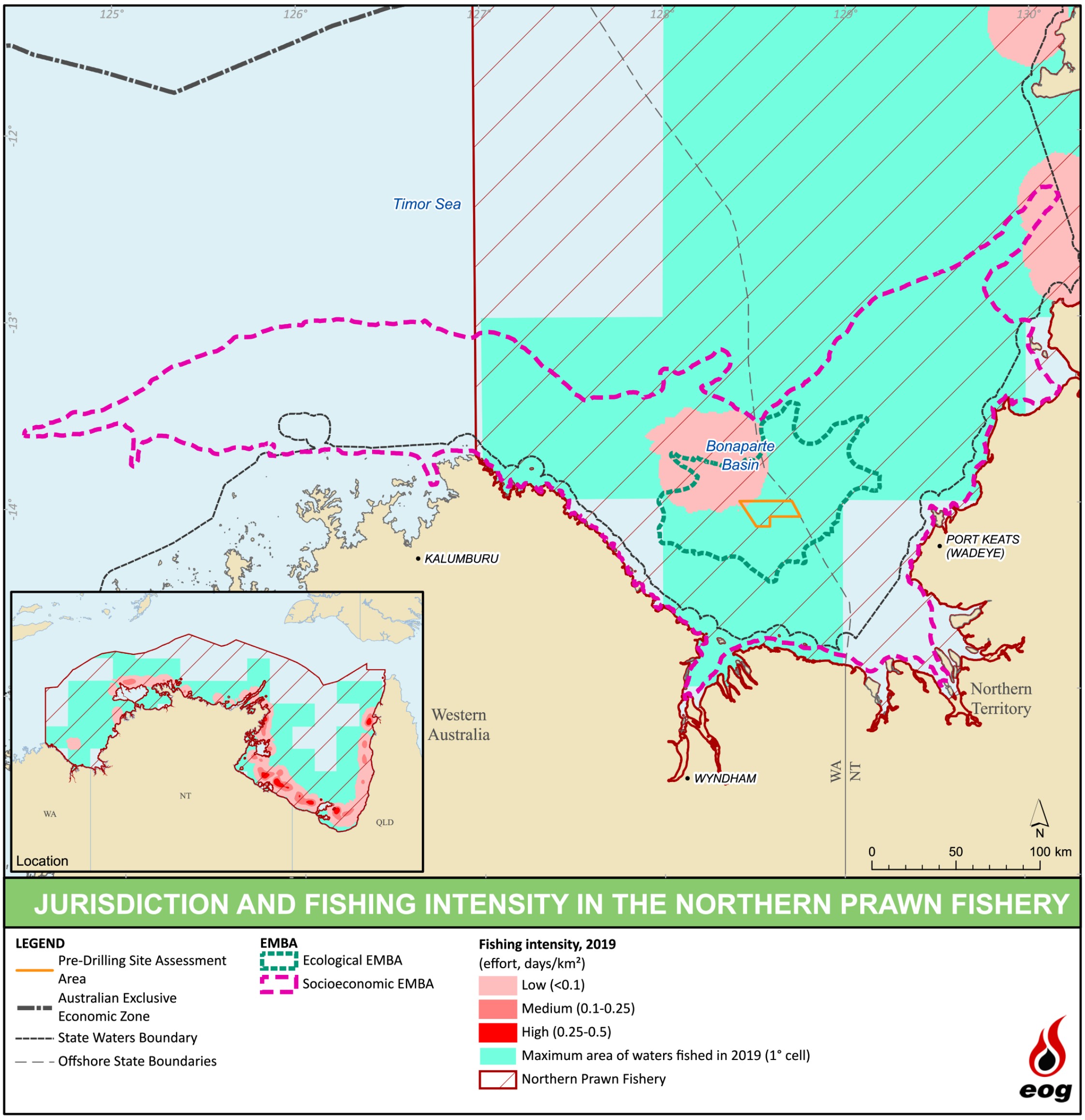


Figure 5.41b. NPF fishing intensity in the EMBA (2019)

<u>Northern Prawn Fishery</u>

Prawn species reach a commercial size at six months of age and can live for up to two years. Growth rates vary considerably between species and sexes, with females generally growing faster and to a larger size than males. The larger the prawn, the higher the price.

Most species are sexually mature at six months, but fertility increases with age. Females can produce hundreds of thousands of eggs at a single spawning at twelve months old and may spawn more than once in a season. After spawning in offshore waters, the eggs sink to the bottom after release, where they hatch into larvae within about 24 hours. Usually <1% of these offspring survive the two-to-four-week planktonic larval phase to reach suitable coastal nursery habitats where they may settle. After one to three months in the nursery grounds, the young prawns move offshore into the fishing grounds.

NPF catch in the JBG is comprised primarily of banana prawns (mainly *F. indicus* and some *F. merguiensis*), with banana prawn catch being more than double that of tiger prawns and endeavour prawns in 2019 combined (Patterson *et al.*, 2020). The JBG comprises about

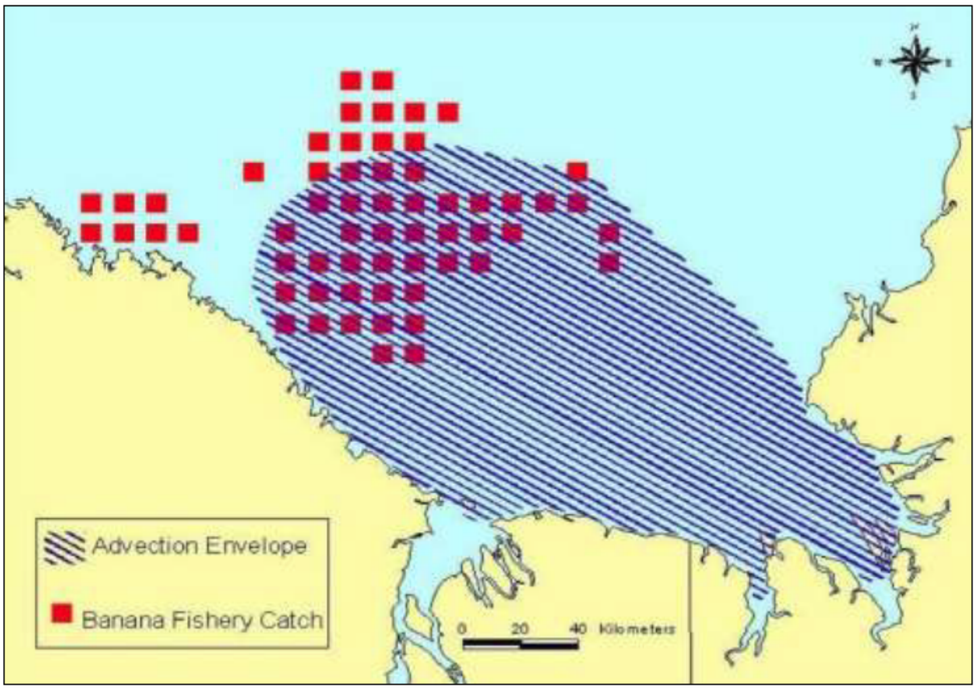
30,000 km^2 of the westernmost portion of the NPF (see Figure 5.41). Fishing for *F. indicus* is permitted day and night in both NPF fishing seasons. Fishing takes place in waters 35–70 m deep, with most fishing effort between 50 m and 60 m. The trawling regime for this species is similar to the tiger prawn sub-fishery in other regions of the NPF, where the total duration of individual trawls is usually about 3 hours long. Although the JBG fishery comprises less than 5% of the area of the NPF, it contributes about 65% of the NPF's red legged banana prawn catch and around 20% of the NPF's total banana prawn catch (combined *F. merguensis* and *F. indicus*) (Loneragan *et al*., 2002), but research to date indicates that *F. indicus* prawns spawn offshore near to the fishing area throughout the year with two spawning peaks: the late dry season (September to November) and the late wet season (March to May). The larvae move inshore and then wash out as juveniles with the wet season floods.

Loneragan et al (2002) reported that the offshore fishery for *F. indicus* occurs in water depths of 50 – 80 m in the north western offshore waters of the JBG. Thus, the juvenile phase is found in estuarine habitats up to 120 km south and 240 km east-southeast of the southern and eastern limits of the JBG *F. indicus* fishery. The juvenile phase of *F. merguiensis* is found in estuarine habitats in the western JBG, about 50 km to the southwest of the *F. indicus* fishery, offshore. Although these mangrove habitats are the closest inshore habitats to the fishery, they are not used by *F. indicus*. This suggests that the larvae of *F. indicus* resulting from spawning in the fishing grounds move large distances to the south and east to their nursery habitats (Figure 5.42). They also imply that the emigrating juveniles and sub-adults migrate from the mangrove nursery habitats, north and west, across shallower sand substrates (30-40 m deep) to the deeper-water fishery (on mud substrates about 50-80 m deep).

The migration of juvenile *F. indicus* in the JBG appears to be split into two periods, with the migration of the main cohort occurring between November and March, with a possible second cohort migrating from April to June (Neil Loneragan, CSIRO Division of Marine Research, pers. comm., April 2000) (Figure 5.43).

Migration of the juveniles is thought to be triggered by rainfall and river discharge. A seasonal closure for the NPF in the JBG exists in the period 31 March – 15 June (AFMA, 2021) (Figure 5.44). The seasonal closure is an exclusion zone in place for all licence holders within the NPF, and the purpose of this closure is to protect small juvenile prawns as they migrate offshore to deeper waters in the southern JBG, where the adults are targeted during the trawling operations (AFMA, 2021). Any catch south of the seasonal closure line is taken in the second fishing season only (August to November), whereas catch taken north of the closure line is taken during both the first and second seasons. The activity area is located within this exclusion zone.

Due to the large tidal range (6–8 m) in the JBG and its reputed influence on prawn abundance in the region, red-legged banana prawns are fished on the neap tides, when tidal range and currents are minimal (Tonks *et al*., 2008). Thus, over a tide cycle, fishing effort is high on the late spring-neap, neap and early neap-spring tides, and low to non-existent at other times when the fleet moves to fishing grounds north of Melville Island and Port Essington, outside the JBG. The extra steaming time that this fishing pattern generates, together with the remoteness of the JBG and the lower price of red-legged banana prawns in comparison to other species of prawns, makes the JBG a less attractive area to fish than other parts of the NPF. As a result, the annual fishing effort in the JBG fishery is mostly dependent on the catch levels elsewhere in the NPF; if catches are good elsewhere, effort in the JBG is low (Loneragan *et al*., 2002).



Source: Loneragan et al (2002).

Figure 5.42. Size and the probable advection envelope for post-larval *F.indicus* in the JBG

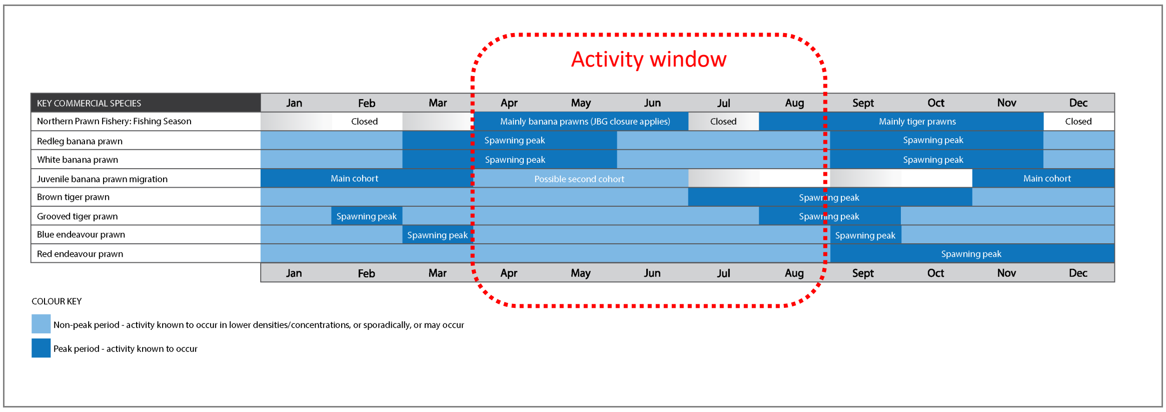


Figure 5.43. Commercial prawn species spawning

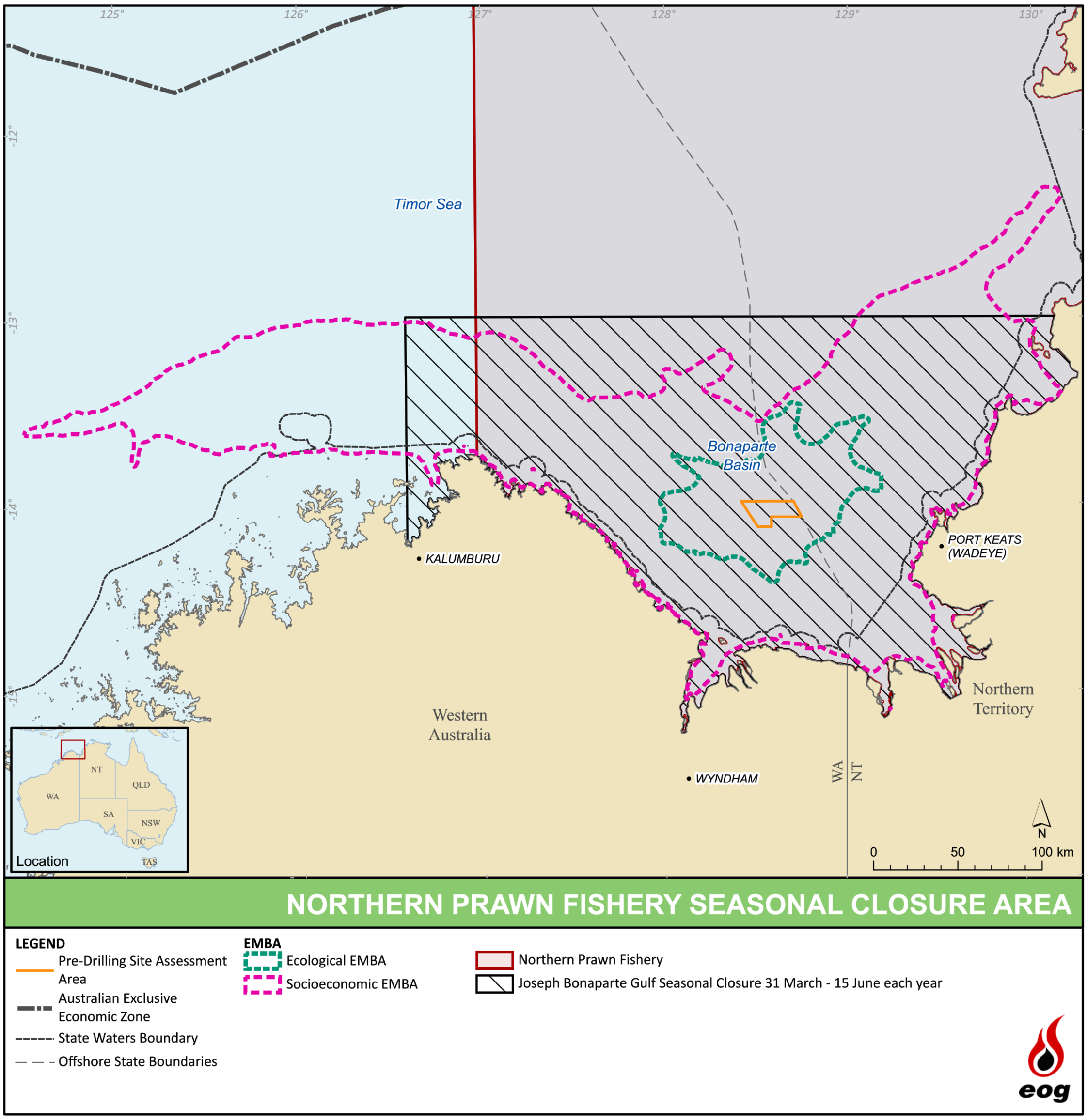


Figure 5.44. JBG closure area of the NPF

Western Australia-managed Fisheries

Western Australian-managed commercial fisheries that are authorised to harvest in the waters of the activity area and EMBA include the following (noting that not all actively fish):

- Mackerel Managed Fisheries (MMF) (Area 1 – Kimberley);
- Northern Demersal Scalefish Managed Fishery;
- Pearl Oyster Managed Fishery (Zone 3)
- Abalone Managed fishery (Area 8);
- Marine Aquarium Fish Fishery;
- Kimberley Crab Managed Fishery (North Coast Crab Fishery);
- Kimberly Prawn Managed Fishery; and

- Specimen Shell Fishery.

Through its consultation process with the WA DPIRD, EOG identified the MMF, the Northern Demersal Scalefish Managed Fishery, Kimberley Crab Managed Fishery, Kimberley Prawn Managed Fishery and the Kimberley Gillnet and Barramundi Fishery as the key fisheries that actively fish in the activity area and/or EMBA.

Table 5.14 presents information for the fisheries that have recent evidence of fishing in the activity area and/or EMBA.

Table 5.14. Western Australian-managed commercial fisheries with jurisdictions to fish within the activity area and EMBA

Fishery	Target species	Does fishing activity intersect activity area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Northern Demersal Scalefish Managed Fishery (Area 1, Zone A) (Figure 5.45)	Targets predominately goldband snapper (*Pristipomoides multidens*), crimson snapper, red emperor (*Lutjanus sebae*) bluespotted emperor (*Lethrinus punctulatus*), saddletail snapper (*L. malabaricus*), rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*L. vitta*), rosy threadfin bream (*Nemipterus furcosus*) and spangled emperor (*Lethrinus nebulosus*).	**Activity area?** **Unknown.** **Spill EMBA?** **Likely.**	Assumed to be year-round.	Although permitted to use handlines, droplines and traplines, since 2002 the fishery has been essentially trap based. Six vessels actively fished in 2019, which is down from seven vessels operating in 2016.	Catch data available for the last five years: • 2019 – 1,507 t. • 2018 – 1,297 t. • 2017 – 1,317 t. • 2016 – 1,173 t. • 2015 – 1,046 t. Majority of catch (87%) was landed in Zone B in the 2019 season.
MMF (Area 1 and 2) (Figure 5.46)	Spanish mackerel (*Scomberomorus commerson*)	**Activity area?** **Unknown.** **Spill EMBA?** **Likely.**	Fishing was primarily from May – November in 2019.	A total of 15 vessels operated during 2019 across the fishery. In 2014, only three vessels operated in the Kimberley region. Trolling and handline are the only allowable fishing methods.	Catch data available for the last five years: • 2019 – 291 t. • 2018 – 213 t. • 2017 – 283 t. • 2016 – 276 t. • 2015 – 302 t.

Fishery	Target species	Does fishing activity intersect activity area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Kimberley Crab Managed Fishery (KCMF) (Figure 5.47)	Green mud crabs (*Scylla serrata*) and brown mud crabs (*Scylla olivacea*).	**Activity area?** **No.** **Spill EMBA?** **Likely.**	Generally March to November, with June to September being the most productive months.	Crab traps are the primary fishing method. In 2019, six people were employed as skippers and crew on vessels fishing for mud crab in the KCMF.	Catch data available for recent years: • 2019 – 7.4 t. • 2018 – 3.2 t. • 2017 – 9.0 t. • 2016 – 2.5 t.
Kimberley Prawn Managed Fishery (Figure 5.48)	Banana prawns (*Fenneropenaeus indicus* and *F. merguiensis*) are the primary target species though brown tiger prawns (*Penaeus esculentus*) and blue endeavour prawns (*Metapenaeus endeavouri*) are taken as bycatch.	**Activity area?** **No.** **Spill EMBA?** **Yes.**	There are two fishing periods for the season (April to mid-June, then from August to the end of November) with around 90% of the total landings taken in the first fishing period.	Otter board trawl system is the primary fishing method.	Catch data available for the last five years: • 2019 – 100 t. • 2018 – 333 t. • 2017 – 269 t. • 2016 – 155 t. • 2015 – 175 t.
Kimberley Gillnet and Barramundi Fishery (Figure 5.49)	Barramundi (*Lates calcarifer*), king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*) are the primary target species.	**Activity area?** **No.** **Spill EMBA?** **Likely.**	Year round, though predominantly occurs from April to September.	Fishing is restricted to state waters. There are currently four licences to the fishery.	Catch data available for the last five years: • 2019 – 73.4 t. • 2018 – 91.8 t. • 2017 – 79.9 t. • 2016 – 74.6 t. • 2015 – 82.1 t.

Gaughan and Santoro (2021; 2020; 2018); Gaughan et al (2019), Fletcher et al (2017), Fletcher and Santoro (2015).

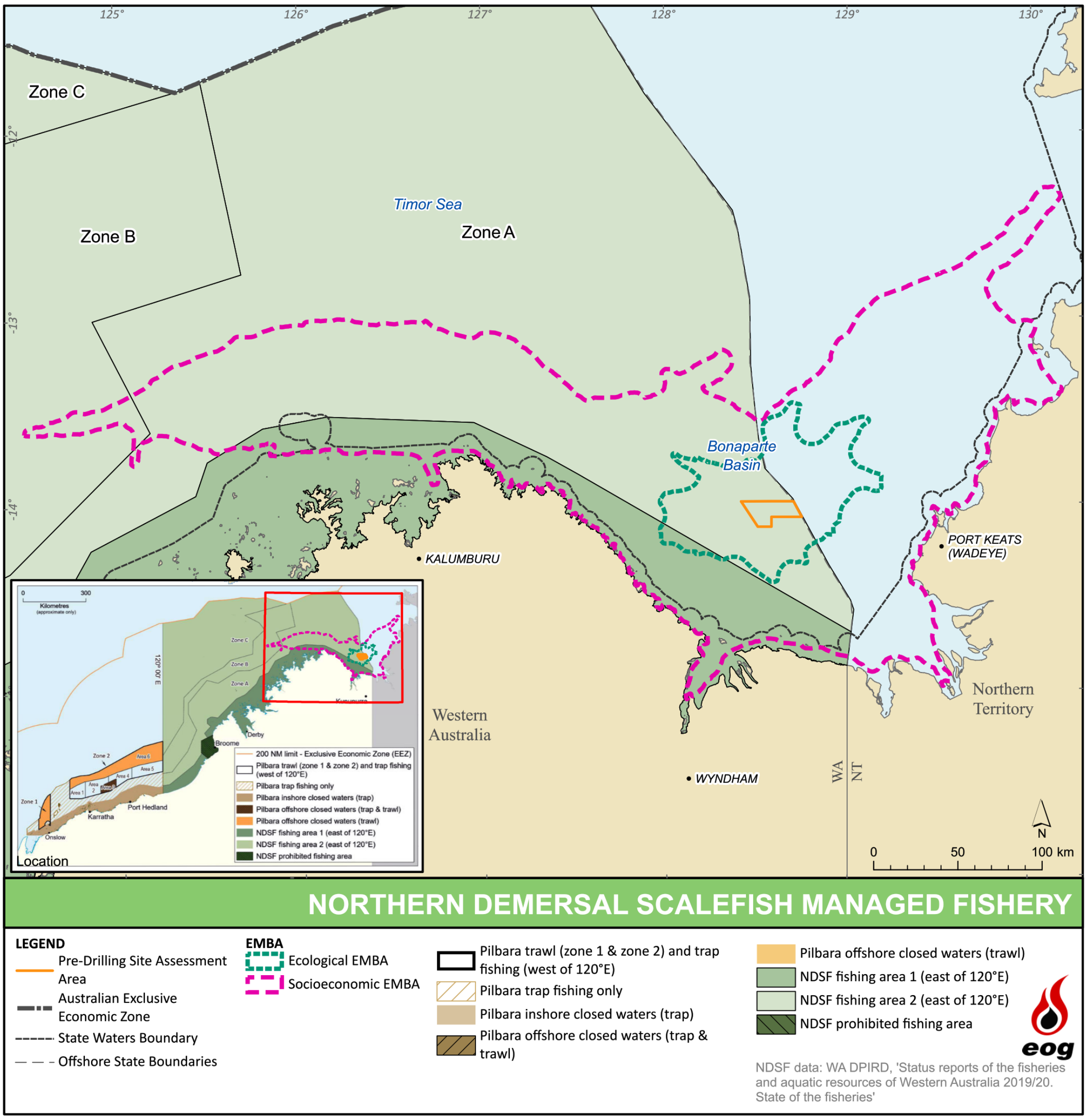


Figure 5.45. WA Northern Demersal Scalefish Fishery

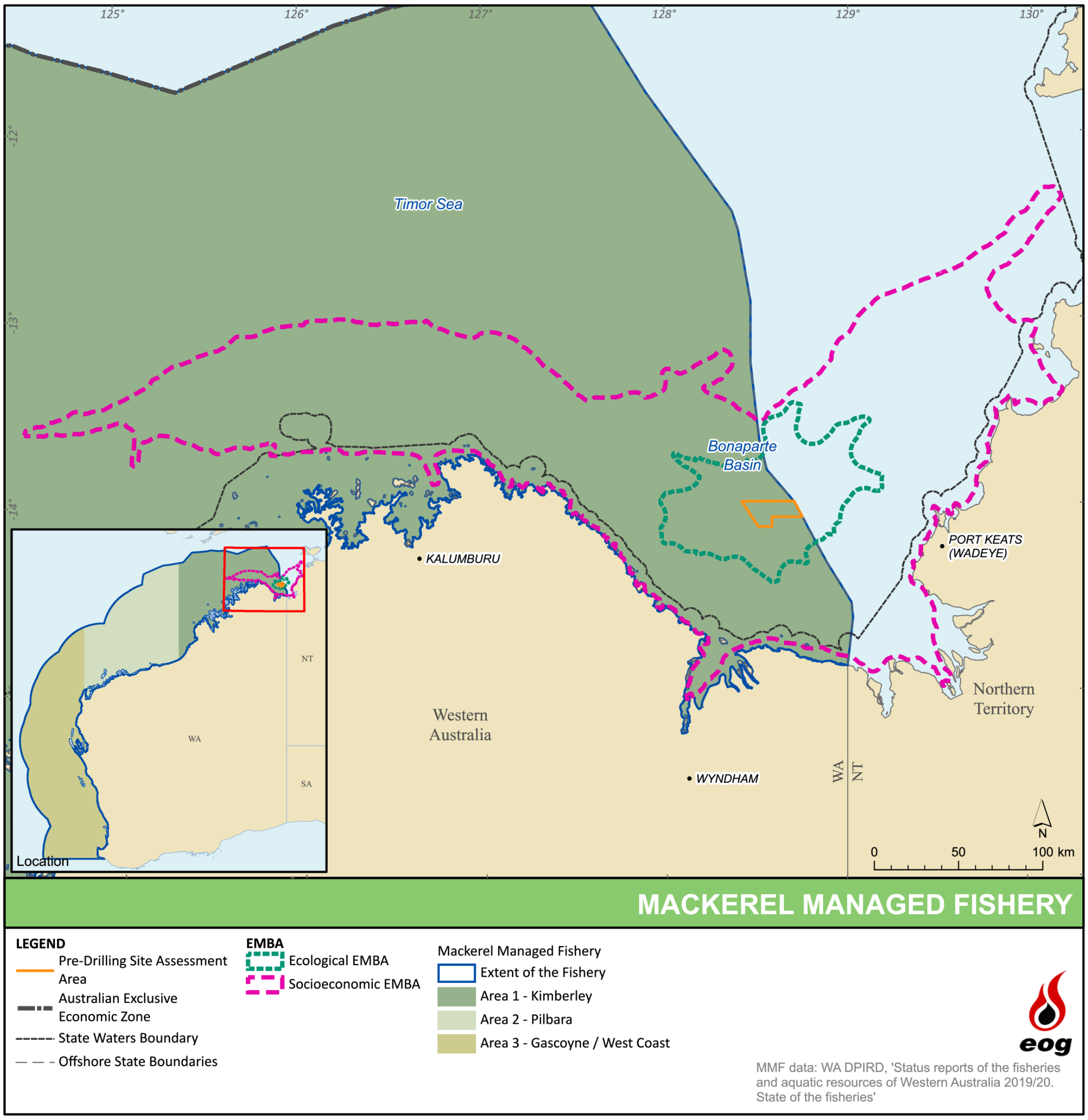


Figure 5.46. Western Australian Mackerel Managed Fishery

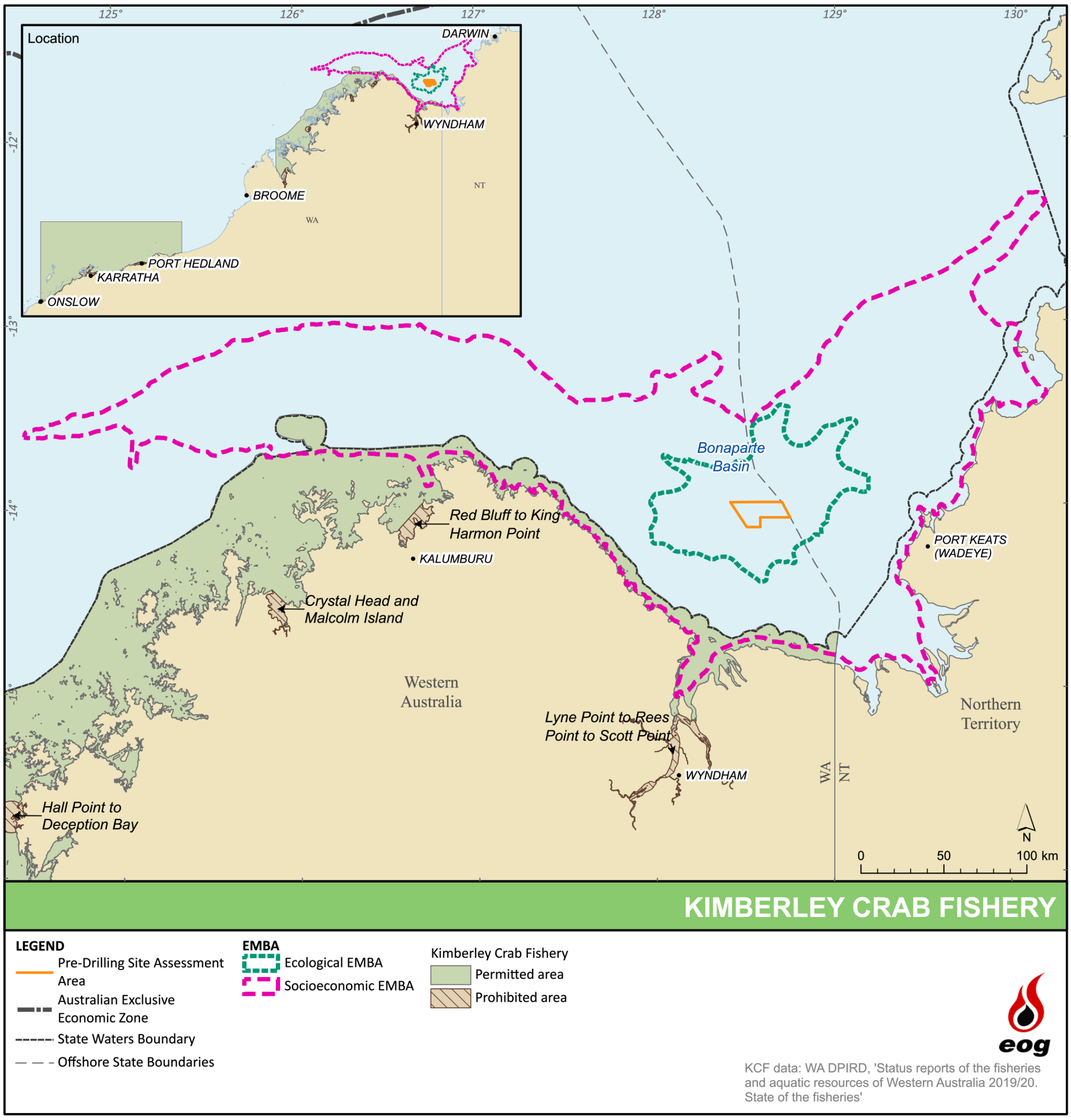


Figure 5.47. WA Kimberley Managed Crab Fishery (North Coast Crab Fishery)

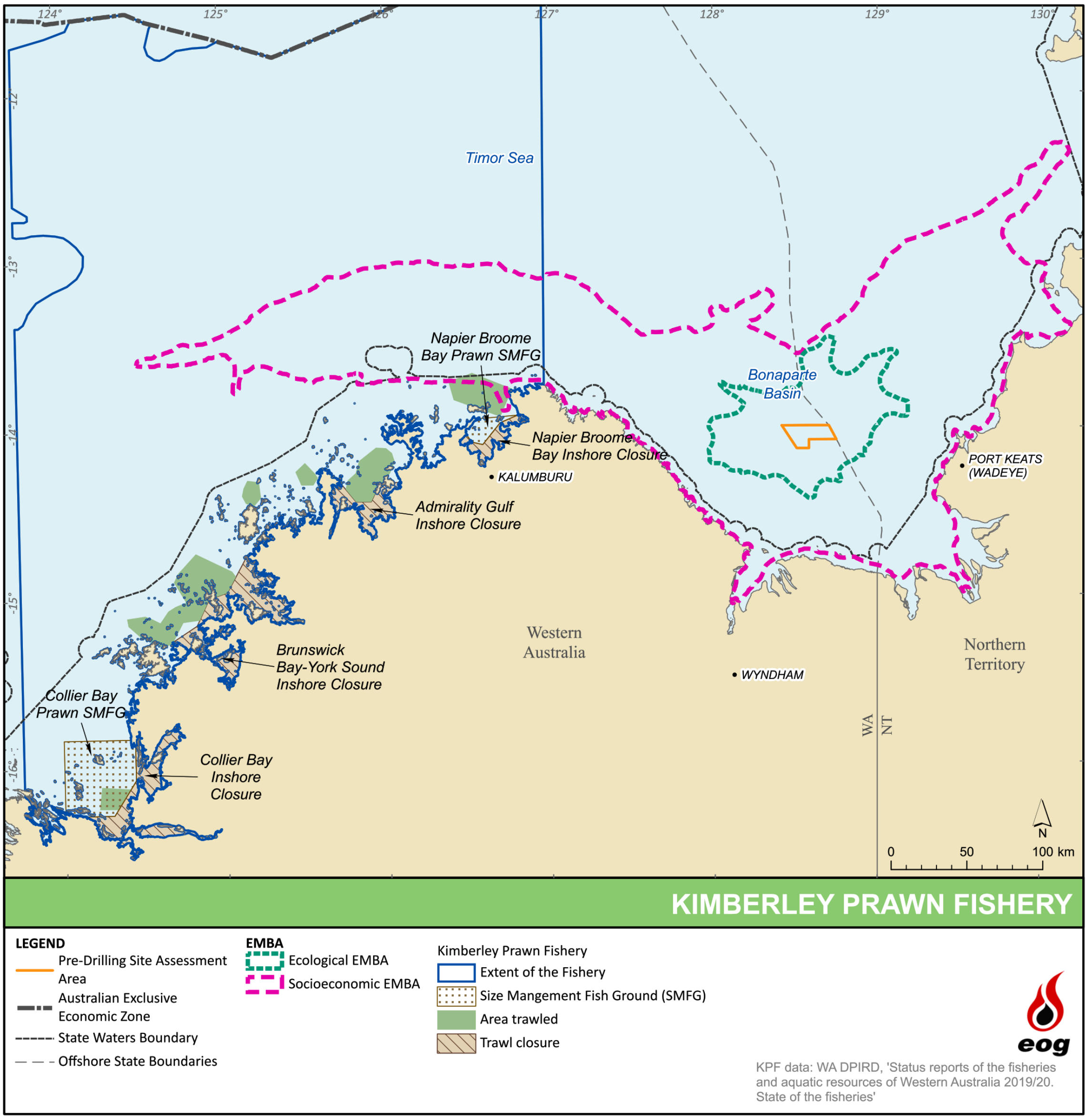


Figure 5.48. WA Kimberley Prawn Managed Fishery

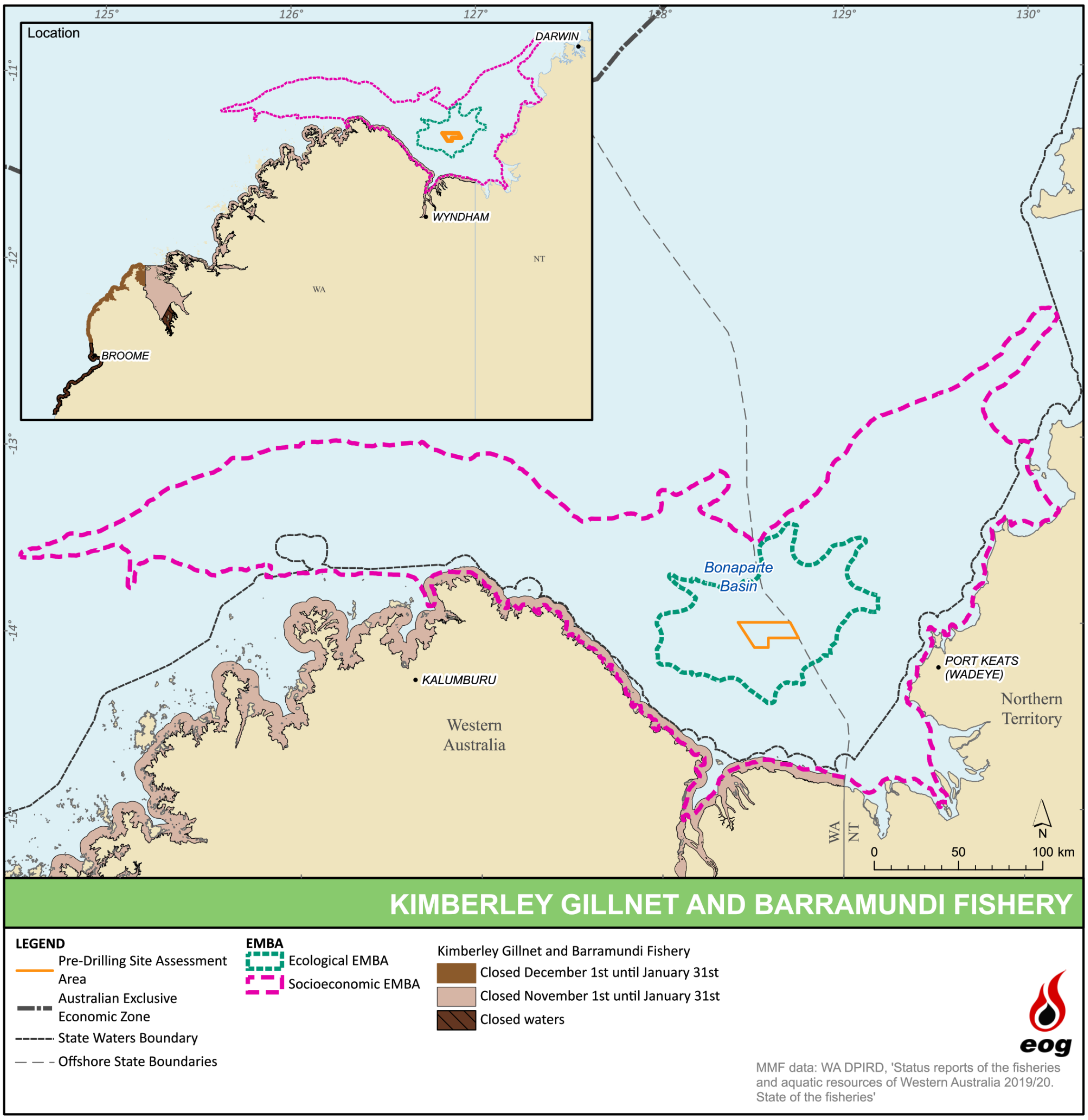


Figure 5.49. WA Kimberley Gillnet and Barramundi Fishery

Northern Territory-managed Fisheries

The NT DITT confirms there are no NT-managed commercial fisheries that fish within the activity area.

NT-managed commercial fisheries that are authorised to harvest in the waters of the EMBA include the following (noting that not all actively fish in the EMBA):

- Spanish Mackerel Fishery;
- Barramundi Fishery;
- Coastal line fishery;
- Offshore Net and Line Fishery; and
- Demersal Fishery.

A review of data from the NT DITT website and consultation with DITT Fisheries identified the Demersal Fishery, Spanish Mackerel Fishery and Offshore Net and Line Fishery as likely to have fishing effort in the EMBA. Table 5.15 presents the available information for these fisheries.

Table 5.15. Northern Territory-managed commercial fisheries with jurisdictions to fish within the activity area and EMBA

Fishery	Target species	Does fishing activity intersect activity area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Demersal Fishery (Figure 5.50)	Primarily red snapper (*Lutjanus erythropterus*), goldband snapper (*Pristipomoides multidens*) and saddletail snapper (*L. malabaricus*).	**Activity area?** **No.** **Spill EMBA?** **Possibly.**	Assumed year-round.	Fishing method is through the use of vertical lines, drop lines, finfish long-lines, baited fish traps and semi-demersal trawl nets in two multi-gear areas. Seven vessels operated in 2016. In 2021 there were 18 licences in the fishery.	In 2017, 3,388 t (including 2,371 t of red snapper and 338 t of goldband snapper) was caught, with an estimated value of $17.9 million. In 2016, 3,463 t (including 2,510 t of red snapper and 318 t of goldband snapper) was caught.
Spanish Mackerel Fishery (Figure 5.51)	Primarily Spanish mackerel (*Scomberomorus commerson*).	**Activity area?** **No.** **Spill EMBA?** **Possibly.**	Assumed year-round.	The primary fishing method used by all sectors is trolling, where baited hooks or lures are towed behind a boat moving at 3–6 knots near reefs, headlands and shoals. In 2021 there were 15 licences in the fishery, all of which were allocated.	Catch data available for the last five years: • 2019/20 – 357 t. • 2018/19 – 408 t. • 2017/18 – 372 t. • 2016/17 – 411 t. • 2015/16 – 399 t.
Offshore Net and Line Fishery (Figure 5.52)	Primarily grey mackeral (*S. semifasciatus*) and black-tip sharks (*Carcharhinidae limbatus*), with other shark species including hammerhead, bull, tiger, pigeye, lemon and winghead.	**Activity area?** **No.** **Spill EMBA?** **Possibly.**	Assumed year-round.	Demersal or pelagic longlines or pelagic net gear is permitted.	No data available.

Sources: NT Government (2019), DPIR (2021, 2019, 2018).

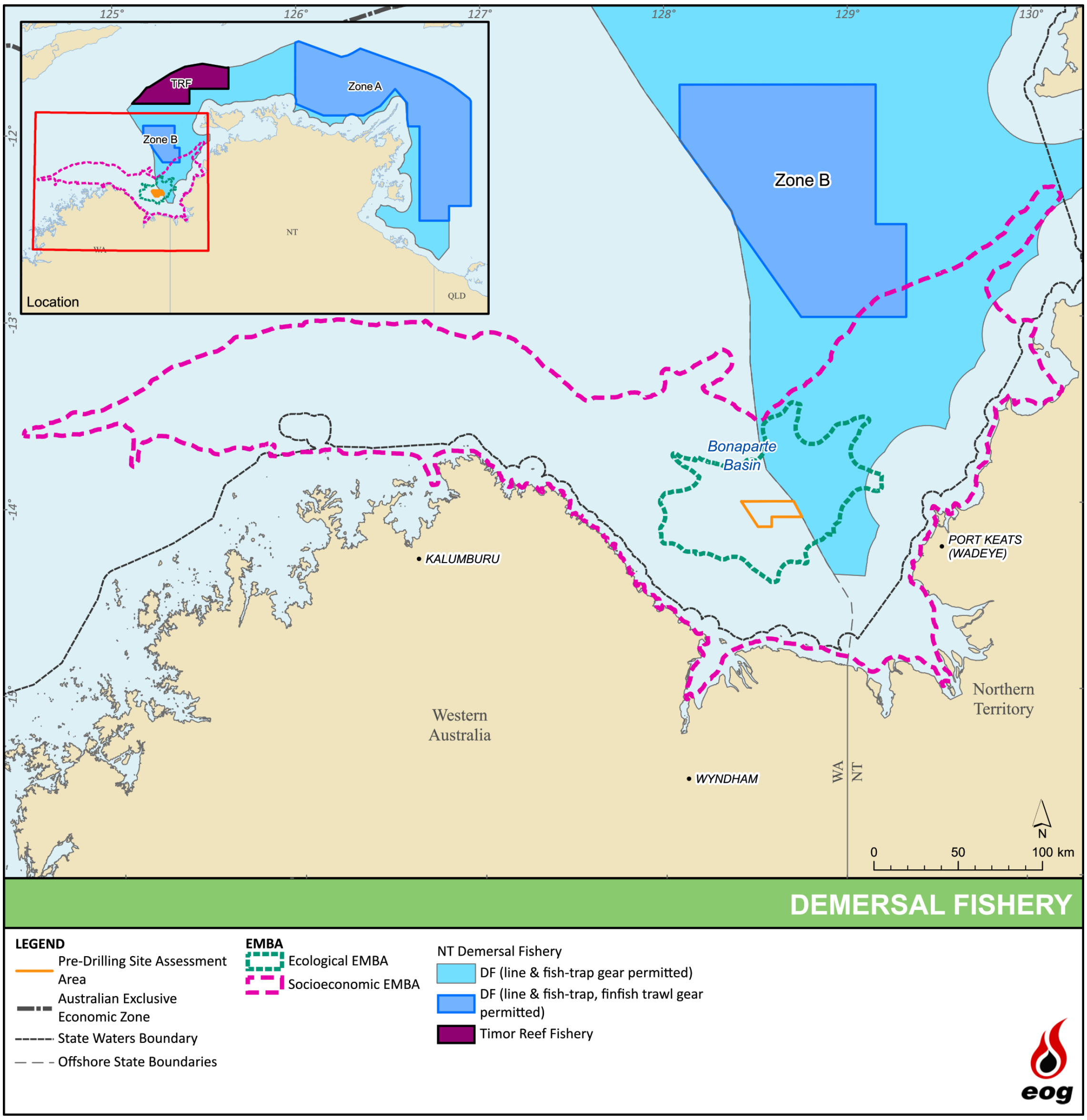


Figure 5.50. NT Demersal Fishery

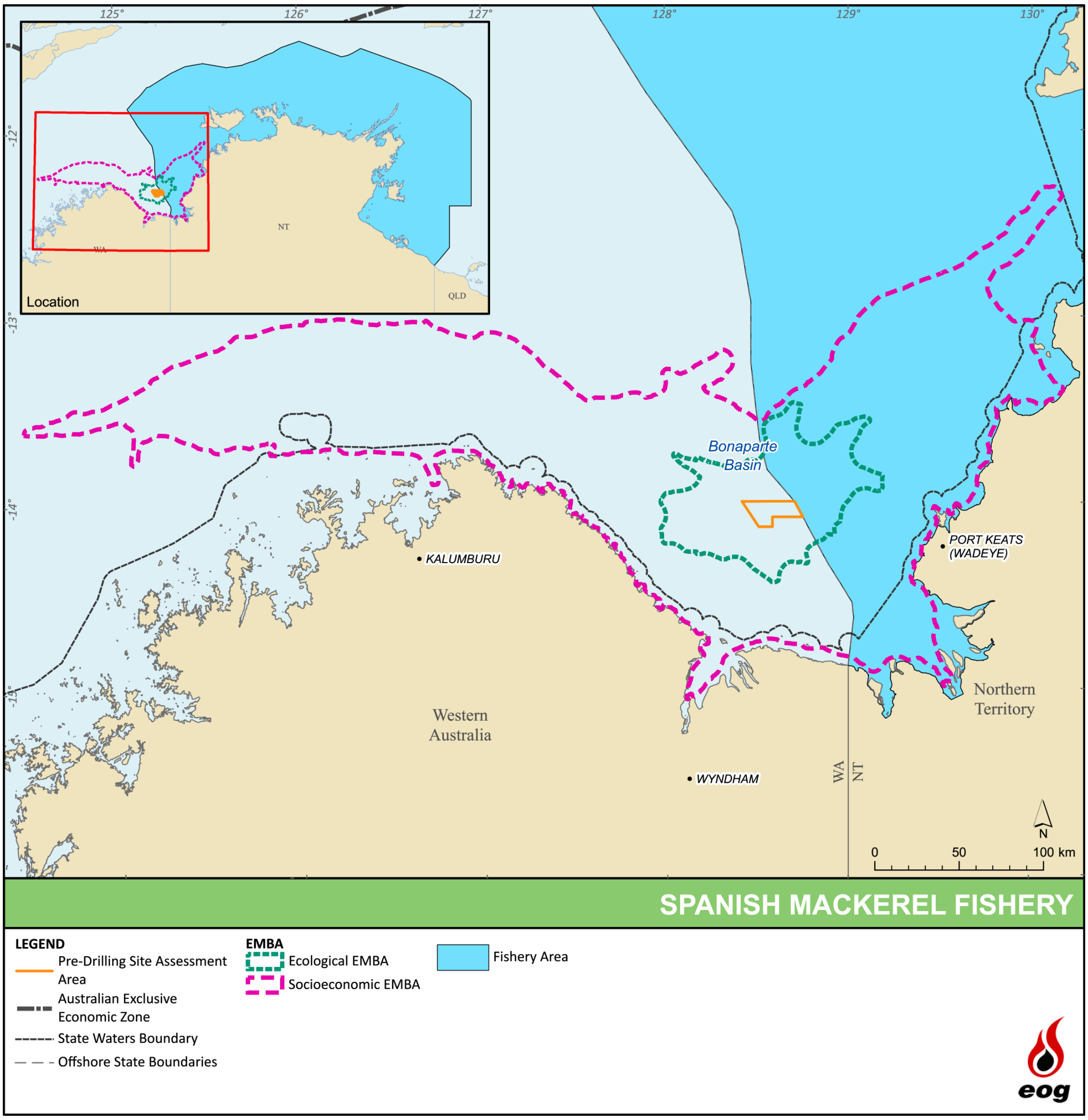


Figure 5.51. NT Spanish Mackerel Fishery

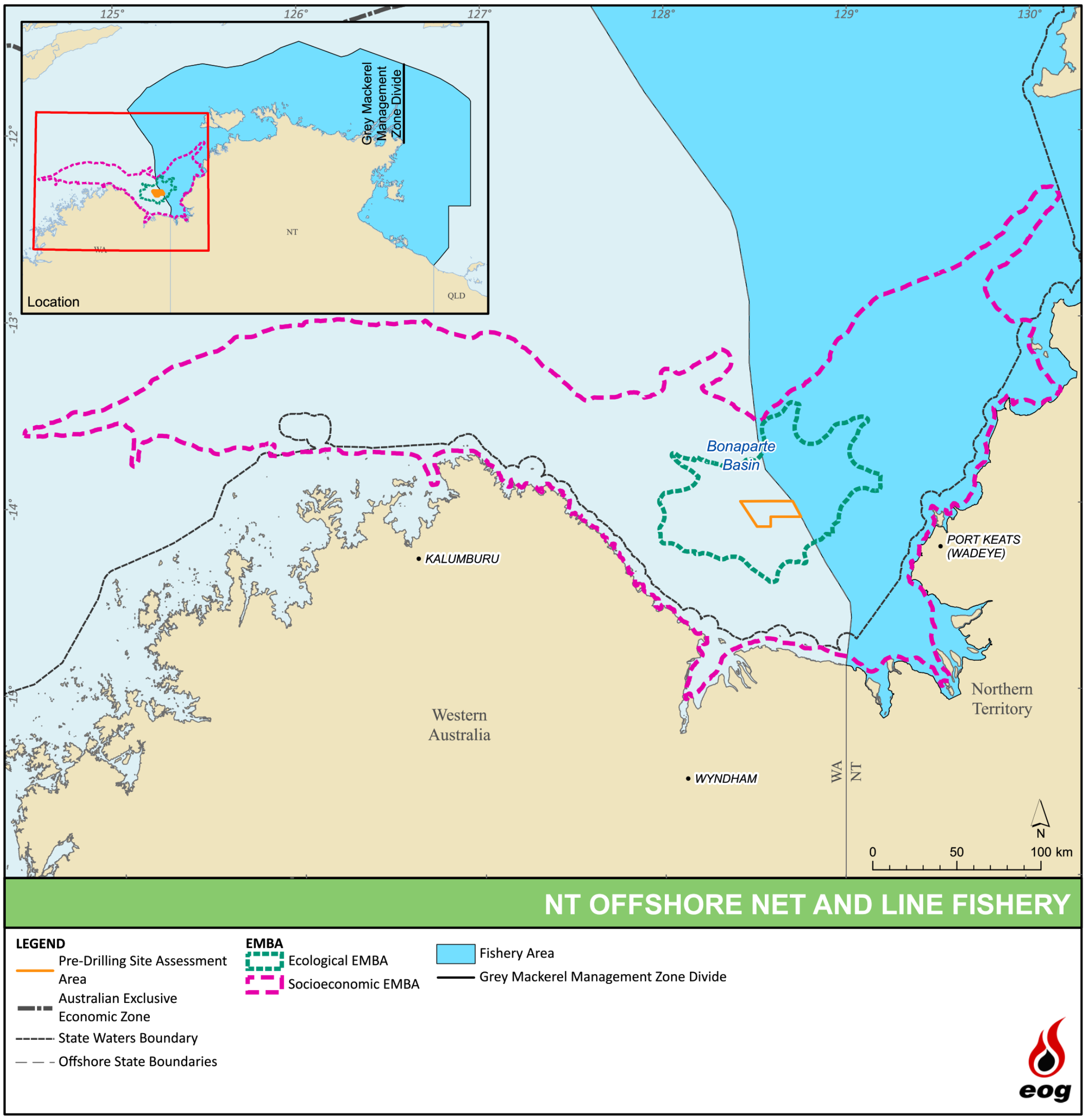


Figure 5.52. NT Offshore Net and Line Fishery

5.6.2. Recreational Fishing

Within the North Coast Bioregion, recreational fishing is experiencing significant growth, with a distinct seasonal peak in winter (Gaughan and Santoro, 2018). Offshore islands, coral reefs and continental shelf provide species of major recreational interest including tropical snapper, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Gaughan and Santoro, 2018). There are no islands, reefs or significant seabed features in the activity area that would attract recreational fishers to the activity area.

Recreational fishing activities are primarily based out of Darwin, located 288 km northeast of the activity area. Given the long distance of the activity area from the mainland and main population areas (e.g., Wadeye), there is expected to be little or no recreational fishing activities in the activity area.

RecFish West and the AFANT have not raised any issues regarding recreational fishing in or around the activity area.

5.6.3. Coastal Settlements

The coastline adjacent to the JBG is sparsely populated, with the townships of Wadeye, NT (85 km east) and Wyndham, WA (163 km south) being the closest.

The population of Wadeye was 2,260 people at the time of the 2016 census, with Aboriginal and/or Torres Strait Islander people making up 89.4% of the population (ABS, 2021). Of the employed people in Wadeye, the education and local government administration sectors were the largest employment sectors, which accounted for 21.7% of the workforce.

The population of Wyndham was 780 people at the time of the 2016 census, with Aboriginal and/or Torres Strait Islander people making up 53.7% of the population (ABS, 2021). Of the employed people in Wyndham, the social services, hospital and secondary education sectors were the largest employment sectors, which accounted for 30.5% of the workforce.

5.6.4. Tourism

The JBG is highly remote and therefore has not been significantly developed for tourism. For up to five months of the year, access to the JBG region is restricted to boat or helicopter due to wet season rains, and road access to areas of Aboriginal freehold land requires prior permission from the Northern Land Council (NLC) (Woodside, 2004).

There are no attractions in the activity area or immediate surrounds (e.g., known reefs, shipwrecks, canyons) to attract tourists.

Expedition cruise boats operate in the North Kimberley Marine Park in the dry season (April to October), between Broome and Wyndham or Darwin, and offer multi-day tours (DPW, 2016). Vessels used range from small fishing and sightseeing tour boats to large luxury cruise ships carrying up to 100 passengers (DPW, 2016). Access to the coast is possible although only by using a four-wheel drive. Scenic flights and fishing expeditions operate in connection with coastal accommodation or cruise boats as well as from Broome, Derby and Kununurra (DPW, 2016).

Charter fishing and tourism activities operate from Darwin and the Kimberley and target areas of high scenic value and/or offshore coral reef areas (Woodside, 2004). These attributes have been reported to be sparse in the offshore areas of the JBG, and therefore, given the isolated nature of the area, the likelihood of charter fishing and tourism is also anticipated to be low (Woodside, 2004). Charter boats operating out of Darwin and Broome/Derby may occasionally visit or pass through the JBG.

5.6.5. Offshore Energy Exploration and Production

The Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. The closest operation is the Blacktip Gas Field, located in adjacent permit WA-33-L and operated by ENI Australia (Figure 5.53). The Blacktip Gas Field consists of an unmanned WHP, two producing wells, flowlines and a subsea gas export pipeline (GEP) that runs from the WHP to shore near Wadeye, NT. The Blacktip GEP is located 1.8 km northeast of the activity area.

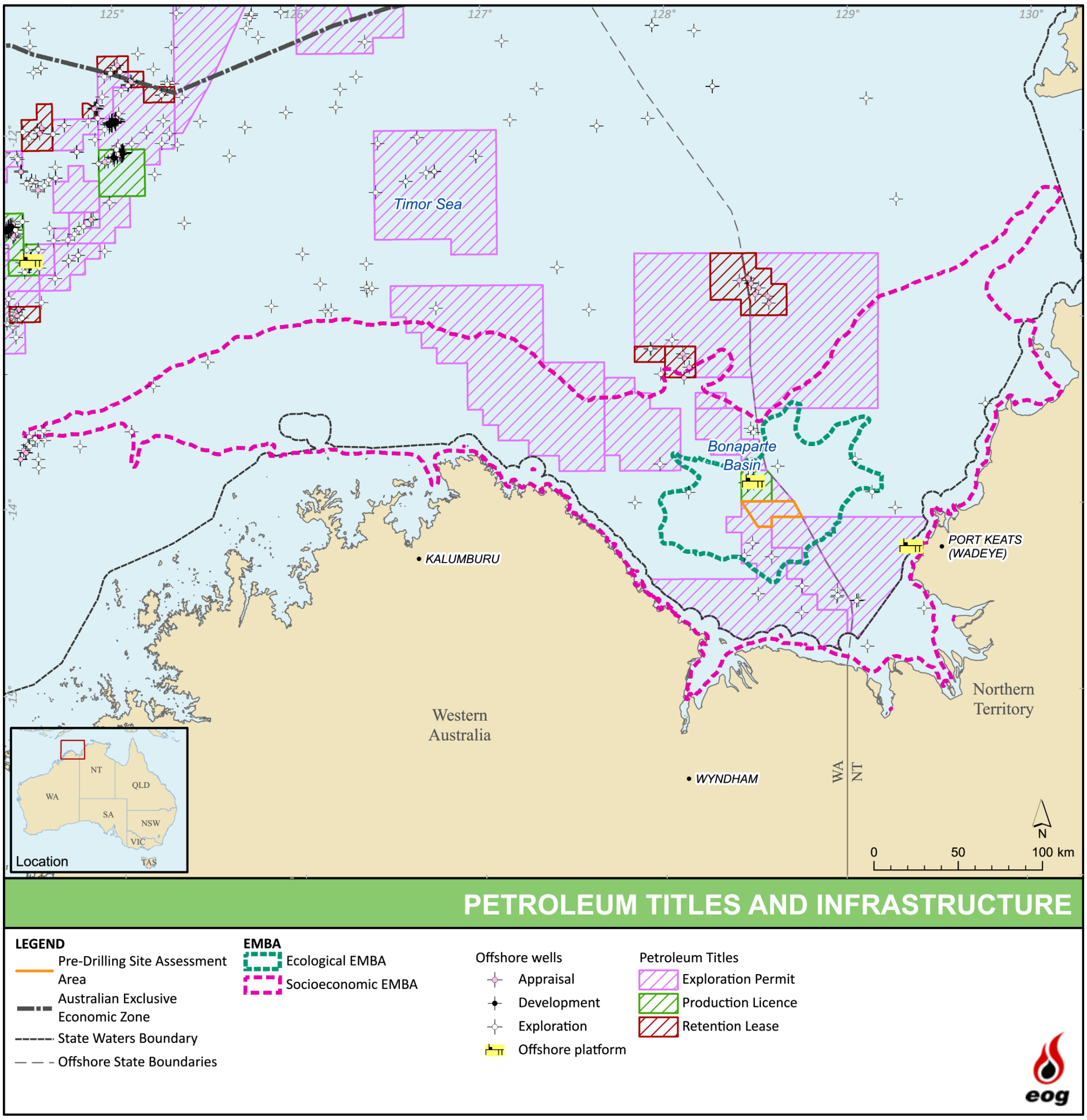


Figure 5.53. Petroleum activity in the spill EMBA

5.6.6. Commercial Shipping

The closest major commercial port is Darwin, located ~288 km northeast of the activity area. The location of the Darwin Port to Asia and the region's offshore oil and gas fields makes the surrounding area a key shipping region. High shipping and vessel traffic occurs in and around Darwin Harbour, around operating petroleum fields (such as Blacktip) and along key shipping routes to and from Southeast Asia and to and from oil and gas fields.

Very low levels of shipping traffic occur through the activity area. Using Automatic Identification System (AIS) data from AMSA and spatial analysis, it was determined that there is also a low level of shipping traffic in the areas immediately adjacent to the activity area and that vessels in this area are mainly transiting and not lingering. An analysis of the shipping traffic recorded from the activity area and its immediate surrounds (i.e., within 10 km of the activity area) is presented in Table 5.16. Shipping traffic in the activity area and EMBA using AIS data from August 2020 to July 2021 is presented in Figure 5.54. As indicated in Figure 5.54, the activity area is located south of the major shipping lanes coming out of Darwin, which contributes to the very low level of shipping traffic recorded in the region of the activity. The highest number of vessels (12) was recorded in June 2020 with only 1-2 vessels recorded in some months from August 2020-February 2021 and none recorded during March-April 2021. It is noted that some vessels may not possess AIS technology and therefore not appear in the AMSA dataset, though this is considered to be unlikely or representative of only a low number of smaller vessels.

Table 5.16. Commercial shipping traffic recorded in the activity area

Type	2020					2021						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Undefined	2	1	-	-	-	-	-	-	-	5	8	-
Engaged in diving operation	-	-	-	1	-	-	-	-	-	-	-	1
Fishing	-	-	-	-	1	-	-	-	-	-	1	1
Other	-	-	1	-	-	-	-	-	-	-	1	1
Pleasure craft	-	-	-	-	-	-	-	-	-	-	1	-
Port tender	-	-	1	-	-	1	1	-	-	-	-	2
Sailing	-	-	-	-	-	-	-	-	-	1	1	1
Tanker - all	-	-	-	-	1	-	1	-	-	-	-	-
Total	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**-**	**-**	**6**	**12**	**6**

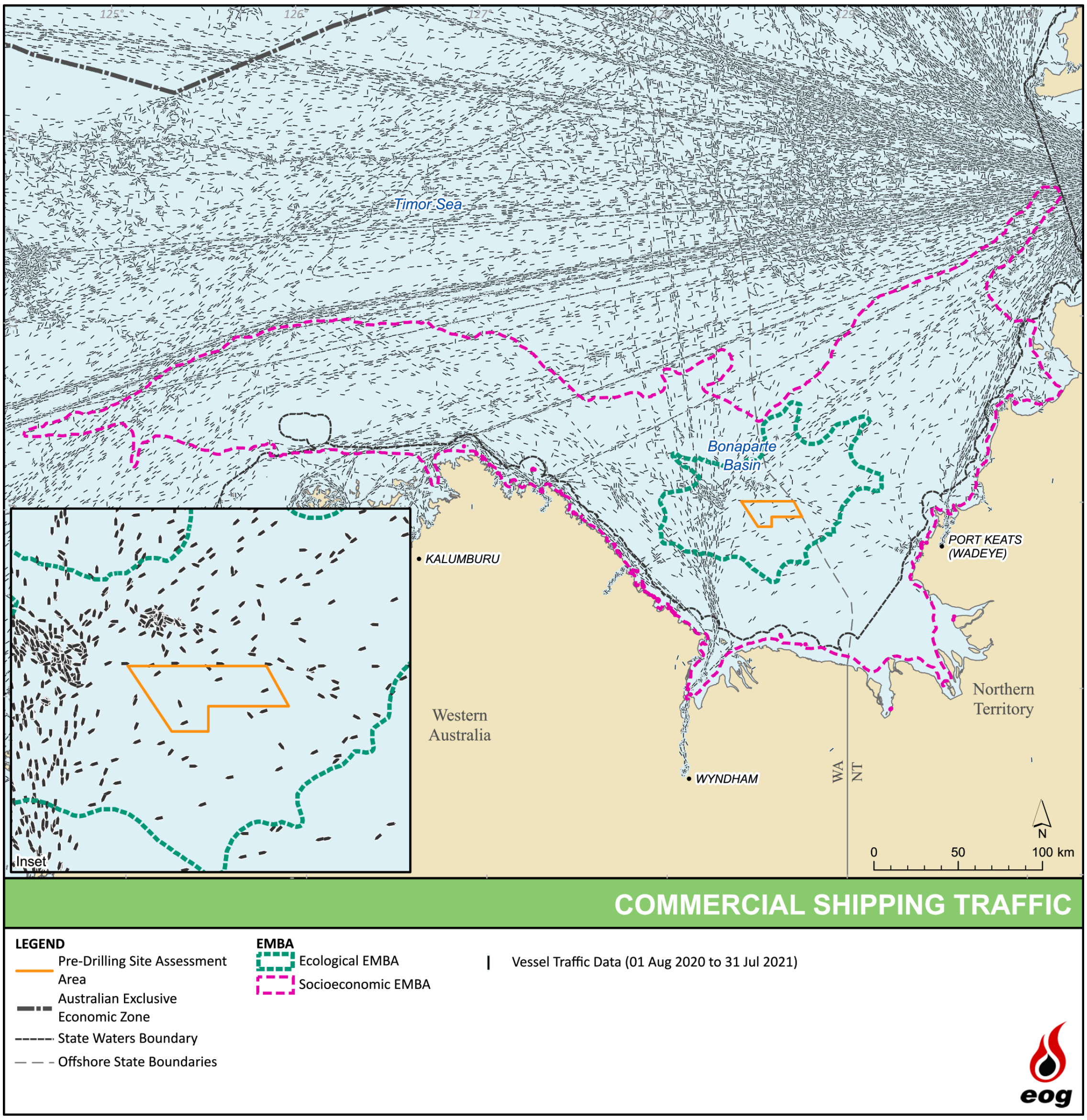


Figure 5.54. Commercial shipping traffic in the activity area and spill EMBA

5.6.7. Defence Activities

The activity area is overlapped by a defence training area, which is a maritime military zone administered by the Australian Defence Force (Figure 5.55). This is an area where exercises such as operational aerial training or live weapon firing may occur. The DoD has advised that military flying training may take place over the activity area, with aircraft flying as low as 500 feet above the water.

There is also an Air to Air Refuelling (AAR) and Airborne Early Warning and Control (AEW&C) airspaces that overlap the activity area and EMBA. The EMBA (but not the activity area) also intersects an area with potential for unexploded ordnance (UXO), which is presented in Figure 5.56. The DoD have stated that beyond the data presented in Figure 5.56, there are no records of specific UXO in the activity area.

Australian Border Force and Australian Defence Force vessels undertake civil and maritime surveillance within the region with the primary purpose of monitoring the passage of illegal entry vessels and illegal fishing activity within these areas. Refugees seeking asylum in Australia are also known to utilise the area, travelling between Indonesia and Australia.

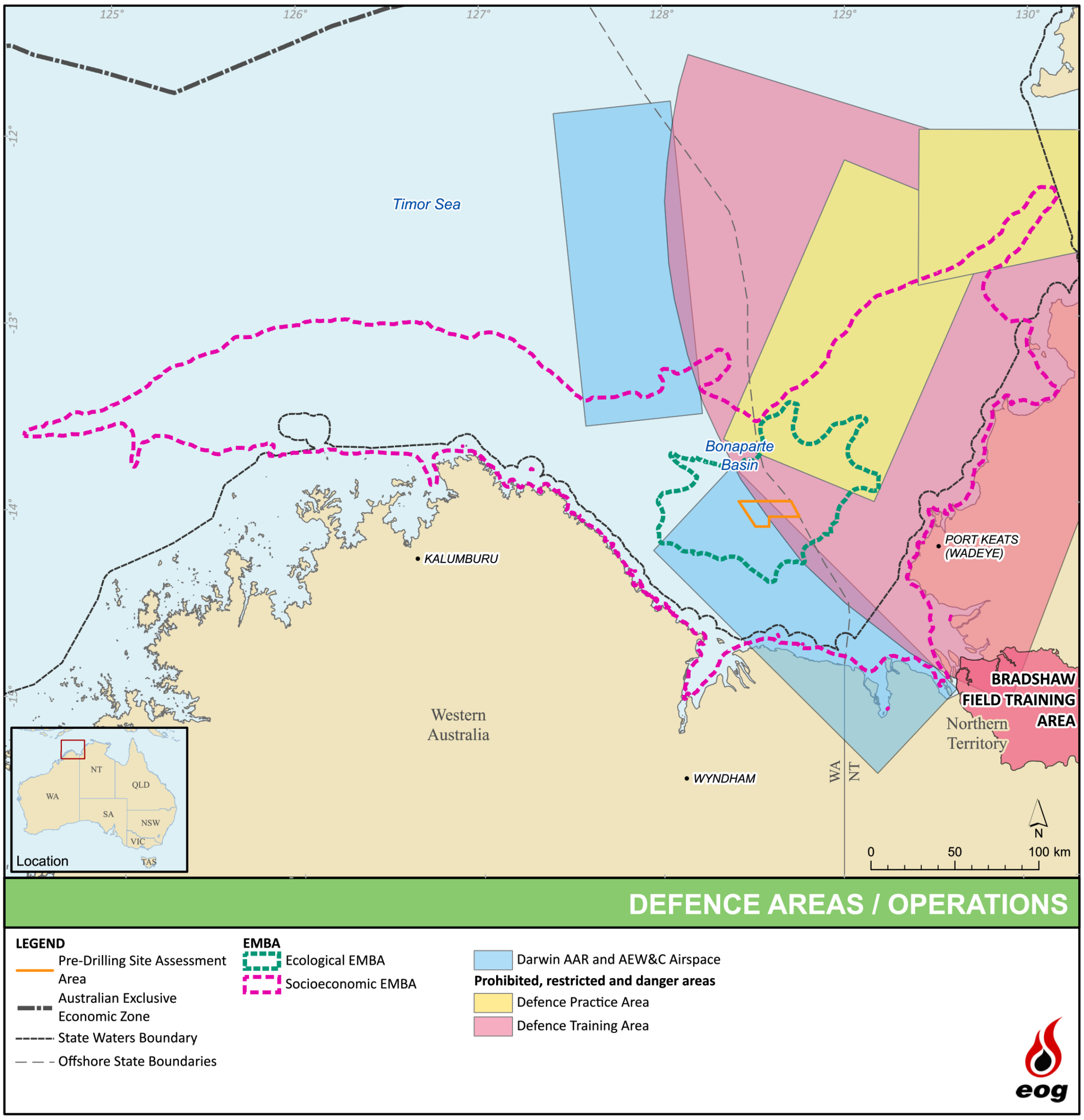
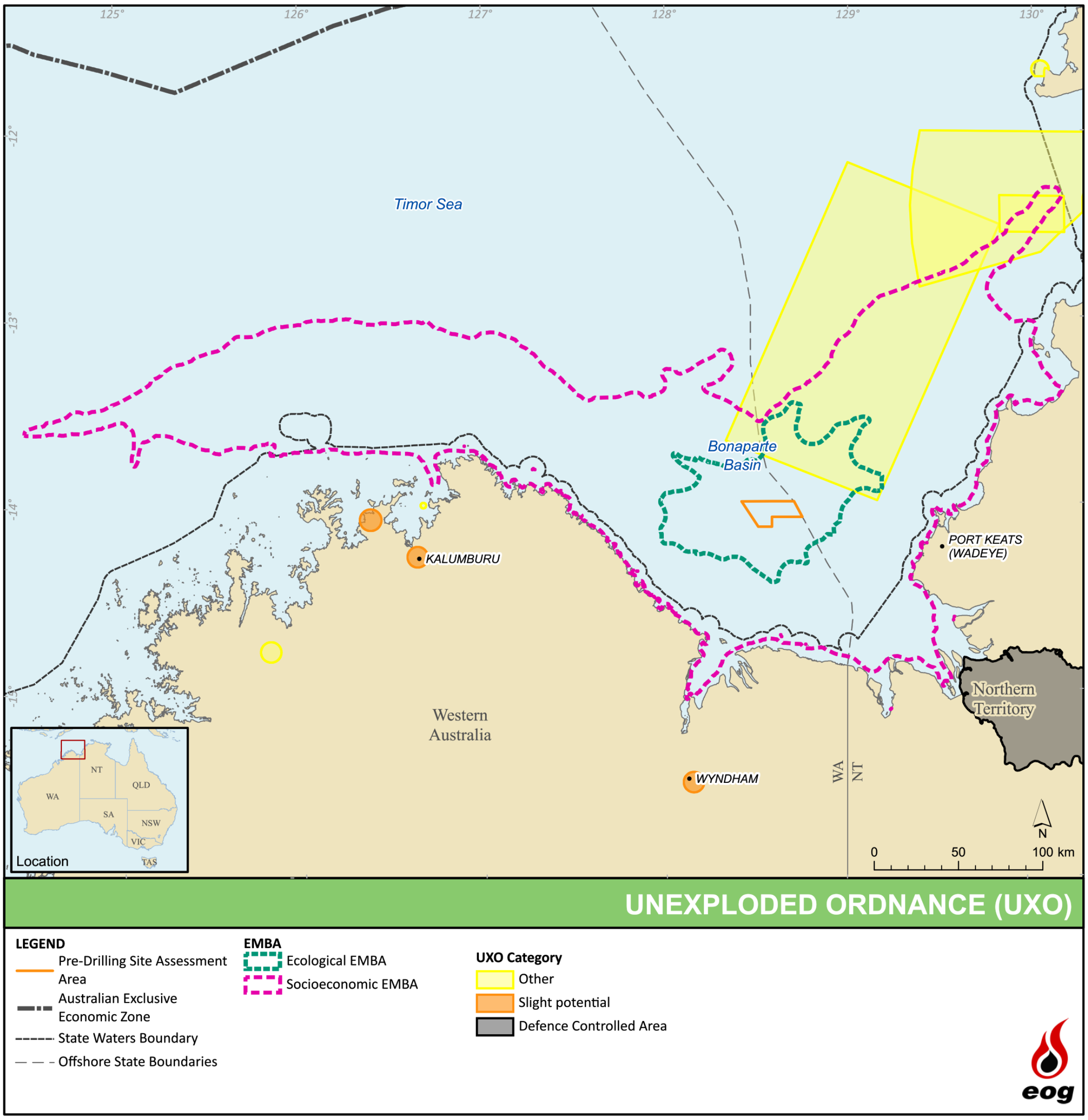


Figure 5.55. Defence areas intersected by the activity area and spill EMBA



Source: DoD (2021).

Figure 5.56. Unexploded ordnance risk in the EMBA

6. Environmental Impact & Risk Assessment Methodology

As required under Regulation 13(5) of the OPGGS(E), this chapter describes the environmental impact and risk assessment methodology used in this EP.

The EOG Environmental Management System defines the company's requirements to mitigate and manage environmental risks at all levels within the business, and this risk management framework is described in this section. This framework is consistent with the Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000:2018, *Risk Management – Principles and Guidelines*).

Figure 6.1 outlines the risk assessment management process, with each step of this process described in this chapter. Note that for simplicity, this process is called a risk assessment process, even though impacts and risks are defined differently (see Section 6.3.1 for more information).

Figure 6.1. Risk management framework

6.1. Step 1 – Establish the Context

The first step in the risk assessment process is to establish the context. This involves:

- Understanding the regulatory framework in which the activity takes place (described in the 'Environmental Regulatory Framework' in Chapter 3);
- Defining the activities that will cause impacts and create risks (outlined in the 'Activity Description' in Chapter 2);
- Understanding the concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Chapter 4, 'Stakeholder Consultation'); and
- Describing the environment in which the activity takes place (the 'Existing Environment' is described in Chapter 5).

Once the context has been established, the hazards of the activity can be identified, along with the impacts and risks of these hazards. This process is described in the following sections.

6.2. Step 2 – Communicate and Consult

In accordance with Regulations 11A and 14(9) of the OPGGS(E), EOG has consulted with relevant persons in the development of this EP to obtain information about their functions, activities and interests and assess how the activity may impact on these. This information has been used to inform the impact and risk assessment in the EP. The stakeholder consultation process is described in detail in Chapter 4.

6.3. Step 3 – Identify Risks

The steps used to identify the risks associated with each aspect of the activity include:

- Identify each hazard associated with the activity;
- Identify the sensitive environmental resources within and adjacent to the activity area;
- Identify the impacts and risks associated with each hazard;
    - For impacts, identify the environmental consequence of the impacts.
    - For risks, identify the likelihood (probability) of the risk occurring and the consequence if it does occur.
- Identify control measures; and
- Assign a level of risk to each potential environmental impact using a risk matrix.

In accordance with this framework, all risks must be reduced to a level that is considered to be As Low As Reasonably Practicable (ALARP) (see Section 6.8.1).

A risk identification and assessment workshop was undertaken on 31 August 2021 to identify the key impacts and risks associated with the activity. Following the review of each hazard and their associated impacts and risks, control measures were also reviewed to ensure the impact consequence or risk rating is ALARP. An assessment of what is 'reasonably practicable' requires professional judgements to be made against the relevant matrices using the advice of technical experts as well as published standards, availability of mitigation measures and industry practice.

The information from this workshop is captured within the activity risk register, which has been used as the basis for the impact and risk assessment in Chapter 7.

6.3.1 Definitions

The OPGGS(E) Regulations 14(5)(6) require that the EP detail and evaluate the environmental impacts and risks for an activity, including control measures used to reduce the impacts and risks of the activity to ALARP and an acceptable level. This must include impacts and risks arising directly or indirectly from all activity operations (i.e., planned events) or potential emergency conditions or incidents (i.e., unplanned events).

In its *Environment Plan content requirements* guidance note (N-04750-GN1344, September 2020), NOPSEMA distinguishes between environmental impacts and risks. For context, Table 6.1 provides the definitions of impacts and risk according to the OPGGS(E) and international risk management standards.

Table 6.1. Definitions of impact and risk

Source	Impact	Risk
OPGGS(E) (Regulation 4)	Any change to the environment, whether adverse or beneficial, that wholly or partially results from an activity.	Not defined.
Environment Plan content requirements Guidance Note (N-04750-GN1344, September 2020)	A planned event, an inherent part of the activity.	Not defined.
Environment Plan decision making Guideline (N04750-GL1721, June 2021)	Any change to the environment, whether adverse or beneficial, that wholly or partially results from an activity.	Not defined.
NOPSEMA website (Environment > Assessment Process > Environment Plans > Titleholder FAQs)	Impact assessment is concerned with events that are reasonably certain to occur.	Risk assessment is concerned with events that may possibly occur.
ISO AS/NZS 31000: 2018 (Risk management – Principles and guidelines)	Not defined.	The effect of uncertainty on objectives.
ISO AS/NZS 14001: 2016 (Environmental management systems – Requirements with guidance for use)	Not defined.	The effect of uncertainty on objectives.
ISO AS/NZS 4360: 2004 (Risk management)	Not defined.	The chance of something happening that will have an impact on objectives.
HB203: 2012 (Managing environment-related risk)	Any change to the environment or a component of the environment, whether adverse or beneficial, wholly or partly resulting from an organisation's environmental aspects.	The effect of uncertainty on objectives. The level of risk can be expressed in terms of a combination of the consequences and the likelihoods of those consequences occurring.

For this activity, EOG has determined that impacts and risks are defined as follows:

- **Impacts** result from **planned** events – there *will* be consequences (known or unknown) associated with the event occurring. Impacts are an inherent part of the activity. For example, acoustic discharges will be generated during the PDSA and this will have consequences for marine life.
    - For impacts, only a consequence is assigned (likelihood is irrelevant given that the event will occur) (as per the risk matrix in Table 6.2).
- **Risks** result from **unplanned events** – there *may* be consequences if an unplanned event occurs. Risks are not an inherent part of the activity. For example, a hydrocarbon spill may occur if the survey vessel collides with another vessel, but this is not a certainty. The risk of this event is determined by multiplying the consequence of the impact (using factors such as the type and volume of hydrocarbons and the nature of the receiving environment) by the likelihood of this event happening (which may be determined objectively or subjectively, qualitatively or quantitatively).
    - For risks, the consequence and likelihood are combined to determine the risk rating (see Table 6.2).

6.4. Step 4 – Analyse the Risks

When analysing risk, the following must be considered:

- Identify the maximum credible consequence (being the reasonable worst case but non-fanciful outcome) arising from the impact or risk without introducing controls ('inherent' consequence). Then do the same after controls are introduced to determine the 'residual' consequence.
- Identify the likelihood of the risk event occurring ('remote' through to 'likely'), considering the controls identified and their effectiveness (inherent and residual).
- For risks, determine the level of risk using the matrix, being the intersection of consequence and likelihood.

This process is outlined here.

6.4.1 Consequence Criteria

'Consequence' refers to the maximum credible outcome of an event affecting a receptor, value or use. EOG's consequence criteria are presented in Table 6.2. Where there is uncertainty or incomplete information, a conservative assessment is made on the basis of the maximum credible consequence. Consequence criteria have been developed to consider the extent, severity and duration of the impact or risk. Assigning a consequence criteria to a hazard also takes into account:

- Past records;
- Relevant experience;
- Industry practice and experience;
- Relevant published literature;
- Quantitative or engineering modelling; and
- Specialist or expert judgement.

Table 6.2. Consequence criteria

Consequence	Definition
Beneficial	• Likely to cause enhancement to the environment or socioeconomic benefits.
Negligible	• No changes, or small adverse changes unlikely to be noticed or measurable against background conditions.
Minor	• Adverse changes that can be monitored and/or noticed, but are within the scope of existing variability and do not meet any of the 'severe' or 'moderate' impact definitions.
Moderate	One or more of the following: • Localised, occasional violations of air or water quality standards or guidelines. • Localised contamination of sediments. • Localised damage to sensitive habitats such as hard bottom areas, chemosynthetic communities, mangroves or wetlands. • A few deaths or injuries of protected species, occasional, temporary disruption of their critical activities (e.g., breeding, nesting, nursing), and/or localized damage to their critical habitat. • Localised, short-term interference with fishing activities, recreation or tourism. • Localised damage to or contamination of beaches, parks, tourism areas, or other recreational resources. • Localised, short-term adverse impacts on the economy or socio-economic conditions.
Severe	One or more of the following: • Extensive, continual violation of air or water quality standards or guidelines. • Extensive, persistent contamination of sediments. • Extensive damage to sensitive habitats such as hard bottom areas, chemosynthetic communities, mangroves, or wetlands. • Extensive damage to non-sensitive habitats to the extent that ecosystem function and ecological relationships would be altered. • Numerous deaths or injuries of a protected species, continual disruption of their critical activities (e.g., breeding, nesting, nursing), and/or destruction of their critical habitat. • Extensive, continual interference with fishing activities, recreation, or tourism. • Extensive, persistent damage to or contamination of important cultural, historical or religious sites or tourism areas. • Extensive, persistent adverse impacts on the economy or socio-economic conditions. • A threat to public health or public safety. • Substantial public controversy or social unrest.

6.4.2 Likelihood Criteria

'Likelihood' refers to the chance of an event happening and the maximum credible consequence occurring from that event. EOG's likelihood criteria are presented in Table 6.3.

Table 6.3. Likelihood criteria

Probability	Definition
Likely	Can reasonably be expected to occur one or more times during the project. Impacts of most routine project activities are in this category.
Occasional	Not planned or expected, but could occur at some time during the project.
Rare	Highly unlikely; exceptional conditions may allow the event to occur during the project.
Remote	Has occurred before in the industry but is extremely unlikely to occur during the project.

6.4.3 Risk Matrix

Risk levels are assessed using the matrix presented in Table 6.4. The risk is evaluated by 'multiplying' likelihood and consequence. The recommended form of treatment action, escalation and monitoring for each risk level is provided in Table 6.5.

The 'initial' rating (pre-treatment) and 'residual' risk rating (with control measures adopted) for each impact and risk is provided in Chapter 7.

Table 6.4. EOG risk assessment matrix

LEGEND		Decreasing impact consequence ←				
		Beneficial	Negligible	Minor	Moderate	Severe
Decreasing probability ↓	Likely	Beneficial	Negligible	Low	Medium	High
	Occasional	Beneficial	Negligible	Low	Medium	High
	Rare	Beneficial	Negligible	Negligible	Low	High
	Remote	Beneficial	Negligible	Negligible	Low	Medium

Table 6.5. 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.

6.5. Step 5 – Evaluate the Risk

The purpose of impact and risk evaluation (herein referred to simply as risk assessment) is to assist in making decisions, based on the outcomes of analysis, about the sorts of controls required to reduce an impact or risk to ALARP. Planned and unplanned events are subject to risk assessment in the same manner.

Risk evaluation also considers the following:

- Defining the level of risk (higher and lower order impacts and risks);
- Demonstration of ALARP;
- Uncertainty of impacts and risks;
- Demonstration of acceptability; and
- Principles of ecologically sustainable development (ESD).

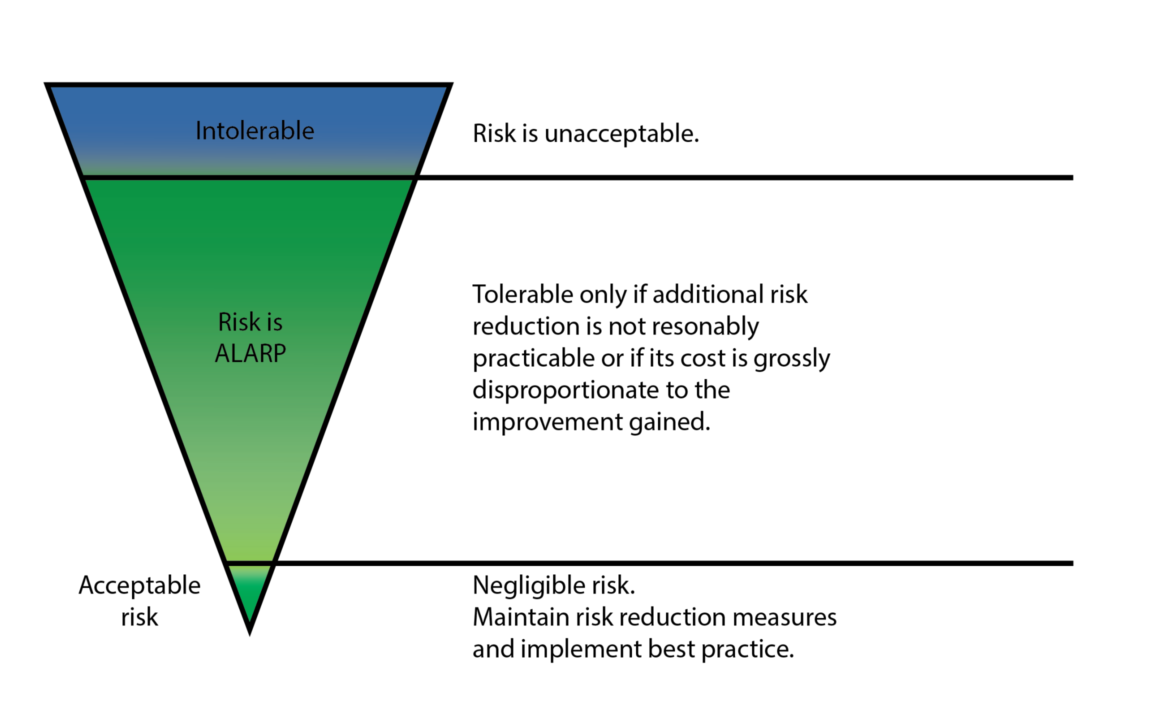
Each of these considerations is described in more detail in this section.

6.5.1. Demonstration of ALARP

The ALARP principle states that it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent attempting to reduce an impact or risk to zero. This concept is shown diagrammatically in Figure 6.2.

EOG's approach to demonstrating ALARP includes:

- Systematically identifying and assessing all potential environmental impacts and risks associated with the activity;
- Where relevant, applying industry 'good practice' controls to manage impacts and risks;
- Assessing available and feasible control measures for their environmental benefit and cost, which is summarised in a cost-benefit analysis; and
- For higher order impacts and risks, implementing further controls if feasible and reasonably practicable to do so.



Source: CER (2015).

Figure 6.2. The ALARP Principle

There is no universally-accepted guidance to applying the ALARP principle to environmental assessments. For this EP, the guidance provided in NOPSEMA's *Environment Plan decision making guideline* (N-04750-GL1721, June 2021) has been applied and augmented where necessary.

The level of ALARP assessment is dependent upon the:

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

An iterative risk evaluation process is employed until such time as any further reduction in the residual risk ranking is not reasonably practicable to implement. At this point, the impact or risk is reduced to ALARP. The determination of ALARP is outlined in Table 6.6.

Table 6.6. Alignment of EOG consequence and risk ratings with ALARP ratings

Consequence rating	Beneficial	Negligible	Minor	Moderate	Severe
ALARP level – planned event	Broadly acceptable	Tolerable if ALARP			Intolerable
Residual impact category	Lower order			Higher order	
Risk rating	Beneficial	Negligible	Low	Medium	High
ALARP level - unplanned event	Broadly acceptable	Tolerable if ALARP		Intolerable	
Residual risk category	Lower order risks			Higher order risks	

A description of how the ALARP process is applied to the impact and risk assessment process for the project is presented in this section.

Hierarchy of Controls

EOG demonstrates ALARP, in part, by adopting the 'Hierarchy of Controls' philosophy (Figure 6.3). The hierarchy of controls is a system used across hazardous industries to minimise or eliminate exposure to hazards. The hierarchy of controls is, in order of effectiveness:

- Elimination;
- Substitution;
- Engineering controls;
- Administrative controls; and
- Personal protective equipment (PPE) – this has not been included here as it is specific to the assessment of safety risks rather than environmental management.

Although commonly used in the evaluation of occupational health and safety hazard control, the hierarchy of controls philosophy is also a useful framework to evaluate potential environmental controls to ensure reasonable and practicable solutions have not been overlooked. To this effect, the assessment of control measures presented in the impact and risk assessment tables in Chapter 7 take into account the hierarchy of controls, in the order listed above.

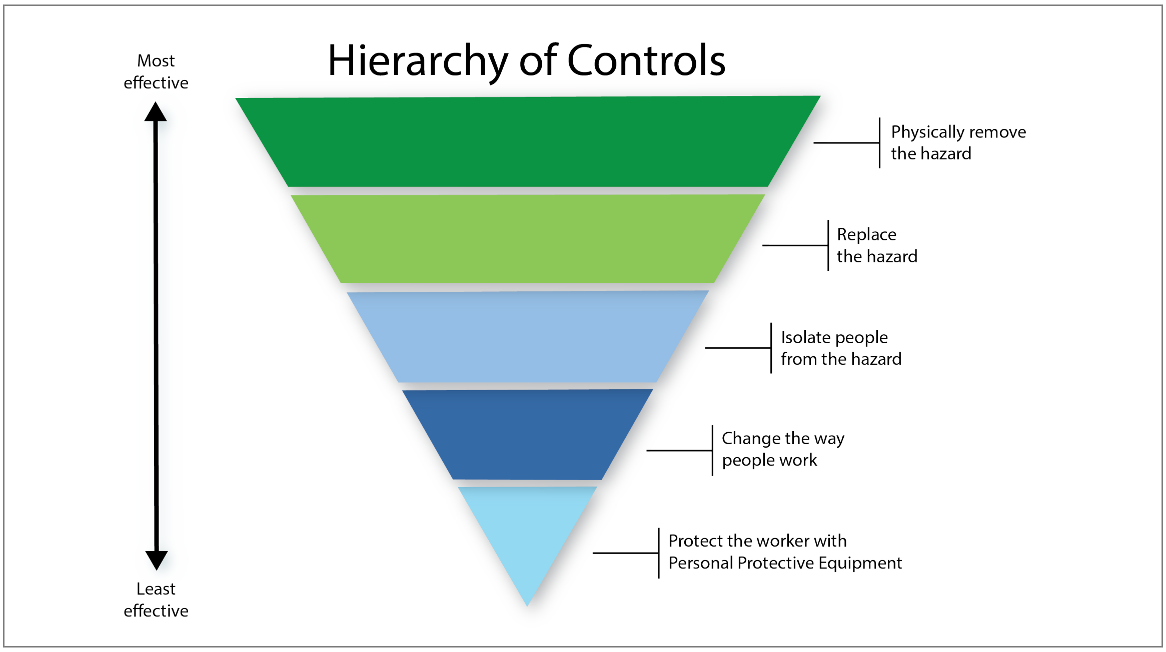


Figure 6.3. The Hierarchy of Controls

Assessing the Suitability of Available Control Measures

NOPSEMA's *Environment Plan decision making guideline* (N-04750-GL1721, June 2021) states that in order to demonstrate ALARP, a titleholder must be able to implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure. This process is applied in the demonstration of ALARP sections in the impact and risk assessment tables throughout Chapter 7.

When deciding on whether to implement proposed control measures in the impact and risk assessment tables in Chapter 7, the issues outlined in Table 6.7 are considered.

Table 6.7. Considerations for the adoption of control measures

Consideration	Question
Environmental benefit (EB)	• Does it provide a clear or measurable reduction in environmental impact or risk? • What are the environmental benefits to receptors if the measure is adopted?
Cost (C)	• What is the relative cost (which includes money, time, and resources) that may be borne by EOG if the control measure is adopted? • Does it introduce additional risk in other operational areas (e.g., will the implementation of a control measure have an impact elsewhere (such as additional emissions and discharges or safety risks to personnel))? • Is it technically feasible and can it be implemented?
Evaluation (Ev)	• Is it consistent with national or industry standards and practices? • Will the change be effective, taking into account the: o Sensitivity of the receptor; o Current level of risk with the existing controls; o Amount of additional risk reduction that the control will deliver; o Level of confidence that the risk reduction impact will be achieved; and o Resources, schedule and cost required to implement the control.

Reducing impacts and risks to ALARP is an ongoing process and new risk reduction measures may be identified at any time, including during the activity. EOG actively encourages recording and review of observations through its incident management system. Incidents and lessons learned within EOG and from the wider industry are reviewed and utilised to identify hazards and controls.

Defining the Level of Risk

Lower-order Environmental Impacts and Risks

NOPSEMA defines lower-order environmental impacts and risks as those where the environment or receptor is not formally managed, less vulnerable, widely distributed, not protected and/or threatened and there is confidence in the effectiveness of adopted control measures.

Impacts and risks are considered to be lower-order and ALARP when, using EOG's risk matrix (see Table 6.4), the residual:

- Impact consequence is rated as 'beneficial', 'negligible' or 'minor'; or
- Risk rating is 'beneficial', 'negligible' or 'low' (see also Table 6.5).

In these cases, applying 'good industry practice' (see Section 6.8.3) control measures is sufficient to manage the impact or risk to ALARP.

Higher-order Environmental Impacts and Risks

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

Impacts and risks are considered to be higher-order when, using the EOG risk matrix (see Table 6.4), the residual:

- Impact consequence is rated as 'moderate' or 'severe'; or
- Risk rating is 'medium' or 'high' (see also Table 6.5).

In these cases, further controls must be considered as per Section 6.8.3.

Uncertainty of Impacts and Risks

Based upon the level of uncertainty associated with the impact or risk, the following framework, adapted by NOPSEMA (2015) from the Guidance on Risk Related Decision Making (Oil & Gas UK, 2014) (Figure 6.3) provides the decision-making framework to establish ALARP.

This framework provides appropriate tools, commensurate to the level of uncertainty or novelty associated with the impact or risk (referred to as the Decision Type A, B or C). The decision type is selected based on an informed decision around the uncertainty of the risk. Decision types and methodologies to establish ALARP are outlined in Table 6.8.

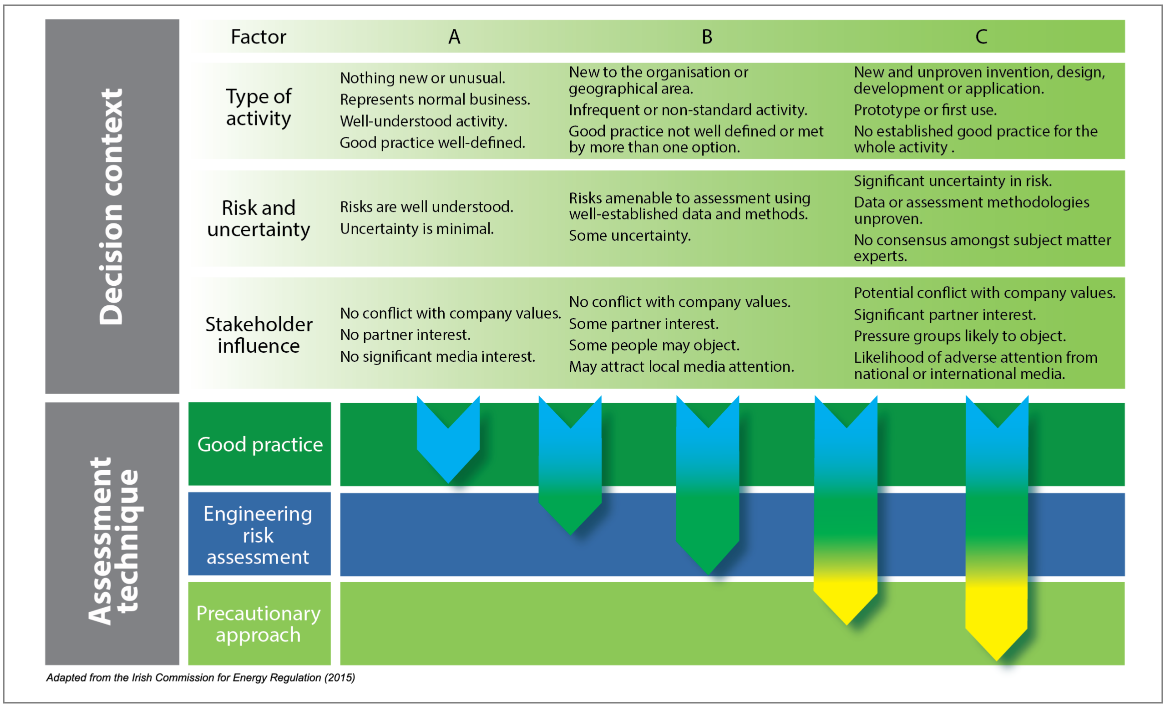


Figure 6.4. Impact and risk 'uncertainty' decision-making framework

Table 6.8. ALARP decision-making based upon level of uncertainty

Decision type	Decision-making tools
A	<u>Good industry practice</u> Identifies the requirements of legislation, codes and standards that are to be complied with for the activity. Applies the 'Hierarchy of Controls' philosophy, which is a system used in the industry to identify effective controls to minimise or eliminate exposure to impacts or risks. Identifies further engineering control standards and guidelines that may be applied over and above that required to meet the legislation, codes and standards.
B	*In addition to decision type A:* <u>Engineering risk-based tools</u> Engineering risk-based tools to assess the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost benefit analysis to support the selection of control measures identified during the risk assessment process.
C	*In addition to decision type A and B:* <u>Precautionary Principle</u> Application of the Precautionary Principle is to be applied when good industry practice and engineering risk-based tools fail to address uncertainties.

The decision-making tools outlined in Table 6.8 are explained further here.

<u>Good Practice</u>

In the absence of an Australian definition, the OGUK (2014) and the Irish Commission for Energy Regulation (CER) (2015) define 'Good Practice' as:

> *The recognised risk management practices and measures that are used by competent organisations to manage well-understood hazards arising from their activities.*

NOPSEMA has not endorsed any 'approved codes of practice' or standards to give them a legal status in terms of good practice. Good practice is taken to refer to any well-defined and established standard or codes of practice adopted by an industrial/occupational sector, including 'learnings' from incidents that may yet be incorporated into standards.

Good practice can also be used as the generic term for those standards for controlling risk that have been judged and recognised as satisfying the law when applied to a particular relevant case in an appropriate manner. For this EP, sources of good practice, adapted from CER (2015) are the relevant:

- Commonwealth, state and territory legislation and regulations (outlined in Section 3.2 and Section 3.3);
- Government guidance (outlined in Section 3.4);
- International conventions (outlined in Section 3.5); and
- Industry standards (outlined in Section 3.6).

Good practice also requires that hazard management is considered in a hierarchy, with the concept being that it is inherently safer to eliminate a hazard than to reduce its frequency or manage its consequences (CER, 2015). This being the case, the 'hierarchy of controls' philosophy is applied to reduce the risks associated with hazards (described in Section 6.8.1).

<u>Engineering Risk Assessment</u>

All impacts and risks that require assessment beyond that of good practice (i.e., decision type A) are subject to an engineering risk assessment.

Engineering risk-based tools can include, but are not limited to, engineering analysis (e.g., structural, fatigue, mooring, process simulation) and consequence modelling (e.g., ship collision, dropped object) (CER, 2015). A cost-benefit analysis to support the selection of control measures identified during the risk assessment process may also be undertaken.

<u>Precautionary Principle</u>

All impacts and risks that do meet decision type A or type B and require assessment beyond that of good practice and engineering risk assessment are subject to the 'Precautionary Principle'. CER (2015) states that if the assessment, taking account of all available engineering and scientific evidence, is insufficient, inconclusive or uncertain, then the precautionary principle should be adopted in the hazard management process. While there is no globally-recognised definition of the Precautionary Principle, it is generally accepted to mean:

> *Uncertain analysis is replaced by conservative assumptions which will increase the likelihood of a risk reduction measure being implemented.*

The degree to which this principle is adopted should be commensurate with the level of uncertainty in the assessment and the level of danger (hazard consequences) believed to be possible.

Under the precautionary principle, environmental considerations are expected to take precedence over economic considerations, meaning that an environmental control measure is more likely to be implemented. In this decision context, the decision could have significant economic consequences to an organisation.

6.5.2. Demonstration of Acceptability

Regulation 13(5)(c) of the OPGGS(E) requires the EP to demonstrate that environmental impacts and risks are acceptable.

EOG considers a range of factors to demonstrate the acceptability of the environmental impacts and risks associated with its activities. This evaluation works at several levels, as outlined in Table 6.9. The criteria for demonstrating acceptability were developed based on EOG's interpretation of NOPSEMA's *Environment Plan decision making guideline* (N-04750-GL1721-GL1721, June 2021).

Table 6.9. Acceptability criteria

Test	Question	Acceptability demonstrated
Internal context		
Policy compliance	Is the proposed management of the hazard aligned with EOG's Safety and Environmental Policy?	The impact or risk must be compliant with the objectives of the policy.
Management System Compliance	Is the proposed management of the hazard aligned with EOG's Safety and Environment Management System?	Where specific EOG procedures, guidelines or expectations are in place for management of the impact or risk, acceptance is demonstrated.
External context		
Stakeholder engagement	Have relevant persons and stakeholders raised any concerns about activity impacts or risks? If so, are control measures in place to manage those concerns?	Merits of claims or objections raised by relevant persons and stakeholders must have been adequately assessed and additional control measures adopted where appropriate.
Legislation, industry standard and best practice		
Legislative context	Do the control measures meet the expectations of existing Commonwealth, WA or NT legislation?	The proposed control measures align with legislative requirements.
Industry practice	Do the control measures align with international and Australian industry guidelines and practices?	The proposed control measures align with relevant industry guidelines and practices.
Environmental context	What are the overall impacts and risks to MNES and other areas of conservation significance? Do control measures align with the aims and objectives of marine park management plans and species conservation advice, recovery plans or threat abatement plans?	There are no long-term impacts to MNES and the proposed control measures ensure that impacts or risks are not inconsistent with the aims and objectives of marine park management plans and species conservation advice, recovery plans or threat abatement plans.
ESD Principles*	Are the control measures aligned with the principles of ESD?	The EIA presented throughout Chapter 7 is consistent with the principles of ESD.

**See Table 6.10 for more information.*

Principles of Ecologically Sustainable Development

Based on Australia's National Strategy for Ecologically Sustainable Development (Council of Australian Governments, 1992), Section 3A of the EPBC Act defines ESD as:

> *Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased.*

Table 6.10 outlines the principles of ESD as defined under the EPBC Act and describes how this EP aligns with these principles.

Table 6.10. Assessment of ESD principles

Principle		EP demonstration
A	Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	This principle is inherently met through the EP assessment process.
B	If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	Serious or irreversible environmental damage resulting from the activity has been eliminated through the activity design (see Chapter 2). None of the residual impacts is rated higher than 'moderate' and none of the residual risks is rated higher than 'medium.' Scientific certainty has been maximised by employing a spill EMBA as a risk assessment boundary.
C	The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The EP assessment methodology ensures that risks from the activity are managed to be ALARP and acceptable.
D	The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	This principle is considered for each hazard in the adoption of environmental controls (i.e., environmental performance outcomes and environmental performance standards) that aim to minimise environmental harm. There is a strong focus in this EP on conserving biodiversity and ecological integrity by understanding the marine environment and commercial fishing activity in the activity area and EMBA (Chapter 5) and implementing control measures to minimise impacts and risks (Chapter 7).
E	Improved valuation, pricing and incentive mechanisms should be promoted.	This principle is not relevant to this activity.

6.6. Step 6 – Treat the Risk

The activity environmental impact and risk register (discussed in Section 6.2) and this EP record the environmental control measures (e.g., measures to prevent, minimise and mitigate impacts and risks) that were determined by a qualified and experienced team familiar with the activity and the sensitivities of the existing environment.

These control measures are listed throughout the impact assessment and risk assessment tables in Chapter 7.

6.7. Step 7 - Monitor and Review

Monitoring and review activities are incorporated into the impact and risk management process to ensure that control measures are effective and efficient in both design and operation. This is achieved through the environmental performance outcomes and standards and measurement criteria that are assigned to each environmental hazard.

The monitoring and review process is undertaken to support the compliance reporting process and is an opportunity to identify emerging risks that have arisen, that need to be analysed and addressed, if required.

Monitoring and review of activities are described in the Implementation Strategy (Chapter 8).

7. Environmental Impact and Risk Assessment

This chapter presents the EIA and ERA for the environmental impacts and risks identified for the activity using the methodology described in Chapter 6, as required under Regulations 13(5)(6) of the OPGGS(E).

This chapter presents the control measures, EPO, EPS and measurement criteria required to manage (I.e., avoid, minimise or mitigate) the identified impacts and risks. The following definitions are used in this section, as defined in Regulation 4 of the OPPGS(E):

- **Control measure** – a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks;
- **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., the environmental objective);
- **EPS** – a statement of the performance required of a control measure; and
- **Measurement criteria** – defines the measure by which environmental performance will be measured to determine whether the EPO has been met.

A summary of the impact consequence rankings and risk ranking for each hazard identified and assessed in this chapter is presented in Table 7.1.

Table 7.1. Activity environmental impacts and risk summary

Identifier	Hazard	Inherent	Residual
Impacts			
1	Underwater sound – impacts to biological receptors		
	- Plankton	Negligible	Negligible
	- Crustaceans (i.e., prawns)	Negligible	Negligible
	- Fish (without swim bladders, i.e., sharks)	Negligible	Negligible
	- Fish (with swim bladders)	Negligible	Negligible
	- Cetaceans	Negligible	Negligible
	- Marine reptiles (i.e., turtles)	Negligible	Negligible
	- Avifauna	Negligible	Negligible
2	Underwater sound – impacts to commercial fisheries		
	Northern Prawn Fishery (Cwth)	Negligible	Negligible
	Mackerel Managed Fishery (WA)	Negligible	Negligible
	Northern Demersal Scalefish Fishery (WA)	Negligible	Negligible
	Kimberley Crab Managed Fishery (North Coast Crab Fishery) (WA)	Negligible	Negligible
	Kimberley Prawn Managed Fishery (WA)	Negligible	Negligible
	Kimberley Gillnet and Barramundi Fishery (WA)	Negligible	Negligible
	Spanish mackerel (NT)	Negligible	Negligible

Identifier	Hazard	Inherent	Residual
	Offshore Net and Line Fishery (NT)	Negligible	Negligible
	Demersal Fishery (NT)	Negligible	Negligible
3	Displacement of other marine users		
	- Commercial fisheries	Negligible	Negligible
	- Merchant shipping	Negligible	Negligible
4	Seabed disturbance	Negligible	Negligible
5	Light emissions	Negligible	Negligible
6	Atmospheric emissions	Negligible	Negligible
7	Putrescible waste discharges	Negligible	Negligible
8	Sewage and grey water discharges	Negligible	Negligible
9	Cooling and brine water discharges	Negligible	Negligible
10	Bilge water and deck drainage discharges	Negligible	Negligible
Risk		Risk rating	
1	Accidental discharge of waste to the ocean	Low	Negligible
2	Vessel collision with megafauna	Low	Negligible
3	Introduction and establishment of IMS	Negligible	Negligible
4	Interference with other marine users	Negligible	Negligible
5	Damage to subsea infrastructure	Low	Negligible
6	MDO release		
	- Benthic fauna	Negligible	Negligible
	- Macroalgal communities	Negligible	Negligible
	- Plankton	Negligible	Negligible
	- Pelagic fish	Negligible	Negligible
	- Cetaceans	Negligible	Negligible
	- Marine reptiles	Negligible	Negligible
	- Seabirds and Shorebirds	Negligible	Negligible
	- Shoreline habitats (sandy beaches and rocky shores)	Negligible	Negligible
	- Commercial fisheries	Negligible	Negligible
7	MDO spill response activities		
	- Fauna disturbance	Low	Negligible
	- Fauna injury	Low	Negligible
	- Fauna death	Negligible	Negligible

7.1. IMPACT 1 – Underwater Sound – Impact on Biological Receptors

7.1.1 Hazard

Underwater sound will be generated from the following activity sources:

- Engine noise transmitted through the hull and propeller noise from the activity vessels; and.
- Sound generated by G&G equipment, principally the geophysical equipment.

7.1.2 Known and Potential Environmental Impacts

The impacts and risks resulting from underwater sound, especially sound generated by seismic sources, are generally well understood with regard to potential mortality and/or physiological injury for species in the water column, however, uncertainty lies in understanding the spatial and temporal extents of behavioural disturbances and the potential effects on populations and requires the application of context-specific information.

The potential environmental impacts to marine fauna from high levels of underwater sound are:

- Physical injury to auditory tissues or other air-filled organs;
- Hearing impairment, temporary threshold shift (TTS – the temporary loss of hearing sensitivity caused by excessive noise exposure) or 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 activity area, to varying degrees:

- Plankton (including commercially important fish larvae/eggs);
- Marine invertebrate assemblages;
- 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 (e.g., Australian snubfin dolphin).
- Turtles – foraging habitat for marine turtles (e.g., flatback turtle, green turtle)

- Foraging habitat for seabirds and shorebirds;
- Target species for commercially-important fisheries known to operate in and around the activity 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).

The frequency range from the geophysical equipment overlaps with the frequency range of some marine fauna groups but is unlikely to be heard by many marine species.

The marine species most at risk from acoustic disturbance from geophysical sound sources are generally species that hear and communicate in a similar low frequency range to the range of sounds produced (particularly baleen whale species). In addition, fish and invertebrate species that are deemed as truly site-attached (i.e., less able to swim away from the moving sound sources due to close associations with benthic features) are at increased risk from acoustic disturbance.

7.1.1. EMBA

The EMBA for underwater sound is unlikely to be beyond tens of metres (or hundreds of metres) from the sound source, as outlined in this chapter (Figure 7.1 to Figure 7.8).

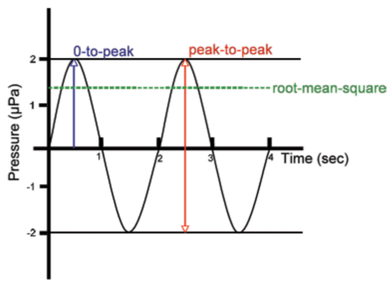
Receptors that are known to occur or may occur within the underwater sound EMBA, either as residents or migrants, are:

- Plankton;
- Benthic invertebrates (i.e. prawns);
- Fish (with and without swim bladders);
- Cetaceans (including dugongs);
- Marine reptiles (i.e. turtles); and
- Avifauna.

7.1.2. Evaluation of Environmental Impacts

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). Table 7.2 defines the acoustic terms used throughout this section.

Table 7.2. Acoustic terminology used in this EIA

Term	Definition
Sound	A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.
Decibel (dB)	Sound is measured on 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) – SEL, SPL, PK and PK-PK, all described in this table.
Frequency	The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. **Unit:** hertz (Hz). 1 Hz is equal to 1 cycle per second.
Source level	A measure of sound pressure at a nominal distance of 1 m from a theoretical point source that radiates the same total sound power as the actual source. It is a theoretical value for a seismic source because a seismic source is not a point source, but rather, comprises individual elements in a defined area. Source level can be expressed as an SPL, SEL or PK. **Unit:** dB re 1 $\mu Pa^2 m^2$ (pressure level) or dB re 1 $\mu Pa^2 m^2 s$ (exposure level).
Impulse/Pulse	The terms used to refer to the discharge of a seismic source are impulse and pulse, therefore the terms used to describe a single discharge are per-impulse or per-pulse. Impulsive sound is sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA, 2013). Airguns used for seismic surveys are a good example of impulsive sound.
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 $\mu Pa^2 \cdot s$
SEL_{24hr}	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}.
Zero-to-peak sound pressure (PK) *Impulsive sounds*	The greatest magnitude of the sound pressure during a specified time interval. PK levels are modelled to assess mortality and potential mortality to fish larvae and eggs, fish and turtles. A simple sound wave and three common methods to characterise the loudness of sounds, including zero-to-peak sound pressure, are illustrated below. **Unit:** dB re 1 µPa. 

Term	Definition
Peak-to-peak sound pressure (PK-PK) *Impulsive sounds*	Sum of the peak compressional pressure (highest pressure variation) and the peak rarefactional pressure (lowest pressure variation) during a specified time interval. PK-PK is the difference between the minimum and maximum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound. **Unit:** dB re 1 µPa. See also the PK graph.
Root-mean-square 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 over the duration of the acoustic event (i.e., the duration of a single seismic pulse). Because the SPL represents the effective sound pressure over the full duration of the acoustic event rather than the maximum instantaneous peak pressure (PK or PK-PK), it is regularly used to represent the effective or perceived loudness of a sound and to assess the potential for a behavioural response from marine fauna. **Unit**: dB re 1 µPa. See also the PK graph.
Particle motion	The motion caused by a sound wave of a given infinitesimal part of the medium relative to the medium as a whole, and it is an integral part of any sound field. Particle motion is directional (unlike pressure) and is typically described using three-dimensional vector notation. Particle motion levels can be expressed in a variety of units related to displacement; velocity or acceleration. Acoustic particle velocity is the time derivative of particle displacement, and likewise, acceleration is the time derivative of velocity. • Sound particle velocity (v) - contribution to velocity of a material element caused by the action of sound, in units of metre per second (m/s). It is the physical speed of a particle in a material moving back and forth in the direction of the pressure wave. • Sound particle acceleration (*a*) - the contribution to acceleration of a material element caused by the action of sound, in units of metre per second squared (m/s^2). It is the rate of change of the velocity with respect to time. Benthic invertebrates (e.g., scallops) and many types of fish are sensitive only to particle velocity or acceleration rather than pressure, however, limited measurements of data are available on the levels of particle motion that may result in effects. Some measurements are available from studies on bivalves and therefore modelled particle motion values have been referenced for this EIA.
Transmission loss	The decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment. It can also be referred to as propagation loss.
TTS in hearing	TTS is the temporary loss of hearing sensitivity caused by excessive noise exposure. Exposure to sufficiently intense sound may lead to an increased hearing threshold in any living animal capable of perceiving acoustic stimuli (Finneran, 2015). If this shift is reversed and the hearing threshold returns to normal, the effect is called a TTS. The onset of TTS is often defined as threshold shift of 6 dB above the normal hearing threshold (Southall *et al*., 2019). Impairment to the hearing apparatus of a marine animal may result from a fatiguing stimulus measured in terms of sound exposure level (SEL), which considers the sound level and duration of the exposure signal. Intense sounds may also damage the hearing apparatus independent of duration, so an additional metric of peak pressure (PK) is needed to assess acoustic exposure impairment risk.

Term	Definition
PTS in hearing	PTS is the permanent loss of hearing sensitivity caused by excessive noise exposure. It is considered an auditory injury. If a TTS does not return to normal, the residual shift is called a PTS.
Behavioural response	The context of sound exposure plays a critical and complex role in behavioural responses in marine mammals (Gomez *et al*., 2016). For example, different species (and different individuals or groups within a species) may respond differently to varying levels of sound depending on their behaviours and motivation at the time (depending on whether they're foraging, socialising, resting or mating) and other factors such as the type of sound, duration of exposure, and the suddenness of the onset of the received sound (Ellison *et al*., 2012; Gomez *et al*., 2016). The NMFS in the USA uses an impulsive noise criteria threshold of 160 dB re 1 µPa (SPL) for potential behavioural disturbance to marine mammals (NOAA, 2019). The threshold for behavioural response represents the level at which a moderate behavioural response may occur, such as changes in swimming speed, direction and dive profile, localised deviations in migratory patterns, brief to moderate shift in group distribution, short term cessation or modification of vocal behaviour. (McCauley *et al*., 2000; Southall *et al*., 2007; Tyack, 2008). Avoidance, however, is not directly related to sound level thresholds but also influenced by the state of the individuals (e.g., their reproductive, health and foraging condition) and the context of exposure. It is considered that avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from areas of biological importance such as nursery, resting or feeding areas during an important period for the species. Higher received levels are not always associated with stronger behavioural responses and vice versa, and a clear dose-response relationship has not been identified (Southall *et al*., 2007). In addition, a behavioural response does not necessarily equate to a significant avoidance or deviation in cetacean movements that would actually displace individuals or the population from the wider area. Similarly, proximity of the animal to the sound source, irrespective of received level, has been identified as an influencing factor, with behavioural response in humpback whales being both dependent on the proximity of whale to the vessel source and also the received level (i.e., at the same received level no behavioural response was detected when the source was greater than 3 km away) (Dunlop *et al*., 2018).
Masking	Acoustic masking may occur when a noise impedes the ability of an animal to perceive a signal (Wood *et al*., 2012; Erbe *et al*., 2016). For this to occur the noise must be loud enough, have similar frequency content to the signal, and must happen at the same time (Wood *et al*., 2012). Masking and the potential effects of masking on communication and listening space of marine mammals are not fully understood and remain an area of active research (Terhune *et al*., 1979; Cunningham & Mountain, 2014; Tennessen & Parks, 2016; Cholewiak *et al*., 2018; Dunlop, 2018; 2019; Gabriele *et al*., 2018; Putland *et al*., 2018). Currently, there are no specific received level thresholds for reliably assessing or regulating masking responses to seismic noise (Gomez *et al*., 2016).

Vessel sound

The vessel 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).

It is unlikely that engine sound levels will be greater than that of any other similarly-size vessel normally operating in the area (such as vessels supporting the offshore oil and gas operations in the area, commercial shipping vessels, and merchant vessels).

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 between investigation sites, 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., slightly less than ambient underwater sound intensity in the activity 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.

The environmental significance of acoustic disturbances arising from the vessels during this investigation is considered to be negligible because:

- The activity will be of very short duration, and no more than a few hours at any one location);
- The activity will be undertaken over a small area (6 km^2 for the geotechnical investigations and 54 km^2 for the geophysical investigations);
- The presence of threatened cetaceans in the region is known to be low;
- There are no known sensitive benthic ecosystems in the activity area, such as reefs;
- There is only low intensity commercial fishing in the activity area;
- Fish species known to occur in the region are common and widely distributed and 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 activity area.

Temporary and permanent threshold shifts are very unlikely to occur in any marine species as a result of vessel operations.

The sounds produced by the vessels during this activity will not be outside the range of other anthropogenic sound and ambient underwater sound of the activity area (see Table 5.4).

Geophysical equipment

The frequencies and sound source levels likely to be generated by the geophysical equipment are presented in Table 7.3. This sound is directed down towards the seabed rather than horizontally. While there is a significant volume of published research regarding the effects of offshore seismic noise on marine fauna, there is a paucity of equivalent information relating to the impacts of noise generated by non-seismic geophysical equipment.

Table 7.3. 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 900	210–220
SBP	0.05–24 (depending on the exact equipment selected)	100–225 (depending on the exact equipment selected)
Shallow seismic (sparker or bubble pulser system)	0.2 - 5	200-225

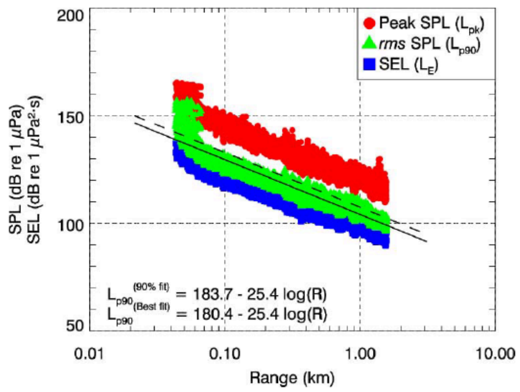
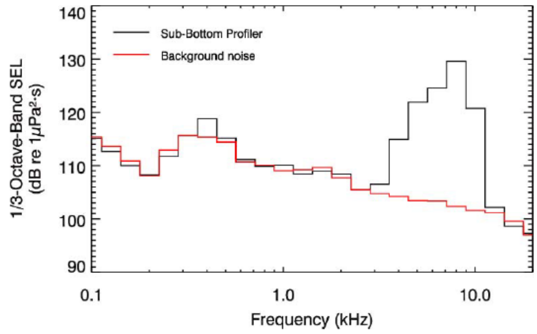
One particular paper (Reiser *et al*., 2011) presents high quality data regarding the SPL and SEL of geophysical equipment based on measurements undertaken in the Alaskan Chukchi and Beaufort Seas in 2010. Table 7.4 summarises this research using SPL metrics, while Figure 7.1 to Figure 7.8 present the same results using SPL and SEL metrics.

This data illustrates that the sound levels generated by geophysical equipment rapidly attenuates within hundreds of metres of the sound source.

Table 7.4. Summary of geophysical sounds from the Chukchi and Beaufort Sea investigations

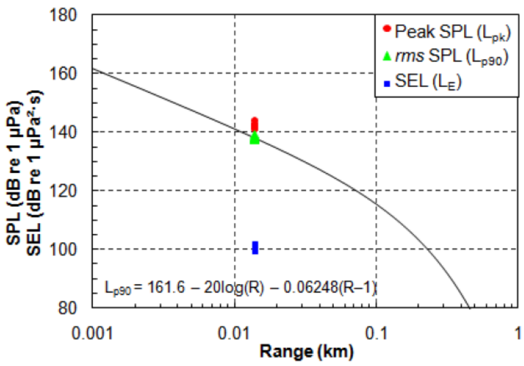
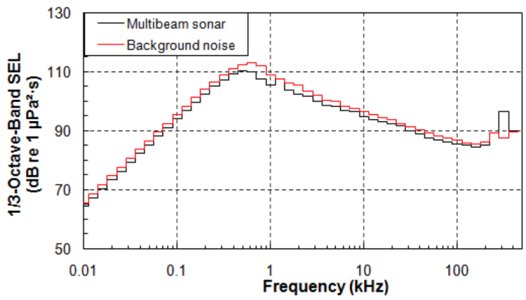
Distance to sound level threshold (rms SPL dB re 1 µPa @ 1 m)	SBP tow fish			MBES sonar, vessel-mounted		SSS		Shallow seismic air gun	
	Chukchi Sea	Beaufort Sea		Chukchi Sea	Beaufort Sea	Beaufort Sea		Beaufort Sea	
	90th percentile fit	90th percentile fit, Camden Bay	90th percentile fit, Harrison Bay		90th percentile fit	@ 120 kHz in-beam (90th percentile fit)	@ 400 kHz in-beam (90th percentile fit)	Single 10 cui source (forward endfire*) - Harrison Bay	40 cui array (forward endfire*) - Harrison Bay
Receiver depth	48 m	34 m	17 m	6 m	7 m	7 m	7 m	12 m	12 m
190	-	-	-	-	3	-	2	3	9
180	-	-	-	-	6	4	5	22	100
170	-	-	-	-	14	22	16	150	620
160	9	1	9	1	32	95	45	600	1,700
150	21	5	30	4	66	280	95	1,400	3,000
140	52	22	97	11	120	550	160	2,500	4,500
130	130	85	310	31	210	880	240	3,700	6,100
120	320	300	1,000	72	330	1,200	330	5,000	7,700
110	790	870	3,300	-	-	-	-	-	-
100	1,900	1,900	11,000	-	-	-	-	-	-
SL (dB re 1 µPA @1 m)	*183.7*	162.1	178.8	161.6	201.4	187.4	191.1	195.3	198.7

** Used as the more conservative (i.e., higher) figure than aft endfire.*
Source: Reiser et al (2011).

	
SBP peak, 90% rms SPL and SEL versus slant range. Solid line is best fit of the empirical function to Lp90 values. Dashed line is the best-fit shifted to exceed 90% of the Lp90 values (90th percentile fit).	SBP 1/3-octave band SEL over a 30-ms time window averaged over 10 of the highest rms-amplitude pulses measured at 50 m slant range. The corresponding average band levels of background noise from the 10 preceding 30 ms windows are shown in red.

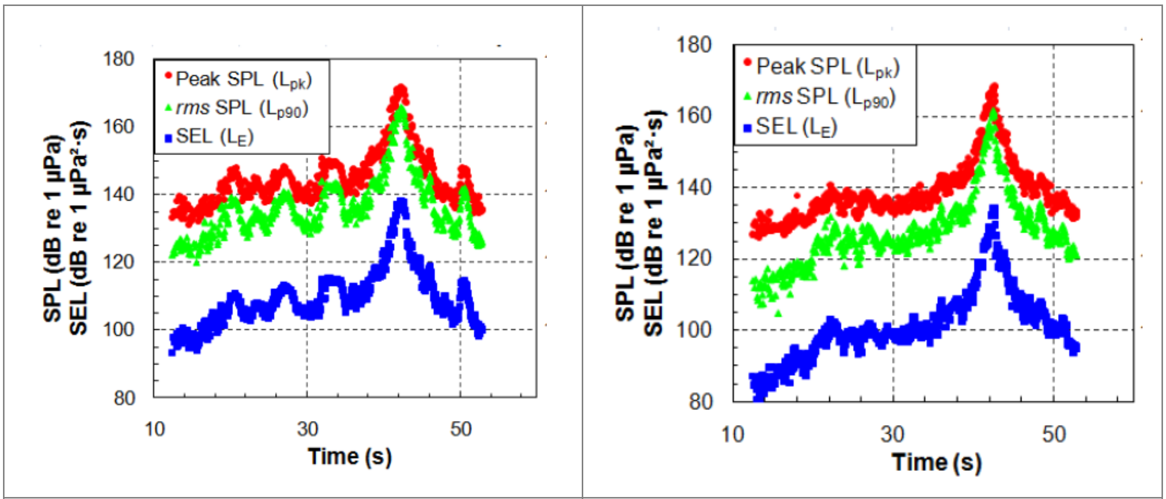
Source: Reiser et al (2011).

Figure 7.1. SBP measurements from the Chukchi Sea measured at 48 m receiver depth

	
Multibeam sonar 300-kHz pulse peak SPL, 90% rms SPL, and SEL of the 10 highest rms-amplitude pulses, and sound levels as a function of range predicted from the back-propagated source levels.	Multibeam sonar average 1/3-octave band SEL over 1.5 ms time windows from 10 pulses measured at 14 m range. The corresponding average band levels of background noise from the preceding 1.5 ms windows are shown in red.

Source: Reiser et al (2011).

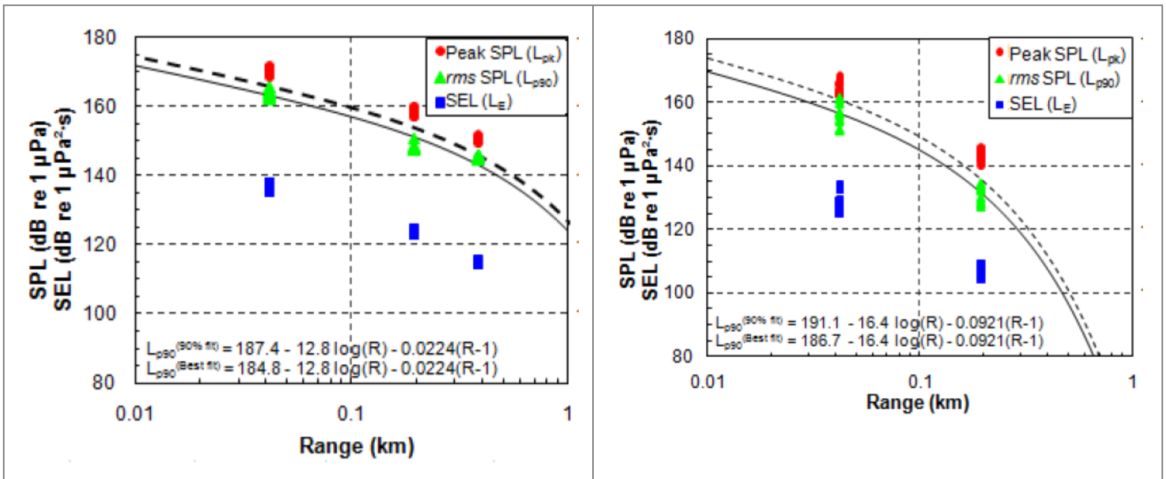
Figure 7.2. MBES measurements from the Chukchi Sea measured at 6 m receiver depth and 14 m range



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).

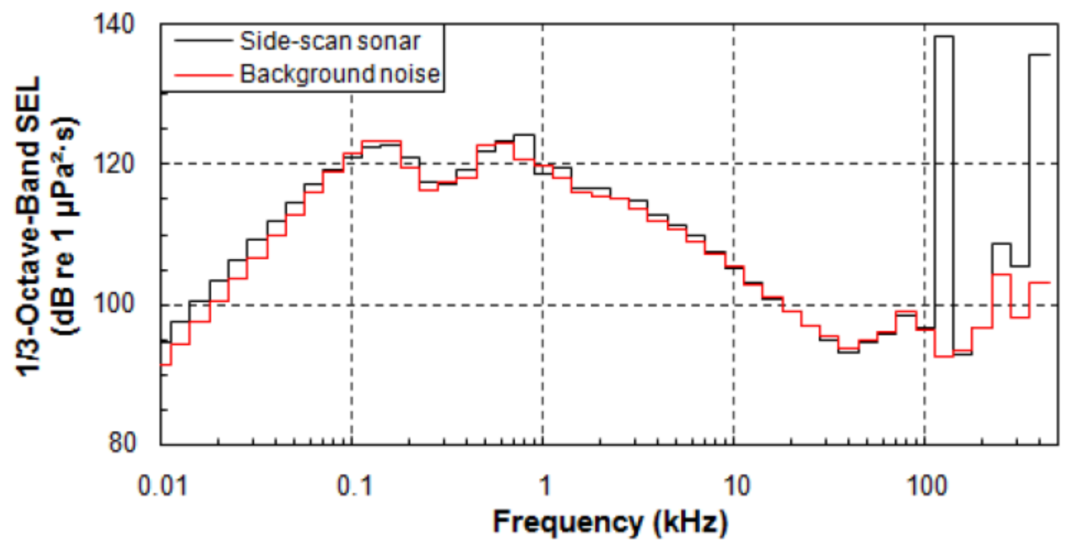
Figure 7.3. SSS measurements from the Chukchi Sea measured at 7 m receiver depth and 42 m range



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 Lp90 values. Dashed line is the best-fit shifted to exceed 90% of the Lp90 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 Lp90 values. Dashed line is the best-fit shifted to exceed 90% of the Lp90 values (90th percentile fit).

Source: Reiser et al (2011).

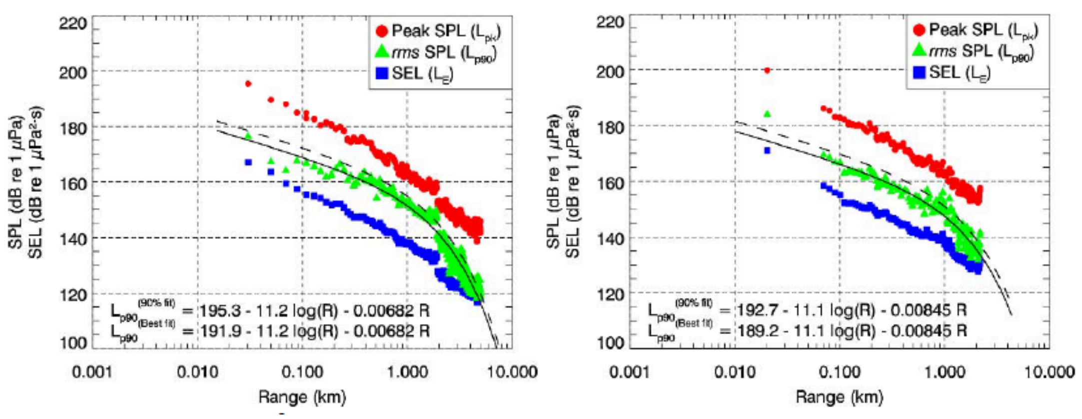
Figure 7.4. SSS measurements from the Chukchi Sea measured at 7 m receiver depth and 42 m range



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: LGL & Jasco Applied Sciences (2010).

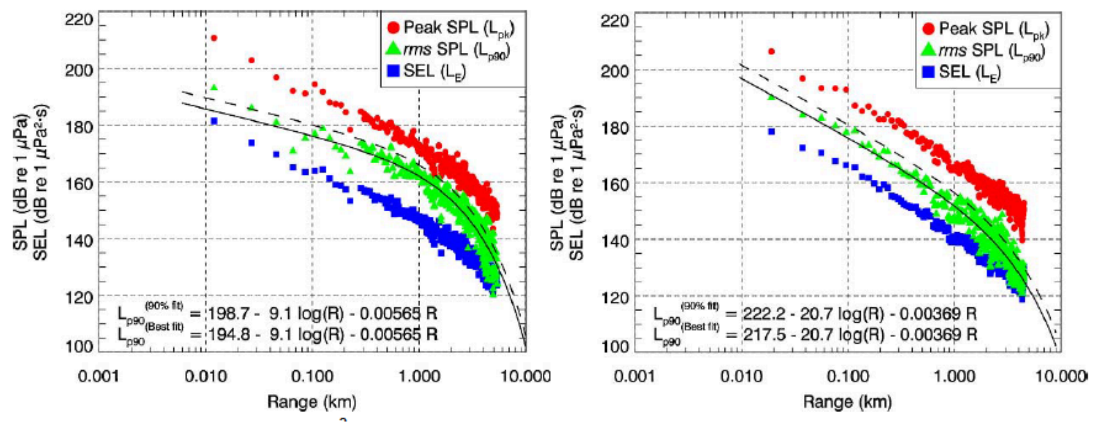
Figure 7.5. SSS measurements from the Chukchi Sea measured at 7 m receiver depth and 42 m range



Single 10 cui airgun peak, 90% rms SPL and SEL versus range in the forward (left) and aft (right) endfire directions. Solid line is best fit of the empirical function to Lp90 values. Dashed line is the best-fit shifted to exceed 90% of the Lp90 values (90th percentile fit).

Source: LGL & Jasco Applied Sciences (2010).

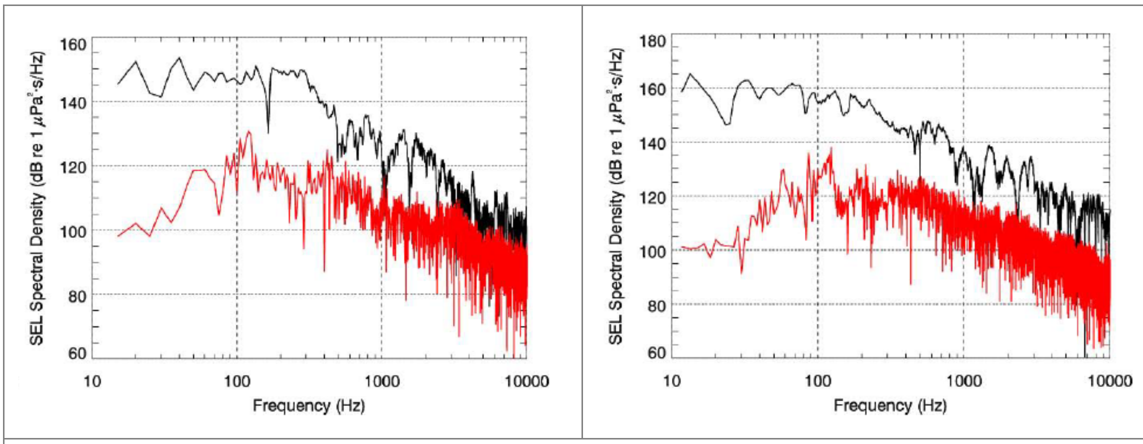
Figure 7.6. Shallow seismic sound levels versus range measurements from Harrison Bay in the Beaufort Sea for the single 10 cui airgun measured in 15 m water depth



Airgun array 40 cui airgun peak, 90% rms SPL and SEL versus range in the forward (left) and aft (right) endfire directions. Solid line is best fit of the empirical function to Lp90 values. Dashed line is the best-fit shifted to exceed 90% of the Lp90 values (90th percentile fit).

Source: LGL & Jasco Applied Sciences (2010).

Figure 7.7. Shallow seismic sound levels versus range measurements from Harrison Bay in the Beaufort Sea for the 40 cui airgun array measured in 15 m water depth



Single 10 cui airgun (left) and 40 cui airgun array (right) SEL spectral density over 200 ms of one pulse, approaching CPA. The corresponding spectral density of background noise from a 0.2-s window preceding the pulse is shown in red.

Source: LGL & Jasco Applied Sciences (2010).

Figure 7.8. Shallow seismic SEL spectral density measurements from Harrison Bay in the Beaufort Sea measured at 12 m water depth and 14 m slant range

Geotechnical equipment

Reiser et al (2011) also studied sound output from a vibratory coring system (vibracore), a NAVCO BH-8 pneumatic vibrator attached to a sprung plate that impacts the top of the steel coring tube. There is a strong acoustic coupling between the vibrator and water because the entire apparatus is submerged during operation. The sounds produced consist of a series of impulses corresponding to the movement and impacts of the vibrator on the pipe (Reiser *et al*., 2011).

Sound generated by this vibracore was measured in a water depth of 46 m and averaged a source level of 187.4 dB re 1µPA @ 1m. A sound level threshold of 170 rms SPL dB re 1µPA @ 1m was reached 15 m from the vibracore. At a threshold of 160 rms SPL dB re 1µPA @ 1m, the distance extended to 69 m and at a threshold of 130 rms SPL dB re 1µPA @ 1m, the distance extended to 7,100 m.

The following sections provide the EIA for underwater sound on the various groups of biological receptors in the activity area. Where available, threshold criteria associated with behavioural and physiological impacts for sensitive receptors have been used to compare measured and predicted sound levels for different sound sources to assess potential impacts.

Impacts to Plankton

Collectively, plankton is a term for all marine organisms that are unable to swim against a current. This diverse group includes phytoplankton (plants) and zooplankton (animals), as well as fish and invertebrate eggs and larvae. There is no credible impact pathway for underwater noise to affect phytoplankton.

Plankton (described in Section 5.3.3) is very widely dispersed throughout the ocean and is transported by prevailing wind and tide- driven currents. They cannot take evasive behaviour to avoid anthropogenic sound sources. However, the potential for impacts 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.

<u>Research results</u>

The following summarises research findings into the impacts of sound from seismic surveys on plankton (noting the relative paucity of research on non-seismic geophysical sound sources other than that presented earlier in this section by Reiser et al (2011)):

- Larval stages are often considered more sensitive to stressors than adult stages, but exposure to seismic sound reveals no differences in larval mortality or abundance for fish, crabs or scallops (Carroll *et al.,* 2017).
- Sound-induced mortality in larval fish, where observed, has been in the range of 0.5 to 3 m around the source, in association with relatively high peak energy levels; however, damage may occur out to approximately 5 m (Payne *et al*., 2008). For example, Kostyuchenko (1973) reported fish egg mortality out to 0.5 m and only pathological effects (e.g., embryo curling, membrane perturbation and yolk displacement) at 5 m in a small percentage of anchovy eggs exposed to an estimated source level of 230 dB re 1 µPa. Matishov (1992) observed delamination of the retina in cod larvae within 1 m of a seismic source with a level of 250 dB re 1 µPa (PK-PK).
- Trials using seismic sound from airguns as a method to reduce the survival of non-native lake trout embryos in the USA produced high mortalities of up to 100%, but only at close range (0.1 m). At distances of 2.7 m from the seismic source, mortalities did not differ from those of controls (Cox *et al*., 2012 as cited in NSW DPI, 2014).
- Gausland (2000) noted several studies confirming that that signal levels exceeding 230-240 dB re 1 µPa (PK-PK) are necessary for harm to occur and so therefore physical damage can only occur within a few metres from the air guns.

- A study conducted by McCauley et al (2017) using two replicated experiments in in southeast Tasmania involved the deployment of acoustic noise loggers to measure air gun signals and used an airgun volume of 150 cui and operating pressure of 2,000 psi. The study measured zooplankton abundance and the proportion of the population that was dead at three distances from the airgun - 0, 200 and 800 m. The results of the experiment found that zooplankton exposure to airguns increased the mortality rate from a natural level of 19% per day to 45% per day (on the day of exposure), with this mortality rate observed out to 1.2 km. This is more than two orders of magnitude greater than the 10 m previously assumed (McCauley *et al.*, 2017).
- In response to the McCauley et al (2017) paper, APPEA commissioned the CSIRO to assess the potential local and regional impacts on zooplankton of a typical marine seismic survey (MSS). A large-scale seismic survey conducted on the North West Shelf of Australia was modelled in a hydrodynamic model using the McCauley et al (2017) mortality results. This is reported in Richardson et al (2017). The modelled survey parameters include a survey area of 2,900 km^2, 60 survey lines, waters 300-800 m deep, an airgun source of 3,000-3,200 cui and operating pressure of 2,000 psi. This paper reports that impact is recorded within the survey area and within 15 km of it, but that these impacts are not discernible at the bioregional scale and barely discernible within 150 km of the survey area. Zooplankton populations recovered quickly after seismic exposure due to their fast growth rates and due to the dispersal and mixing of zooplankton from both inside and outside of the impacted region. The modelling undertaken by Richardson et al (2017) found that while there was a maximum decline of 22% in zooplankton populations in the survey and a 14% decline within 15 km of the survey area, it took only 3 days following the completion of the survey for zooplankton biomass to recover to pre-seismic survey levels within the survey area and within an area of 15 km around the survey area. The study notes that because zooplankton growth rates are slower in colder regions (e.g., Bass Strait) as opposed to warm tropical regions, the recovery rate of zooplankton populations following exposure to MSS is likely to be slower.

<u>Thresholds</u>

Table 7.5 presents the exposure criteria for seismic airguns for fish eggs and larvae. This was developed by Popper et al (2014) based on results from the Working Group on the Effects of Sound on Fish and Turtles, which was formed in 2006 to continue developing noise exposure criteria for fish and turtles, work begun by a NOAA panel two years earlier. In general, any adverse effects of seismic sound on fish behaviour depends on the species, the state of the individuals exposed, and other factors. The SEL metric integrates noise intensity over some period of exposure.

Popper et al (2014) suggest that injury to larvae resulting from seismic impulses may occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 $\mu Pa^2 \cdot s$ (SEL24h). However, Popper et al (2014) suggest that recoverable injury and TTS is likely within tens of metres of a seismic source, generally less than the distance associated with their proposed mortal injury threshold. The threshold proposed for mortal injury is derived from pile driving impacts to fish and is likely to be conservative. The body of literature indicates that mortality and sub-lethal injury are limited to within tens of metres of seismic sources.

The studies undertaken by McCauley et al (2017) and Richardson et al (2017), while important in increasing the industry’s knowledge of the potential impacts of MSS on plankton, do not in themselves set new thresholds for modelling the impacts of MSS on plankton. Consequently, EOG has elected to use the thresholds developed by Popper et al (2014) for this impact assessment as they are well established and represent years of ongoing work in this field. In the context of much lower sound sources used for geophysical investigations, these thresholds are considered conservative.

Table 7.5. Exposure criteria for seismic sources – fish eggs and larvae

Distance from the source	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Seismic sound					
Near	210 db SEL_{24h} *or* >207 dB PK	Moderate	Moderate	Low	Moderate
Intermediate		Low	Low	Low	Low
Far		Low	Low	Low	Low
Low-frequency sonar					
Near	Low	Low	Low	Low	Low
Intermediate	Low	Low	Low	Low	Low
Far	Low	Low	Low	Low	Low
High-frequency sonar					
Near	N/A	N/A	N/A	N/A	N/A
Intermediate	N/A	N/A	N/A	N/A	N/A
Far	N/A	N/A	N/A	N/A	N/A

Source: Popper et al (2014).

Guide to distance from the source

(N) Near = tens of metres.

(I) Intermediate = within hundreds of metres.

(F) Far = thousands of metres.

Potential impacts

The data presented in Figure 7.1 to Figure 7.8 (which reports results in SEL, the same unit of measurement used in Table 7.5) indicates that the sound levels from geophysical activities will not reach the thresholds outlined in Table 7.5 and therefore impacts from the activity are likely to be insignificant to plankton.

Impacts to plankton are likely to be insignificant at both a local and population level or compared with natural variability and mortality rates for plankton organisms. Additional factors contributing to the insignificance of impacts to plankton are:

- Any mortality or mortal injury effects to fish eggs and larvae resulting from seismic noise emissions are likely to be inconsequential compared to natural mortality rates of fish eggs and larvae, which are very high (exceeding 50% per day in some species and commonly exceeding 10% per day) (Houde, 2002).
- Estimated distances for mortality of fish eggs and larvae (within hundreds of metres); and low risk to incur a recoverable injury, TTS or behavioural response (as per threshold values provided by Popper (2014)) would impact fish eggs and larvae at a local rather than a regional scale.

- In the seismic exposure experiment undertaken by McCauley et al (2017) zooplankton mortality rate background levels were 19%, thus predicted impacts to zooplankton from the seismic survey are likely to be within natural mortality rates. Given the sound sources for the activity is substantially less than as conventional seismic survey, an even smaller impact is expected
- Due to the large natural spatial, temporal variability and scale of plankton and spawning biomass throughout the wider region, the activity is not expected to have a detrimental effect on plankton.
- The timing of the activity means that many fish species of commercial and recreational interest that spawn during the spring and early summer period (and therefore have larvae forming part of the zooplankton biomass during this time) will avoid or have minimal exposure to geophysical sound sources, thereby minimising impacts on potential recruitment of juveniles and adults to the relevant species populations.

Based on this evaluation, the impact consequence for plankton resulting from underwater noise generated by the activity is negligible at an ecosystem and population level.

Impacts to Fish

Fish species known to occur within the activity area and surrounds are listed and/or described in Section 5.3.4. 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).

<u>Research results</u>

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, as described in the following sub-sections.

The following provides a summary of research findings of the impacts of seismic sound on plankton (noting the relative paucity of research on non-seismic geophysical sound sources).

Physiological impacts

Direct physical damage may occur to fish if they approach within a few metres (<5 m) of the seismic source (Gausland, 2000; McCauley *et al*., 2000a; Parvin *et al*., 2007).

Lethal effects of seismic surveys on fish have not been reported, but those with a swim bladder closely connected to the inner ear are more susceptible than those without (McCauley, 1994). Fish with thin-walled, lightly damped and large swim bladders will be most susceptible to mechanical damage or trauma from seismic pulses. Other fish, including the elasmobranchs (sharks and rays), family Scombridae (mackerels and tuna) and many of the flatfish and flounder species do not possess a swim bladder and so are not susceptible to swim bladder-induced trauma (McCauley, 1994). Carroll et al (2017) provides a summary into the impacts of seismic airgun sound on fish, which indicates that lethal effects of seismic surveys on fish have not been observed.

Behavioural impacts

Gausland (2000) postulates that while seismic airgun operation causes little direct physical damage to fish at distances greater than 1-2 m from the source, it is evident that fish respond to sounds emitted from airguns, and that avoidance seems to be the primary response for all species.

Available evidence suggests that behavioural change for some fish species may occur, however this is thought to be localised and temporary, with displacement of pelagic or migratory fish populations having insignificant repercussions at a population level (McCauley, 1994). Behavioural changes such as startle or alarm responses are expected to be localised and temporary, with displacement of pelagic or migratory fish likely to have insignificant repercussions at a population level (McCauley, 1994; McCauley & Kent, 2012; Popper *et al*., 2015; Popper *et al*., 2007). The following studies support this:

- Przeslawski et al (2016b) found little evidence consistent with behavioural changes induced by a 2D seismic survey undertaken over part of the western Gippsland Basin in 2015. Gummy sharks were detected returning to the experimental zone during the period of seismic operations, and behaviour consistent with a possible response to the survey operations was restricted to flathead, which showed an increase in swimming speed during the survey period and change in diel movement patterns after the survey. The increased swimming speed may indicate a startle response, but if so, the range of movement was not sufficient to generate a significant difference in displacement (travel) across the monitored array.
- Streever et al (2016) indicate that it is possible that fish move away from seismic sources, thereby not being exposed to high levels of sound.
- Slotte et al (2004) examined potential effects of on fish abundance to exposure to a seismic airgun array (source SPL of 222.6 dB re 1 µPa·mp-p) during a period of one month. The SPLs received by the fish were not measured. Acoustic surveys of the local distributions of various kinds of pelagic fish, including herring, blue whiting, and mesopelagic species, were conducted during the seismic surveys. There was no strong evidence of short-term horizontal distributional effects. With respect to vertical distribution, blue whiting and mesopelagics were distributed deeper (20 to 50 m) during the seismic survey compared to pre-exposure.
- Trials of effects of nearby airgun operations on captive fish, undertaken by McCauley et al (2000) showed a generic fish 'alarm' response of swimming faster, swimming to the bottom, tightening school structure, or all three. From a review of trials and available published information, McCauley et al (2000) concluded the following effects on fish:
    - Demersal fish could be expected to begin to change their behaviour by increasing speed and swimming deeper in the water column;
    - As air gun level increases, fish would be expected to form compact schools probably near the bottom in continental shelf water depths (<200 m);
    - Eventually levels may be reached at which involuntarily startle responses occur in the form of the classic C-turn (involuntary flexing of the body and subsequent darting swim away from the source);

- Startle responses may be generated by fish within 300 m and up to 2,000 m of an operating airgun array; and
- Flight response could be expected up to several kilometres.

- The McCauley et al (2000) trials, as well as studies by Wardle et al (2001), Dalen et al (1996) and Gausland (2000), also indicate the following:
  - Fish generally show little evidence of increased stress from exposure to seismic signals unless restricted from moving away from the source; and
  - Fish may become acclimatised to seismic signals over time.
- Popper et al (2014) summarises that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours.

Site-attached fish species that exhibit a high degree of site fidelity are more likely to be affected to geophysical 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 activity area or immediate surrounds. As such, impacts to such species are not considered here.

Limited research has been conducted on responses from elasmobranchs (sharks and rays, including juveniles) to underwater sound. This may be because sharks and rays differ from bony fish in that they have no accessory organs of hearing (i.e., a swim bladder) and therefore are unlikely to respond to acoustic pressure (Myrberg, 2001). Elasmobranchs sense sound via the inner ear and organs and as they lack a swim bladder it is thought that they are only capable of detecting the particle motion component of acoustic stimuli (Myrberg, 2001).

In addition to particle motion, elasmobranchs are also sensitive to low frequency sound between 40 and 800 Hz (Myrberg, 2001). This range overlaps with some of the geophysical sound sources (mainly SBP and shallow seismic, Table 7.6). However, sharks do not appear to be attracted by continuous signals or higher frequency sounds that presumably they cannot hear (Popper & Løkkeborg, 2008). Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1 µPa above background ambient noise levels) when approaching within 10 m of the sound source. The available evidence indicates sharks will generally avoid sound sources, so the likely impacts on sharks are expected to be limited to short-term behavioural responses, such as avoidance of waters around the operating geophysical equipment. For the purposes of this EIA, sharks are included in the same group as fish without swim bladders and for the reasons outlined above, along with the fact that the Recovery Plan for the White Shark (DSEWPC, 2013) does not list anthropogenic sound as a threat to this species, impacts to sharks are considered to be negligible.

<u>Thresholds</u>

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 7.6). 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 7.6. Exposure criteria for seismic sources – fish

Type of fish	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Seismic sound					
Fish with no swim bladder	>219 db 24 hr SEL *or* >213 dB peak	>216 db 24 hr SEL *or* >213 dB peak	>186 db 24 hr SEL	(N) Low	(N) High
				(I) Low	(I) Moderate
				(F) Low	(F) Low
Fish with swim bladder not involved in hearing	210 db 24 hr SEL *or* >207 dB peak	>203 db 24 hr SEL *or* >207 dB peak	>186 db 24 hr SEL	(N) Low	(N) High
				(I) Low	(I) Moderate
				(F) Low	(F) Low
Fish with swim bladder involved in hearing	207 db 24 hr SEL *or* >207 dB peak	>203 db 24 hr SEL *or* >207 dB peak	>186 db 24 hr SEL	(N) Low	(N) High
				(I) Low	(I) High
				(F) Moderate	(F) Moderate
Low-frequency sonar					
Fish with no swim bladder	(N) Low	(N) Low	>193 dB rms	(N) Low	(N) Low
	(I) Low	(I) Low		(I) Low	(I) Low
	(F) Low	(F) Low		(F) Low	(F) Low
Fish with swim bladder not involved in hearing	>193 dB rms	>193 dB rms	>193 dB rms	(N) Low	(N) Low
				(I) Low	(I) Low
				(F) Low	(F) Low
Fish with swim bladder involved in hearing	>193 dB rms	>193 dB rms	>193 dB rms	(N) Moderate	>197 dB rms
				(I) Low	
				(F) Low	
High-frequency sonar					
Fish with no swim bladder	(N) Low	(N) Low	N/A	N/A	N/A
	(I) Low	(I) Low			
	(F) Low	(F) Low			
Fish with swim bladder not involved in hearing	>210 dB rms	>210 dB rms	N/A	N/A	N/A
Fish with swim bladder	>210 dB rms	>210 dB rms	>210 dB rms	(N) Low	>209 dB rms
				(I) Low	

Type of fish	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
involved in hearing				(F) Low	

Source: Popper et al (2014).

Distance from the source

(N) Near = tens of metres.

(I) Intermediate = within hundreds of metres.

(F) Far = thousands of metres.

Potential impacts

The data presented in Figure 7.1 to Figure 7.8 (which reports results in SEL, the same unit of measurement used in Table 7.6) indicates that the sound levels from geophysical activities will not reach the thresholds outlined in Table 7.6 and therefore impacts from the activity are likely to be insignificant to fish.

Fish, including sharks, are omnipresent throughout the activity area and surrounds and the Northwest Marine Bioregion in general. They are likely to be more concentrated around the patchy low-profile reef shoreward of the activity area where sponge and reef habitat provides more feeding opportunities and habitat compared to the flat and featureless seabed containing very soft to firm silty clay of the activity area.

The activity will not have a 'significant' impact on endangered or vulnerable fish species (see Section 5.3.4) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), as outlined in Table 7.7.

Table 7.7. Assessment against EPBC Act Significant Impact Guidelines for fish

Significant impact guideline	Assessment
Lead to a long-term decrease in the size of a population.	Underwater sound generated from geophysical activities will not lead to a long-term decrease in the size of a population given the short duration of the activity and the small size of the single airgun (< 100 cui). Impacts are localised and temporary.
Reduce the area of occupancy of the species.	The area of occupancy may be temporarily reduced given fish primarily respond by avoiding emitted sound from seismic sources, however there will be no long-term reduction in the area of occupancy of fish.
Fragment an existing population into two or more populations.	Underwater sound generated from geophysical activities would not be expected to split up a single fish population into two or more populations.
Adversely affect habitat critical to the survival of a species.	Underwater sound generated from geophysical activities will not affect habitat critical to the survival of a species. is no overlap between underwater noise emissions and critical fish habitat.
Disrupt the breeding cycle of a population.	Underwater sound generated from geophysical activities will not disrupt the breeding cycle of a population. There is no overlap between underwater noise emissions and fish breeding sites.

Significant impact guideline	Assessment
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Underwater sound generated from geophysical activities will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Impacts will be localised and temporary. Habitats for site-attached fish, such as rocky reef, do not occur in the activity area or immediate surrounds.
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 activity will not result in the introduction of IMS.
Introduce disease that may cause the species to decline.	The activity will not result in the introduction of disease.
Interfere with the recovery of the species.	Recovery of threatened fish species will not be interfered with given there is no overlap between underwater sound emissions and areas critical to species recovery (such as breeding or migration).

In addition, there are no fish BIA in the activity area and ecological EMBA.

Threatened shark species that may migrate through or forage or breed within the activity area (e.g., great white shark) are not likely to experience effects that cause mortality (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 activity area.

Based on this evaluation, the impact consequence of underwater sound on fish is assessed as negligible.

Impacts to Marine Invertebrates (Crustaceans)

This section assesses impacts of underwater sound to marine invertebrates, specifically crustaceans. Crustaceans (Arthropoda phylum) possess an exoskeleton that they moult to grow. Their bodies are composed of segments grouped into three parts: the cephalon (head), thorax and the pleon (abdomen). Crustaceans are distinguished from other arthropods by the possession of biramous (two-parted) limbs and by their larval forms. Most aquatic crustaceans are free-living, though some are sessile. Crustaceans that are present in the activity area are described in Section 5.3.1. Commercial invertebrate species, such as prawns, are key invertebrate species in the JBG and are described in Section 5.6.1.

Sensitivity to Sound

Invertebrates are less sensitive to noise impacts than fish species and marine mammals due to their lack of air-filled internal organs. Experiments on lobsters indicates that the statocyst (a mechano-sensory organ responsible for detecting gravity, body positioning and movement) is sensitive to sound and particle motion. The statocyst controls the righting response in lobsters that plays a vital role in the ability to escape predators (Day *et al*., 2019).

Specific studies examining the effect of seismic survey signals on crustaceans, including larval stages, are relatively rare, though recent Australian studies (e.g., Day *et al*., 2019; Day *et al*., 2016a; Przeslawski *et al*., 2016a;b; Carroll *et al*., 2017), have aimed to narrow the knowledge gap. These are being supplemented by global research, including ongoing projects such as Canadian Healthy Oceans Network Project 2.1.4 ('Anthropogenic Noise In The Ocean Soundscape: Effects On Fishes And Invertebrates').

The following studies conducted outside Australia, but considered in the recent review papers, are relevant in establishing possible impacts to crustaceans present in the proposed activity area:

- Wale et al (2013) undertook controlled tank-based experiments and showed that noise from lower level sources, such as ships, altered behaviour in the shallow water European shore crab (*Cancer maenus*) by disrupting feeding, slowing reaction time to threats, and hastening turn-over times for crabs placed on their backs.
- Payne et al (2007) conducted a pilot study of the effects of exposure to seismic sound on various health endpoints of the American lobster (*Homarus americanus*). Adult lobsters were exposed either 20 to 200 times to 202 dB re 1µPap-p or 50 times to 227 dB re 1µPap-p, and then monitored for changes to survival, food consumption, turnover rate, serum protein level, serum enzyme levels, and serum calcium level. Lobsters were exposed to seismic pulses at very close range to the source (~2 m). The SEL that the lobster were exposed to was not described in the report but can be estimated to be up to 207 dB re 1 µPa2·s. Observations were made over a period of a few days to several months and found that:
  - Results indicated no effects on delayed mortality or damage to the mechanosensory systems associated with animal equilibrium and posture (as assessed by turnover rate).
  - There was a decrease in the levels of serum protein, particular serum enzymes and serum calcium in the haemolymph of animals exposed to seismic sound. Statistically significant differences were noted in serum protein at 12 days post-exposure, serum enzymes at 5 days post-exposure, and serum calcium at 12 days post-exposure. Serum enzymes are valuable in detecting major organ damage whereby enzymes leak into the blood upon cellular rupture. Within this study two enzymes, Aspartate transaminase (AST) and Creatine kinase (CK), were not elevated in seismic-exposed animals, reflecting the absence of major cellular rupture or necrosis being affected by seismic sound, including high exposure conditions. Similar results were obtained in studies with snow crabs (Christian *et al*., 2003). However, there was evidence of decreased serum enzymes in some trials, indicating the possibility of hemodilution or uptake of excess water by the animals. A similar decrease in serum protein and calcium was noted in some trials indicating a potential for disturbance to osmoregulation (i.e., the process by which the body regulates the osmotic pressure of any organisms' fluids in order to keep the homeostasis of the organisms' water level constant). Altogether, the results suggest a potential for osmo-regulatory disturbance in lobsters exposed to seismic.
  - During the histological analysis conducted 4 months post-exposure, no structural differences in hepatopancreatic tissues were noted, which would denote cell or tissue rupture, necrosis or inflammation. There was also no evidence of tissue necrosis or inflammation in the ovaries. However, histology identified elevated deposits of carbohydrates, thought to be glycogen, in the hepatopancreas of seismic-exposed animals. Such abnormal accumulations are believed to be due to disturbance in cellular processes connected with synthesis and secretion, however, the report concludes that further research is required to assess whether this particular observation is due to organ stress. These studies are noted as being exploratory in nature, with the authors cautioning against over-interpretation.

- A pilot study on snow crabs (*Chionoecetes opilio*) (Christian *et al*., 2003; 2004) exposed captive adult male snow crabs, egg-carrying female snow crabs, and fertilised snow crab eggs to variable SPLs (191–221 dB re 1 µPa0-p) and SELs (<130–187 dB re 1 µPa2·s) under controlled field experimental conditions. The crabs were exposed to 200 discharges over a 33-minute period and found that:
    - Neither acute nor chronic (12 weeks post-exposure) mortality was observed for the adult crabs.
    - There was a significant difference in the development rate noted between the exposed and unexposed fertilised eggs/embryos in this study with the egg mass exposed to seismic energy demonstrating a higher proportion of less-developed eggs than the unexposed mass. However, this experiment was performed on eggs stripped from a single berried female and cultured in a laboratory for six weeks prior to exposure and eighteen weeks following exposure. Subsequent work on larvae that had been exposed to seismic array signals as embryos but were allowed to hatch normally without being stripped from berried females did not suffer any negative effects (Payne *et al*., 2008).
    - Stress indicators in the haemolymph of adult male snow crabs were monitored immediately after exposure of the animals to seismic survey sound (Christian et al., 2003; 2004) and at various intervals after exposure. No significant acute or chronic differences between exposed and unexposed animals in terms of the stress indicators (e.g., proteins, enzymes, cell type count) were observed.
- In 2003, a collaborative study was conducted in the southern Gulf of St. Lawrence, Canada, to investigate the effects of exposure to sound from a commercial seismic survey on egg-bearing female snow crabs (DFO, 2004). Caged animals were placed on the ocean bottom at a location within the survey area and at a location outside of the survey area. The maximum received SPL was ~195 dB re 1 µPa0-p. The crabs were exposed for 132 hours of the survey, equivalent to thousands of seismic shots of varying received SPLs. The animals were retrieved and transferred to laboratories for analyses. Neither acute nor chronic lethal or sub-lethal injury to the female crabs or crab embryos was indicated. DFO (2004) reported that some exposed individuals had short-term soiling of gills, antennules and statocysts, bruising of the hepatopancreas and ovary, and detached outer membranes of oocytes. However, they were found to be completely cleaned of sediment when sampled five months later and any differences could not be conclusively linked to exposure to seismic survey sound.
- In a field study, Pearson et al (1994) exposed Stage II larvae of the dungeness crab (*Metacarcinus magister*) to single discharges from a seven-airgun array and compared their mortality and development rates with those of unexposed larvae. For immediate and long-term survival and time to molt, this study did not reveal any statistically significant differences between the exposed and unexposed larvae, even those exposed within 1 m of the seismic source.
- Morris et al (2017) undertook a study into the effects of 2D MSS on the snow crab fishery. Snow crab harvesters in Atlantic Canada contend that seismic noise from widespread hydrocarbon exploration has strong negative effects on catch rates. This study repeated a Before-After-Control-Impact (BACI) study over two years to assess the effects of industry scale seismic exposure on catch rates of snow crab along the continental slope of the Grand Banks (North Atlantic Ocean) of Newfoundland, Canada. The results did not support the contention that MSS negatively affects catch rates in shorter term (i.e., within days) or longer time frames (weeks). However, significant differences in catches were observed across study areas and years. While the inherent variability of the catch per unit effort (CPUE) data limited the statistical power of this study, the results do suggest that if seismic effects on snow crab

harvests do exist, they are smaller than changes related to natural spatial and temporal variation.

- Parry and Gason (2006) undertook a statistical analysis of CPUE data collected over nearly 30 years in the Victorian southern rock lobster fishery (SRL) in southwest Victoria that showed no influence of historical 2D and 3D MSS activity. Analyses looked at short-term (weekly) and long-term variations (up to 7 years) in CPUE to determine whether changes were correlated with the MSS. The surveys occurred in water depths ranging from 10 m to 150 m. The study included surveys occurring during the southern rock lobster spawning period as well as during the lobster fishing season and so would have interacted with adult lobsters and larvae in the same way that the proposed Prion 3D MSS may. This study found no evidence that catch rates were affected in the weeks or years following the surveys, however Day et al (2016a) suggest that catch rates would have had to decrease by around 50% for this study to detect a result.

The following information summarises recent Australian research into the effects of seismic sound sources on crustaceans.

<u>FRDC Study (2016)</u>

In order to further understand interactions between seismic sound and marine invertebrates, the CarbonNet Project contributed funding (along with the Commonwealth Government's Fisheries Research Development Corporation [FRDC] and Origin Energy Ltd) to a research program assessing the impact of MSS on SRL (*Jasus edwardsii*) (and commercial scallops). This program study was undertaken by researchers from the IMAS at the University of Tasmania (Day *et al*., 2016a). Information from this report as it relates to SRL is provided herein.

The research program involved exposure of cohorts of SRL to multiple seismic airgun pulses at two sites (sandy substrate and limestone rock platform), both in 10-12 m water depths off the southern Tasmanian coast. The exposed lobsters were captive and control lobsters (no exposure) were also examined during subsequent analyses undertaken at 0, 14, and 120 days post-exposure. Exposure experiments were undertaken in July 2013 (45 cui airgun, 2,000 psi), July 2014 (150 cui airgun, 1,300 psi and 2,000 psi) and February 2015 (150 cui airgun, 2,000 psi). The airgun was towed at approximately 5 m depth from a distance of 1 km away and at a speed of approximately 5.5-7.4 km/hr with a shot interval of 11.6 seconds. The seismic source circled in close proximity to the lobster pots. The maximum calculated exposures were 212 dB re 1 µPaPK-PK, a per-pulse SEL of 190 dB re 1 µPa^2.s, an accumulated SEL of 199 dB re 1 µPa^2.s and maximum peak magnitude of ground acceleration of 68 ms-2 (this was likely to be an outlier).

While a regression of particle acceleration versus range for the single 150 cui airgun used in the study (minimum range of 6 m) showed that acceleration at 10 and 100 m range were typically 26 and 5 ms^{-2}, respectively, Day et al (2016a) describes findings related to seismic exposure of egg-bearing female spiny lobsters and subsequent larval development, which concludes:

- Exposure to seismic sound did not result in any mortalities of adult lobsters, even at close proximity.
- There was no difference in fecundity between control and exposed lobsters.
- A small but significant difference in the length of the larvae was observed in the exposed lobsters. No difference was found in width or dry mass of the larvae and no hatches were found to suffer from high mortality rates or deformities.
- No energy difference was identified between larvae from control and exposed lobsters.
- Larval activity/survival between control and exposed lobster groups was not significant. Overall there were no differences in the quantity or quality of hatched larvae, indicating that

the condition and development of spiny lobster embryos were not adversely affected by air gun exposure.

- The ability of exposed lobsters, and one cohort of control lobsters, to right themselves, a complex reflex, was compromised in the long term (120 days post-exposure) in three of the four experiments. This response was linked to damage to sensory hairs of the statocyst, the primary mechano-sensory and balance organ in lobsters.
- Tail extension, a simple behavioural reflex response, showed reduction in exposed lobsters in one of the four experiments. However, it is unclear how significant this finding is, as the warm summer water conditions during this particular experiment may be a contributing factor.
- Haemolymph (blood) biochemistry showed little effects on metabolic and respiratory stress, or vitality following exposure.
- Haemocyte count (indicative of immune response function) in exposed lobsters showed a long-term decline to 120 days post-exposure. However, haemocyte counts subsequently recovered to double the number of haemocytes in control lobsters at 365 days post-exposure, which may indicate a possible immune response to pathogens.
- Seismic exposure did not cause any immediate mass mortality. The authors rejected the hypothesis that 'exposure to seismic airguns causes immediate mass mortality, defined as an increase in mortality rate of sufficient proportion to affect population size significantly'. Not considering when both the control and exposed groups suffered mass mortality, the experimental mortality rates at 120 days' post-seismic airgun exposure were between 9.4% and 20%. These fall towards the low end of what might be expected from natural mortality rates. Even the highest levels of mortality recorded, 17.5% and 20% suffered by 4-pass treatments from the 2014 and 2015 experiments, were assessed by the authors to be modest compared to naturally occurring mortality rates.

Overall, no direct lethal effects to adult lobsters or impacts to embryos were observed and impacts were limited to statocyst condition, behavioural reflexes and immune response functions in adult lobsters. Day et al (2016a) note that these effects could have some effect on longer-term survivability.

However, Day et al (2016a) also report that SRL used for the 2014 experiments, which were collected from the Crayfish Point Reserve in the Derwent Estuary near Taroona, were found to have pre-existing damage to statocysts, likely resulting from prolonged exposure to shipping traffic noise in shallow water at this location. The lobster population at Crayfish Point Reserve has been subject to long-term monitoring. The population is thought to be at carrying capacity (Kordjazi *et al*., 2015) and survival rates within this reserve have been estimated through capture and release studies at around 95% (Green and Gardner, 2009).

The abundance of SRL within the Crayfish Point Reserve can reasonably be ascribed to the exclusion of the lobster fishery since 1971. Lobster populations within marine protected areas have consistently been found to demonstrate higher biomass and higher abundance of larger size classes than lobster populations subject to fishing pressure (Barret *et al*., 2009a;b; Young *et al*., 2016). Barret et al (2009) suggested that exploitation had reduced SRL biomass in the fishery adjacent to the Maria Island marine protected area, east coast Tasmania, to <10% of natural values, with consequent severe ecological effects on rocky reef ecosystems (Ling *et al*., 2009, Ling & Johnson, 2012).

Thus, whilst the ecological effects of damaged statocysts in the SRL has not been the subject of dedicated experimental studies, long-term monitoring of the lobster population with damaged statocysts at Cray Point Reserve indicates that any population-level survivability effects are not significant and, importantly, ecological effects are likely to be negligible relative to the effect of fishing mortality.

On the basis of these studies, the following broad conclusions can be drawn about impacts to SRL (and extrapolated to similar crustaceans, such as prawns) exposed to underwater seismic sound:

- Mortality of adult lobsters is unlikely;
- Increased mortality, delayed development or abnormal development to the egg mass carried by any 'berried' females, if present, or larvae produced from those eggs, is highly unlikely;
- Changes to heamolymph biochemistry, an indicator of acute or chronic metabolic stress, in adult lobsters in close proximity to the acoustic source are unlikely;
- Damage to statocysts in adult lobsters in close proximity to the acoustic source is likely, and it is not known whether a significantly damaged statocyst or impaired reflexes might disadvantage the growth or survival of lobsters in the wild;
- Statocyst damage is known to exist in wild SRL populations that have very high survival rates and are near carrying capacity;
- Changes to haemocyte count, an indicator of immune response function, in adult lobsters in close proximity to the acoustic source is likely; and
- Increased probability of mortality, delayed development or abnormal development of crustacean larvae in the water column is only possible at very close range.

WA DPIRD (2018) risk workshop

The WA DPIRD undertook a risk assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in WA to gain a contemporary understanding of MSS related risks to these fauna groups (Webster *et al*., 2018). With regard to crustaceans, the DPIRD risk assessment relied on many of the same scientific studies referenced in this EP (e.g., Day *et al*., 2016, Carroll *et al*., 2017; Parry & Gason, 2006; Payne *et al*., 2007). For lobsters, the risk rating for an airgun array sized between 2,000 and 4,500 cui (20 to 45 times larger than that proposed for this activity based on a single airgun array of no greater than 100 cui) was 'moderate' in water depths of 100 m and 'moderate' for water depths >250 m. This risk rating was based on multiplying a consequence rating of 'moderate' (meaning the risk was acceptable) with a likelihood of 'unlikely' (meaning the consequence may occur but only in exceptional circumstances).

FRDC Study (2021)

Researchers from University of Tasmania's Institute for Marine and Antarctic Studies (IMAS) and Curtin University's Centre of Marine Science and Technology (CMST) undertook further research (FRDC Project Number 2019-051) in order to characterise the impact of exposure to a full-scale MSS on the puerulus and juvenile life history stage of SRL (Day *et al*., 2021). Information from this report is summarised here.

The study involved exposure of SRL puerulus and post-settlement juveniles that were collected in Tasmania to three 2,820 cui seismic arrays towed at 8 m depth at a site off Lakes Entrance, Victoria during a commercial 3D marine seismic survey. Sixteen (16) puerulus were randomly assigned to either control (not exposed to airguns) or E0 (exposed to the seismic source at a nominal range of 0 m from the sail line). Fifty-six (56) post-settlement juveniles were randomly assigned to either control (as above), E0 (as above) or E500 (exposed to the seismic source at a nominal range of 500 m from the sail line). Control treatments were contained on the seabed at 51 m water depth and exposure treatments were contained at 58 m water depth. After the seismic vessel had conducted its run, the researchers recovered the lobsters, which were each in the water for an average of 20.4 hours. Once recovered, lobsters were tested for their righting reflex, which is considered a complex reflex requiring sensory input and neuromuscular coordination. A sub-sample of lobsters was returned to a laboratory to calculate the intermoult period for each lobster. Moulting is a physiologically demanding process that can be delayed, thereby making it a useful marker of growth and development.

The key results of the study include:

- Exposure to the seismic source did not result in mortality for puerulus or juvenile SRL.
- Immediately after exposure, the righting reflex was significantly impaired for all exposure treatments (i.e., E0 and E500 for juveniles and E0 for puerulus) compared to the respective controls.
- Following the first moult there was no significant difference found in righting between juvenile control and E0 treatments (puerulus sample size was too small for statistical analysis). For juvenile E500 lobsters, similar righting to that of controls was observed following the first moult, which indicates recovery from the initial impairment.
- Following the second moult, juvenile E0 lobsters showed significant impairment in righting compared to controls. Righting in juvenile E500 lobsters was similar to that of control, thereby further indicating recovery in this treatment.
- Intermoult period was significantly increased in E0 juvenile lobsters and appeared to be increased in puerulus (though the sample size was too small to be statistically analysed).
- Juvenile E500 lobsters showed a moderate (though non-significant) increase in moult duration.

The authors suggest that the results of the study imply the following:

- Seismic exposure (even to SRL directly beneath the source) is unlikely to result in mortality.
- The seismic source caused righting impairment to the close-range exposure groups (E0 for puerulus and juveniles) that had not recovered by the end of the holding period (two moults for juveniles and three moults for puerulus). This may have implications for predator avoidance behaviour and fitness in the wild.
- Impairment initially experienced in the E500 group of juveniles was not present after the first moult. This suggests that exposure at greater distances is recoverable, thereby rendering impacts to be short-term and recoverable.
- Exposure to the seismic source significantly increased the intermoult duration in E0 juveniles, indicating the potential for slowed development and growth following short range exposure.

In addition, recent underwater acoustic modelling undertaken by Beach Energy (2021) for a 2D seismic source (using a 160 cui sound source towed at a 7 m water depth) and geophysical (SBP and boomer) survey did not predict mortality or injury effects to crustaceans (SRL and giant crab). None of the modelled sound sources from these activities predicted that the noise effect levels at the seafloor (based on the noise effect criteria of 209-213 dB re 1 µPa PK-PK) would be reached.

Thresholds

There are currently no defined noise effect criteria for invertebrates from seismic sound exposure, therefore the results of the Payne et al (2008) study have been adopted as shown in Table 7.8.

Table 7.8. Threshold exposure criteria for crustaceans

Group	Threshold	Criteria
Crustaceans	No mortality or damage to mechano-sensory systems (Payne *et al*., 2008)	202 dB re 1 µPa PK-PK

Potential impacts

The data presented in Figure 7.1 to Figure 7.8 (which reports results in SEL, the same unit of measurement used in Table 7.8) indicates that the sound levels from geophysical activities will not reach the thresholds outlined in Table 7.8 and therefore impacts from the activity are likely to be insignificant to crustaceans.

Impacts to crustaceans are likely to be of negligible consequence based on the following:

- The sound at any one location will be localised and temporary.
- The activity window will overlap with the NPF JBG closure season (April to June) and only one month of the open season (August).
- Although the activity window overlaps with parts of the spawning period for several commercial prawn species (redleg banana, white banana, brown tiger and grooved tiger prawns), they tend to spawn in the shallower inshore waters (such as river and tidal creek systems of the JBG) before moving to deeper waters, meaning that there is less chance of the activity taking place in waters with high numbers of juvenile prawns.
- In comparison to the research summarised in this section, the proposed activity based on a single airgun of shallow seismic array will have significantly lower impact on prawns as opposed to conventional marine seismic survey array.
- Lethal effects to crustaceans have not been observed in studies (Christian *et al*., 2003; Parry and Gason 2006; Payne *et al*., 2007; Day *et al.,* 2016a).
- No significant impacts to adult female prawns berried with eggs are expected during the spawning season given that there have been no reports of acute or chronic mortality in the adult lobsters and no mortality of embryos exposed to seismic impulses (Christian *et al*., 2003).

The very low impact of seismic sound on benthic crustaceans from conventional sources demonstrated from these studies, together with the modelled impacts from the Beach Energy (2021) study, combined with the short duration and very small area of the geophysical activities means that the impact consequence of this activity on crustaceans in the JBG are predicted to be negligible.

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 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 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.

<u>Research results</u>

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.

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).

In Australian waters, the EPBC Act Policy Statement 2.1 determines suitable exclusion zones for seismic surveys with an unweighted per-pulse SEL threshold of 160 dB re 1 µPa2·s (DEWHA, 2008a). This threshold value is used in the policy to determine whale exclusion zones where seismic surveys must lower their acoustic power output, or shut down completely, in order to prevent significant exposure to sound levels that could induce TTS. If it can be demonstrated that SELs from air gun pulses fall below this at less than 1 km, a reduced 1 km 'low-power' exclusion zone can be adopted, while if they are above this threshold, the surveys must operate with a 2 km exclusion zone (the former applies to this geophysical investigation).

This threshold minimises the likelihood of TTS in mysticetes and large odontocetes according to the background paper. Policy Statement 2.1 does not apply to smaller dolphins and porpoises, as DEWHA assessed these cetaceans as having peak hearing sensitivities occurring at higher frequency ranges than those that seismic arrays typically produce.

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; Parks *et al*., 2007; Di loro & 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.

Dolphins. The seven dolphin species that may be encountered in the activity area (see Table 5.7) have broad distributions and habitat requirements. These species are known to 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). The two threatened dolphin species listed in Table 5.7, the Australian humpback dolphin and Australian snubfin dolphin, are generally found in shallow protected waters along the coast and unlikely to be present in the activity area. Because dolphins are mid-frequency cetaceans, the sounds that they make to communicate generally do not overlap with the frequencies used by geophysical sound sources, so they are less susceptible to underwater sound, meaning impacts from this activity will be negligible.

Pygmy blue whales. There are very few peer-reviewed papers that examine the responses of blue or pygmy blue whales to geophysical sound. The only study that specifically examines responses from seismic sound was that from Di loro & 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 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 the much smaller sound sources used for the geophysical investigations, it is unlikely that the activity will create anything other than avoidance behavioural in a highly localised area for a very short amount of time, especially if undertaken during foraging times (see Section 5.3.5).

Humpback whale. Humpback whale breeding and calving BIAs are located off the west Kimberley coastline and extends as far as Bigge Island, approximately 107 km south of the ecological EMBA. Humpback whales are therefore unlikely to be present in the activity area, so no impacts are expected to this species. Any individual within the activity area is expected to be transient. Humpback whales have not been observed to be significantly displaced from their migratory pathways as a result of geophysical 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 from the seismic source.

Sei whale. This species is known to prefer deep offshore waters with no known mating or calving areas in Australian waters. As such, the generation of geophysical sound will not impact on this species.

Fin whale. This species is known to prefer deep offshore waters and are considered rare in Australia. As such, the generation of geophysical sound will not impact on this species.

Thresholds

In August 2016, the 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 proposed 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 $\mu Pa^2 \cdot s$ (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 (2016) 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 of geophysical activities), 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 7.9.

Table 7.9. The unweighted per-pulse SPL, SEL and SEL_{24h} and PK thresholds for acoustic effects on cetaceans

Cetacean hearing group	DEWHA (2008)	NMFS (2013)	NMFS (2016)	
	Unweighted per- pulse SEL (dB re 1 µPa^2.s)	Behaviour	Injury (PTS)	
		SPL (dB re 1 µPa)	Weighted SEL_{24h} (dB re 1 µPa^2.s)	PK (dB re 1 µPa)
LFC	160	160	183	219
MFC			185	230
HFC			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).*

<u>Predicted Impacts</u>

The data presented in Figure 7.1 to Figure 7.8 (which reports results in SEL, the same unit of measurement used in Table 7.9) indicates that the sound levels from geophysical activities mostly remain under the thresholds outlined in Table 7.9 and therefore impacts from the activity are likely to be insignificant to cetaceans.

Cetaceans using low frequency communications (e.g., baleen species such as humpback whales) will be more affected by lower frequency sources (i.e., the SBP and shallow seismic). Cetaceans using mid-frequency communications (e.g., toothed species such as sperm whales) are more affected by the higher frequency sources (i.e., SSS and MBES).

Cetaceans are highly mobile, and behavioural effects are expected to be limited to short-term avoidance of the activity area if sounds levels create disturbance.

The known temporal and spatial characteristics of cetaceans that may occur in and around the activity area make it unlikely that behavioural effects or TTS will occur because:

- Pygmy blue whales - migration is thought to follow deep oceanic routes, and a tagging study by Double et al (2014) identified that the shallowest waters occupied was ~1,300 m. There are no pygmy blue whale BIAs intersected by the activity area, so if this species is present in the region at the time of the activity, it is likely to be in low numbers and not undertaking critical life stages (such as breeding and calving, where animals would be present in one location for longer than if migrating through).
- Humpback whales - are unlikely to be encountered in the activity area (because their southern migration in the wider region occurs during November and December, outside the activity period), and their peak presence in northwest Australia (June to September) is located far west of the activity area. Overall, 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).
- Cetaceans have an observed ability to avoid vessels and acoustic sound sources.
- Any reduction in plankton biomass in and immediately around the activity area as a result of underwater sound is expected to have a negligible effect on the foraging habits of baleen whales because the reduced biomass is temporary, the activity area is located well outside of plankton bloom areas (caused by cold water upwellings) and because they have vast foraging grounds, with the activity area representing a miniscule proportion of these foraging grounds.

The proposed geophysical and geotechnical investigations will not have a 'significant' impact on threatened cetacean species (see Section 5.3.5) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013) as outlined in Table 7.10.

Table 7.10. Assessment against EPBC Act Significant Impact Guidelines for cetaceans

Significant impact guideline	Assessment
Lead to a long-term decrease in the size of a population.	Underwater sound generated from geophysical activities will not lead to a long-term decrease in the size of a population.
Reduce the area of occupancy of the species.	Underwater sound generated from geophysical activities will not lead to a reduction in the area of occupancy of cetaceans.
Fragment an existing population into two or more populations.	Underwater sound generated from geophysical activities would not be expected to split up a single population into two or more populations.
Adversely affect habitat critical to the survival of a species.	Underwater sound generated from geophysical activities will not affect habitat critical to the survival of a species. There is no overlap between underwater noise emissions and critical habitat for cetaceans.
Disrupt the breeding cycle of a population.	Underwater sound generated from geophysical activities will not disrupt the breeding cycle of a population. There is no overlap between underwater noise emissions and cetacean breeding sites.
Modify, destroy, remove, isolate or decrease the availability or quality of	Underwater sound generated from geophysical activities will not modify, destroy, remove, isolate or decrease the

Significant impact guideline	Assessment
habitat to the extent that the species is likely to decline.	availability or quality of habitat to the extent that the species is likely to decline. Impacts will be localised and temporary.
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 activity will not result in the introduction of IMS.
Introduce disease that may cause the species to decline.	The activity will not result in the introduction of disease.
Interfere with the recovery of the species.	Recovery of threatened cetaceans will not be interfered with given there is no overlap between underwater sound emissions and areas critical to species recovery (such as areas of calving, breeding or migration).

The results of the assessment indicate that the impacts on cetaceans will be negligible at both an individual level and local population level.

Impacts to Turtles

Threatened and migratory marine turtle species were identified as having the potential to occur in the activity area and EMBA these are the flatback, green, loggerhead, hawksbill, leatherback and olive ridley turtles (see Section 5.3.6). There are several BIAs for marine turtle species in the region, including those along the coastline in the JBG. The activity area overlaps the olive ridley, green and flatback turtle foraging BIAs, as well as internesting BIA for flatback turtles (see Section 5.3.6).

<u>Research results</u>

There is limited information on sea turtle hearing. Morphological studies of green and loggerhead turtles (Ridgeway *et al*., 1969; Wever, 1978; Lenhardt *et al*., 1985) found that the sea turtle ear is similar to other reptile ears but has some adaptations for underwater listening. A thick layer of fat may conduct sound to the ear in a similar manner as the fat in jawbones of odontocetes (Ketten *et al*., 1999), but sea turtles also retain an air cavity that presumably increases sensitivity to sound pressure. Sea turtles have lower underwater hearing thresholds than those in air, owing to resonance of the aforementioned middle ear cavity, and hence they hear best underwater (Willis, 2016).

Electrophysiological and behavioural studies on green and loggerhead sea turtles found their hearing frequency range to be approximately 50–2,000 Hz, with highest sensitivity to sounds between 200 and 400 Hz (Ridgeway et al., 1969; Bartol et al., 1999; Ketten & Bartol, 2005; Bartol & Ketten, 2006; Yudhana *et al*., 2010; Piniak *et al*., 2011; Lavender *et al*., 2012; 2014), although these studies were all conducted in-air. Underwater audiograms are only available for three species. Two of these species, the red-eared slider (Christensen-Dalsgaard *et al*., 2012), the loggerhead turtle (Martin *et al*., 2012), both demonstrated higher sensitivity at around 500 Hz (Willis, 2016). Recent work on green turtles has refined their maximum underwater sensitivity to be between 200 and 400 Hz (Piniak *et al*., 2016). Yudhana et al (2010)) measured auditory brainstem responses from two hawksbill turtles in Malaysia and found that peak frequency sensitivity occurred at 457 Hz in one turtle and at 508 Hz in the other.

Most studies looking at the effect of seismic sound on marine turtles have focused on behavioural responses given that physiological impacts are more difficult to observe in living animals. Sea turtles have been shown to avoid low-frequency sounds (Lenhardt, 1994) and sounds from an airgun (O'Hara & Wilcox, 1990), but these reports did not note received sound levels. Moein et al (1995) found that penned loggerhead sea turtles initially reacted to a single airgun but then showed low or no response to the sound (i.e., they may have become habituated to it). Caged green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) increased their swimming activity in response to an approaching airgun when the received SPL was above 166 dB re 1 µPa and they behaved erratically when the received SPL was approximately 175 dB re 1 µPa (McCauley *et al*., 2000b).

Sound levels defined by Popper et al (2014) show that animals are very likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of metres), and a low response if they are far (thousands of meters) from the airgun.

Weir (2007) carried out observations from onboard a seismic survey vessel during a 10-month 3D MSS offshore from West Africa, concluding that:

> *"..There was indication that turtles occurred closer to the source during guns-off than full-array, with double the sighting rate during guns-off in all distance bands within 1,000 m of the array."*

The reduction in the number of turtles observed within 1,000 m during operation of a full airgun array (Weir, 2007) is therefore reasonably consistent with the observations of McCauley et al (2003), which indicated an avoidance response threshold of approximately 175 dB re 1 µPa SPL. At very close distances to the seismic array, there is also the possibility of temporary hearing impairment or perhaps even permanent hearing damage to turtles. However, there are very few data on temporary hearing loss and no data on permanent hearing loss in sea turtles exposed to airgun pulses. The greatest impact is likely to occur if seismic operations occur in or near areas where turtles concentrate, and at seasons when turtles are concentrated there.

<u>Thresholds</u>

Table 7.11 presents the exposure criteria for impulsive sound for turtles. This was developed by Popper at al (2014) based on results from the Working Group on the Effects of Sound on Fish and Turtles. In general, any adverse effects of seismic sound on turtle behaviour depends on the species, the state of the individuals exposed, and other factors. The SEL metric integrates noise intensity over some period of exposure.

Table 7.11. Exposure criteria for seismic sources – turtles

Mortality and potential mortal injury	Distance from the source	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
210 db 24_{hr} SEL *or* >207 dB peak	Near	Moderate	Moderate	Low	Moderate
	Intermediate	Low	Low	Low	Low
	Far	Low	Low	Low	Low

<u>Distance from the source</u>
Near = tens of metres.
Intermediate = within hundreds of metres.
Far = thousands of metres.

Additionally, based on the limited data in regard to noise levels that illicit a behavioural response in turtles, a level of 166 dB re 1 µPa drawn from NSF (2011) is typically applied, both in Australia and by NMFS, as the threshold level at which behavioural disturbance could occur.

Predicted impacts

The data presented in Figure 7.1 to Figure 7.8 (which reports results in SEL, the same unit of measurement used in Table 7.11) indicates that the sound levels from geophysical activities do not trigger the thresholds outlined in Table 7.11 and therefore impacts from the activity to turtles will be insignificant.

The geophysical survey will overlap the loggerhead, green and olive ridley turtle foraging BIAs and part of the flatback turtle interesting BIA. In the worst-case, recoverable injury and TTS for any turtles present in the activity area at the time of the activity could occur within tens of metres (per Table 7.11). Behavioural changes, such as avoidance and diving, may occur for individuals within tens of metres of the geophysical equipment. This will not result in short- or long-term population impacts to turtles. The impact consequence level is assessed as negligible.

Impacts to Avifauna

The activity area contains potential foraging habitat for a diverse array of seabirds. In the event that individual birds or flocks are present in the activity area during geophysical operations, 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 activity 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 activity area (see Section 5.3.7) all have considerable foraging habitat present throughout JBG, with many listed as migratory. The small size of the activity area and location offshore is not significant relative to their normal foraging environment. Any temporary dispersal of prey species (i.e., fish) due to geophysical activities would not result in any significant decrease in availability of prey species that is of biological significance for these populations.

The timing of the activity overlaps with the breeding seasons of several seabirds (see Figure 5.30), but they breeding areas are along the coast and a great distance away from the activity area. Underwater sound from the activity will therefore have no impacts on seabird breeding.

Shorebird species such as the curlew sandpiper and lesser sand plover are not expected to be affected by the activity, given their preference for species of prey occurring in areas of intertidal sandflats and mudflats along the coastline.

Thresholds

There are no thresholds or assessment criteria for noise impacts to seabirds and shorebirds from underwater sound exposure.

Predicted impacts

As most seabirds spend very little time under the water surface, and when they do it is for very limited periods (several seconds to a minute), impacts to seabirds will be negligible. The activity area does not contain spatially limiting food sources, with JBG providing abundant foraging grounds.

7.1.3. Impact Assessment

Table 7.12 presents the impact assessment of underwater sound generated from the activity on biological receptors.

Table 7.12. Impact assessment for underwater sound on biological receptors

<table>
<tr><th colspan="3">Summary</th></tr>
<tr><td>Summary of impacts</td><td colspan="2">Physiological or pathological impacts to local populations of marine fauna and avifauna.</td></tr>
<tr><td>Extent of Impact</td><td colspan="2">Likely to be similar to the distances noted in Table 7.4 and Figures 7.1 to 7.8.</td></tr>
<tr><td>Duration of Impact</td><td colspan="2">Underwater sound generation will be of a short duration.</td></tr>
<tr><td>Level of certainty of impacts</td><td colspan="2">Moderate (higher for geophysical sound sources such as conventional seismic sound).</td></tr>
<tr><td rowspan="4">Impact decision framework context</td><td>Decision type</td><td>A – good industry practice required.</td></tr>
<tr><td>Activity</td><td>Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.</td></tr>
<tr><td>Risk and uncertainty</td><td>Risks are well understood, uncertainty is minimal.</td></tr>
<tr><td>Stakeholder influence</td><td>No conflict with company values, no partner interest, no significant media interest.</td></tr>
<tr><td>Defined acceptable level</td><td colspan="2">• No population level impacts to marine fauna and avifauna from the activity.
• Anthropogenic noise in BIAs will be managed such that turtles will continue to utilise the area without injury or displacement from foraging, migration and interesting areas.</td></tr>
<tr><th colspan="3">Impact consequence (inherent)</th></tr>
<tr><td colspan="2">Receptor</td><td>Consequence rating</td></tr>
<tr><td colspan="2">Plankton</td><td>Negligible</td></tr>
<tr><td colspan="2">Fish – with swim bladders</td><td>Negligible</td></tr>
<tr><td colspan="2">Fish – without swim bladders</td><td>Negligible</td></tr>
<tr><td colspan="2">Marine invertebrates (crustaceans)</td><td>Negligible</td></tr>
<tr><td colspan="2">Cetaceans</td><td>Negligible</td></tr>
<tr><td colspan="2">Turtles</td><td>Negligible</td></tr>
<tr><td colspan="2">Avifauna</td><td>Negligible</td></tr>
</table>

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
EPBC Policy Statement 2.1 – Part A (Standard management procedures) for the geophysical investigations **(IMP-01: EPS-01, -03)**	Engineering & administrative	Yes	**EB:** Improved ability to spot and identify marine fauna at risk of impact from underwater sound generated by activity equipment. **C:** Little additional cost – time to induct vessel crew and ensure compliance. **Ev:** Standard management procedures in Part A of the policy statement must be followed by all vessels conducting seismic surveys (including shallow seismic surveys) irrespective of location and time of year. The policy statement notes that these procedures should be sufficient in areas where there is a low likelihood of encountering whales.
EPBC Policy Statement 2.1 – Part A (Standard management procedures) – soft-start procedures for the geophysical investigations	Engineering	No	**EB:** Improved ability to avoid or minimise impacts of underwater sound to marine fauna. **C:** Cost of extra vessel time on water, likely to be several hours in this location during the proposed time window. **Ev:** The equipment to be used for these geophysical investigations is different to conventional (and higher impact) seismic surveys. This equipment can only be turned on or one; there is no ability to gradually 'ramp up' the sound. The shallow seismic survey is likelty to use one or two airguns, and as a single array, they too cannot be ramped up; they are either on or off. Therefore, implementing soft-starts for the geophysical investigations is not an option for this activity.
Use of a smaller sound source for shallow seismic surveying	Engineering	No	**EB:** Potential reduction in impacts to marine fauna. **C:** No additional cost. **Ev**: The exact size of the sound source to be used for shallow seismic surveying will not be known until a contractor is selected, however it is expected to be no greater than 100 cui. At such a small volume, there is little to no opportunity to reduce this volume any further without compromising the objectives of the geophysical investigations.

Vessel engines and thrusters are well maintained **(IMP-01: EPS-04)**	Engineering	Yes	**EB:** Efficient engines and thrusters are likely to result in lower sound and vibration, thereby minimising impacts to sound-sensitive marine fauna. **C:** Maintenance costs can be significant. **Ev:** Vessel maintenance is necessary to maintain a vessel in sea-worthy condition. EOG would not hire a vessel that is not sea-worthy, so there I no alternative to implementing this control measure.
EPBC Policy Statement 2.1 – Part B (Additional management measures) – use of a Marine Mammal Observer (MMO) for the geophysical investigations	Administrati ve	No	**EB:** Improved ability to spot and identify marine fauna at risk of impact from underwater sound generated by activity equipment. **C:** Several thousand dollars to contract an MMO (based on day rate, travel and accommodation). **Ev**: The use of MMOs is covered by Part B (Additional Management Procedures) of the policy statement. Adoption of Part B (either all or parts thereof) is recommended in areas and/or seasons that have a moderate to high likelihood of encountering whales. The likelihood of encountering whales in the activity area during the activity window is low (outside of the known pygmy blue whale and humpback whale migration periods with no whale BIAs within the activity area), so the use of an MMO is not considered necessary. Vessel crew on the vessel can implement EPBC Policy Statement 2.1.
Undertake site-specific acoustic modelling as per the Approved Conservation Advice for *Megaptera noveangliae* (humpback whale)	Administrati ve	No	**EB:** Increase the knowledge of potential impacts. **C:** Several thousand dollars to undertake site-specific acoustic modelling. **Ev:** There is no environmental benefit with this control measure as there are no humpback whale BIAs in or near the activity area.
Develop a noise management plan as per the Approved Conservation Advice for *Megaptera noveangliae* (humpback whale)	Administrati ve	No	**EB:** Potential reduction in impacts to marine fauna. **C:** Several thousand dollars to prepare a noise management plan. **Ev:** There is no environmental benefit as there are no humpback whale BIAs in or near the activity area.

Environmental awareness induction **(IMP-01: EPS-02)**	Administrative	Yes	**EB:** Ensures vessel crew are aware of their obligations regarding implementation of EPBC Policy Statement 2.1, thereby minimising impacts to megafauna. **C:** Minimal additional cost to prepare and present induction. **Ev:** Presenting inductions to ensure crew are aware of their obligations is an industry standard. The benefits outweigh the minor costs.

Environmental Controls and Performance Measurement		
Performance outcome	Performance standard (control)	Measurement criteria
No displacement or injury to whales and turtles during geophysical investigations.	**(IMP-01:EPS-01)** Vessel crew will implement parts of Part A of EPBC Policy Statement 2.1. Specifically:	
	A.3.1: Pre Start-Up Visual Observations • Pre-start visual observations out to 3 km for 30 minutes. • If a whale is observed during the pre-start observations, delay soft start for 30 minutes. • If no whales are observed, activate acoustic equipment.	Daily operations reports verify procedure was followed as required.
	A.3.4: Operations procedure • If a whale is observed within the shutdown zone of the source (500 m), the acoustic source will be shut down. • Acoustic equipment can be reactivated after the whale has been observed to move outside the low power zone or if the whale has not been sighted for 30 minutes.	Daily operations reports verify procedure was followed as required.
	A.3.6 Night-time and low visibility procedure • Wherever practicable, commence operations during daylight hours. • Night-time and low visibility operations will not commence if there have been 3 or more whale-instigated shutdown in the preceding daylight hours.	Daily operations reports verify procedure was followed as required.
	(IMP-01: EPS-02) Environmental awareness induction will be provided to vessel crew prior to start of the activity that includes marine fauna interaction requirements.	Induction presentation and signed attendance sheet.
Cetacean sightings are reported to the DAWE.	**(IMP-01:EPS-03)** *EPBC Act Policy 2.1 – Part A.4* EOG will report cetacean sightings online to the DAWE within 2 months of activity completion (through the online Cetacean Sightings Application where possible or via email).	Transmittal of sighting records are available to verify reports were made.

Vessel engines and thrusters are well maintained.	**(IMP-01: EPS-04)** Engines and thrusters are maintained in accordance with manufacturer's instructions via the Planned Maintenance System (PMS) to ensure they are operating efficiently.	PMS records verify that engines and thrusters are maintained to schedule.

Impact consequence (residual)

Receptor	Consequence rating
Plankton	Negligible
Fish – with swim bladders	Negligible
Fish – without swim bladders	Negligible
Marine invertebrates (crustaceans)	Negligible
Cetaceans	Negligible
Turtles	Negligible
Avifauna	Negligible

The consequence of underwater sound emissions is assessed as negligible because:

- Underwater sound emissions are temporary;
- BIAs for cetaceans (as one of the more sound-sensitive fauna groups) do not occur in and around the activity area; and
- Distances to effect for underwater sound are very low.

Demonstration of ALARP

A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.

Demonstration of Acceptability

Policy compliance	EOG's Safety and Environmental Policy objectives are met.	
Management system compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard	The residual impact consequence is Level 2 (negligible) except for turtles and prawns assessed as Level 3 (minor), which is considered acceptable.	
Engagement	Relevant persons	The NT DITT raised concerns about the impacts of underwater sound on fish (see Chapter 4). Impacts to fish are addressed in this section.
	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns about the effects of underwater sound.
Legislative context	The performance standards outlined in this EP align with the requirements of: • EPBC Act 1999 (Cth): ○ Section 229, 229A – all cetaceans protected in Australian waters, and it is an offence to kill, injure or interfere with a cetacean. • EPBC Act Policy Statement 2.1 (Interaction between offshore seismic exploration and whales) management procedures.	

Industry practice	The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented for this activity.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include: • Considering sensitive locations and times of year for critical activities of species that are present.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines specifically regarding underwater sound for offshore activities.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of sound generation on marine life.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.5.5) have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Noise (item 74). The preparation of this EP meets the objectives of these guidelines, whereby sensitive areas for marine life are identified, and stop procedures are in place when marine mammals are sighted within 500 m of the activity **(IMP-01: EPS-01)**.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met with regard to: • Section 8.2 (Planning): Cetaceans (seasonal presence, migration areas, aggregation areas); • Section 8.7 (Aquatic life): Sighting and reporting (monitoring) procedures **(IMP-01: EPS-01)**; and • Appendix 1: Recommended Mitigation Measures for Cetaceans during Geophysical Operations (via more stringent requirements contained in the EPBC Act Policy) **(IMP-01: EPS-01).**

	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives for offshore geophysical surveys: • Reduce the impact on cetaceans and other marine life to ALARP and an acceptable level. • To reduce the impacts to benthic communities to ALARP and an acceptable level.
	EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (2008a)	The standard management procedures in Part A of the guidelines have been adopted **(IMP-01: EPS-01)**.
Environmental context	MNES	
	AMPs	Underwater sound created by the activity will not reach levels above ambient sound at AMPs.
	Ramsar wetlands	Underwater sound created by the activity will not reach levels above ambient sound at any wetlands.
	TECs	Underwater sound created by the activity will not reach levels above ambient sound at TECs.
	Nationally threatened and migratory species	Underwater sound created by the activity will not reach levels above ambient sound for threatened and migratory species.
	Other matters	
	KEFs	Underwater sound created by the activity will not reach levels above ambient sound at KEFs.
	NIWs	Underwater sound created by the activity will not reach levels above ambient sound at NIWs.
	State marine parks	Underwater sound generated by the activity will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	The Conservation Management Plan for the Blue Whale (DoE, 2015a) and the Conservation Advice for the Humpback Whale (TSSC, 2015a); Sei Whale (TSSC, 2015b) and Fin Whale (TSSC, 2015c) identify noise interference as a threat to these species. The plans state that the risk of physical impacts is minimised by the implementation of EPBC Act policy Statement 2.1, which this activity is implementing. The Recovery Plan for the White Shark (DSEWPC, 2013) does not list anthropogenic sound as a threat to this species.
		The Recovery Plan for Marine Turtles in Australia (DoEE, 2017c) identifies noise interference as a

		threat to turtles, and for acute noise such as seismic surveys, states that surveys planned to occur inside important inter-nesting habitat should be scheduled outside the nesting season. This is not triggered by this activity given the absence of turtle BIAs in the EMBA.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant) as outlined below:	
	A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	The timing of the activity has been selected to balance the requirements between peak fishing activity, whale migration times, sea state considerations and safe vessel operations.
	B. If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	The scientific literature cited throughout this section indicates the PTS in cetaceans (as one of the more sound-sensitive fauna groups) is likely only within close proximity to the sound source (tens of metres), with TTS possible over longer distances. TTS and PTS are unlikely to occur due to the implementation of EPBC Act Policy Statement 2.1.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Impacts to biological receptors are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value.
	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	Impacts to biological receptors are assessed to be localised and temporary. There will not be a loss of species diversity and abundance as a result of the underwater sound generated by the activity.
	E. Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.
Statement of acceptability	EOG considers the impacts from underwater sound to be acceptable because:	

	• It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is negligible (for the majority of biological receptors) and minor (for turtles and benthic invertebrates); • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Underwater sound emissions from the activity will not have long-term or significant impacts on MNES; • The management of underwater sound emissions will ensure it is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of underwater sound emissions will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and • The management of underwater sound emissions will ensure it is not inconsistent with ESD principles.
Environmental Monitoring	
• Monitoring for megafauna.	
Record Keeping	
• Daily operations report. • Transmittal of sighting records to DAWE. • Induction presentation and attendance sheets. • PMS records (engines/thrusters).	

7.2. IMPACT 2 – Underwater Sound – Impact on Commercial Fisheries

7.2.1. Hazard

The proposed geophysical activities may disrupt the sustainability of commercial and recreational fisheries due to the physical, behavioural or physiological responses in target fish species (Carroll *et al*., 2017).

7.2.2. Known and Potential Environmental Impacts

The potential impacts of underwater sound to commercial fisheries include:

- Catchability – movement of stock away from traditional fishing grounds due to the sound;
- Loss of catch - direct mortality to mature individuals, juveniles or larval stages, resulting in immediate or future reduced fishing stock;
- Displacement – inability to fish in the activity area during the activity and/or having to fish areas not normally fished, thereby displacing other fishers (see Section 7.4); and
- Economic impacts - financial loss from reduced catch due to the above-listed factors.

7.2.3. EMBA

The EMBA for underwater sound is unlikely to be beyond tens of metres (or several hundred metres at most) from the sound source, as outlined in Section 7.1.

7.2.4. Evaluation of Environmental Impacts

Impacts to fisheries in general

Potential impacts to commercial fisheries stocks from the activity are limited to a temporary reduction in fish catch within the activity area due to lateral displacement from the operation of geophysical and geotechnical equipment.

Impacts to the fisheries are minimised because:

- The small size of the activity area in relation to the extent of the fisheries actively fished is low (less than 8% for all fisheries), so the likelihood of disrupting the sustainability of commercial fisheries is negligible given the availability of other vast areas of ocean for fishing;
- The timing of the activity area (outside of key fishing periods), combined with its small size, means there will be negligible impacts to spawning or recruitment success at the population or fishery level; and
- There are no unique or geographically restricted seabed features or fishing target species identified in or around the activity area.

Impacts to individual fisheries

The fisheries that actively fish in the activity area are described in Section 5.6.1.

Recreational fishing activities are primarily based out of Darwin, located approximately 288 km northeast of the activity area. Given the distance of the activity area from the mainland and main population areas (e.g., Port Keats), impacts to recreational fishing activities are not predicted to occur. RecFish West and the AFANT have not raised any issues regarding recreational fishing in and around the activity area.

An evaluation and assessment of the impact of underwater sound from the activity against each fishery is provided in this section. The impacts considered in this section are socio-economic in nature; biological and ecological impacts for relevant receptors are considered in Section 7.1.

Northern Prawn Fishery (Cth)

- The spatial overlap between the activity area and the NPF is 0.04%.
- The spatial overlap between the activity area and the low intensity NPF (2020 fishing season data) is 0.01%.
- As per Section 5.6.1, there is low fishing effort in the JBG compared to the Gulf of Carpentaria (east of Darwin), however this is mostly dependent on the catch levels elsewhere in the NPF.
- The temporal overlap between the NPF in the JBG and the activity is one month (August, see Figure 5.43). The activity is likely to be undertaken prior to August, meaning there is a low chance of disruption to the NPF vessel fleet and low probability of impacts to fishing productivity.

These factors, combined with the localised area of geophysical activities and its short duration, means the impact consequence to the NPF is negligible.

Mackerel Managed Fishery (WA)

- The spatial overlap between the activity area and the MMF is 0.02%, in an area that has low fishing intensity.
- While the activity window does overlap with the main fishing season (May to November), there is a very small spatial overlap and low fishing intensity.

WAFIC, as the industry body representing the MMF, has not expressed any specific concerns about the activity for this fishery. These factors, combined with the localised area of geophysical activities and its short duration, means the impact consequence to the MMF is negligible.

Northern Demersal Scalefish Managed Fishery (WA)

- The spatial overlap between the activity area and the NDSMF is 0.072%.
- Fishing Area 2, Zone B of the NDSMF (the portion of the fishery overlapped by the activity area) accounts for 90% of the fishery catch from 2019, of which only 0.085% is overlapped by the activity area.

WAFIC, as the industry body representing the NDSMF, has not expressed any specific concerns about the activity for this fishery. These factors, combined with the localised area of geophysical activities and its short duration, means the impact consequence to the MMF is negligible.

Kimberley Crab Managed Fishery (North Coast Crab Fishery) (WA)

There is no spatial overlap between the KCMF and the activity area.

WAFIC, as the industry body representing the KCMF, has not expressed any specific concerns about the activity for this fishery.

Kimberley Prawn Managed Fishery (WA)

There is no spatial overlap between the KPMF and the activity area.

WAFIC, as the industry body representing the KCMF, has not expressed any specific concerns about the activity for this fishery.

Kimberley Gillnet and Barramundi Fishery (WA)

There is no spatial overlap between the KGBF and the activity area.

WAFIC, as the industry body representing the KGBF, has not expressed any specific concerns about the activity for this fishery.

Spanish Mackerel Fishery (NT)

There is no spatial overlap between the KGBF and the activity area.

NT Fisheries, as the body representing NT commercial fisheries, expressed concern about the impacts of the activity on fish spawning. Spanish mackeral typically spawn in coastal areas, and as such, spawning and juvenile fish are unlikely to be affected by the activity.

Offshore Net and Line Fishery (NT)

There is no spatial overlap between the Offshore Net and Line Fishery and the activity area.

NT Fisheries, as the body representing NT commercial fisheries, expressed concern about the impacts of the activity on fish spawning. Shark and grey mackeral are the key catch targets for this fishery. Fish eggs and juveniles have a low susceptibility to underwater sound (see Section 7.1.2 ('Impacts to Fish'), so impacts will be negligible.

Demersal Fishery (NT)

There is no spatial overlap between the NT Demersal Fishery and the activity area.

NT Fisheries, as the body representing NT commercial fisheries, expressed concern about the impacts of the activity on fish spawning. Snapper species are the key catch targets for this fishery. Fish eggs and juveniles have a low susceptibility to underwater sound (see Section 7.1.2 ('Impacts to Fish'), so impacts will be negligible.

7.2.5. Impact Assessment

Table 7.13 presents the impact assessment of underwater sound from the activity on commercial fisheries.

Table 7.13. Impact assessment for underwater sound on commercial fisheries

Summary		
Summary of impacts	The sustainability of commercial fisheries is disrupted.	
Extent of impacts	Localised.	
Duration of impacts	Temporary - underwater sound will only be emitted for the duration of the activity (see Section 2.2).	
Level of certainty of impacts	Low - fishing activity in the activity area is well understood and impacts to finfish and crustaceans from anthropogenic sound are well understood.	
Impact decision framework context	Decision type	A – good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk and uncertainty	Risks are well understood, uncertainty is minimal.
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.

Defined acceptable level	No commercial fishery is financially worse off as a result of the activity. The sustainability of the commercial fisheries is not compromised as a result of the activity.		
Impact consequence (inherent)			
Fishery		Consequence rating	
NPF (Cth)		Negligible	
MMF (WA)		Negligible	
NDSMF (WA)		Negligible	
KCMF (North Coast Crab Fishery) (WA)		Negligible	
KPMF (WA)		Negligible	
KGBF (WA)		Negligible	
Demersal Fishery (NT)		Negligible	
Offshore Net and Line Fishery (NT)		Negligible	
Spanish Mackerel Fishery (NT)		Negligible	
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Activity to occur during NPF seasonal closure (1st December 2021 – 1st August 2022)	Eliminate	Yes	**EB:** Avoids impacts to the fishery stock. **C:** No cost associated with preparation of claims and claim payments as a result of the activity occurring at this time of year. **Ev:** Environmental benefits can be achieved without cost.
Schedule activity to avoid overlap with spawning periods of commercially important species (prawns).	Eliminate	No	**EB:** Potential reduction in the impact of underwater sound to breeding populations (and juveniles) of a commercially important group of species. **C:** Increases time period of activity to avoid all listed marine fauna due to variation in presence among species. **Ev**: Several prawn species in the region spawn throughout the year (e.g., brown tiger and endeavour prawns), with the peak spawning periods for other species spread throughout the year (see Section 5.3.1), so implementing this control measure is not possible.

Schedule activity to avoid overlap with banana prawn spawning period (March to May) (primary catch species in the NPF)	Eliminate	No	**EB:** Potential reduction in the impact of underwater sound to breeding populations (and juveniles) of a commercially important group of species, noting that the predicted impacts to prawns are negligible. **C:** Costs associated with delayed activity schedule. **Ev:** Restricting the start of the activity to occur after May could impact the ability to collect seabed data in sufficient time to plan for the drilling program (e.g., identifying shallow gas hazards and soil strength to plan the exact location of the well). This is not considered necessary based on the negligible consequence rating for the NPF.
Avoid overlap with MMF fishing season (May to November)	Eliminate	Yes	**EB:** Avoids impacts to the fishery stock. **C:** No cost associated with undertaken the activity outside of the fishing season. **Ev:** The principle of the control measure is likely to mitigate any potential socio-economic consequences of the survey. The benefits outweigh the costs.
Compensate for economic loss due to the survey **(IMP-02: EPS-01)**.	Administrative	Yes	**EB:** are appropriately compensated for any economic loss due to the activity in accordance with EOG claim forms thereby mitigating the potential socio-economic consequences of the activity. **C:** Minor costs to prepare the procedure and administer the claims process. Unknown costs (likely low) of compensation payments. **Ev:** The principle of the control measure is likely to mitigate any potential socio-economic consequences of the survey. The benefits outweigh the costs.
The location and timing of the activity will be communicated to commercial fishers and local marine users **(IMP-02: EPS-02 & 03)**.	Administrative	Yes	**EB:** Potential reduction in noise impacts on commercial fisheries. **C:** Cost associated with stakeholder consultation as part of regulatory requirements. **Ev:** Cost is proportionate to environmental benefit.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Commercial fishers are compensated for	**(IMP-02: EPS-01)** EOG claim form to be available to individual licenced fishers who have	Email correspondence verifies claim forms were issued to relevant fishers.

economic loss due to the survey.	expressed concern about loss of catch and request a claim of losses from EOG.	Stakeholder consultation communication records copy of claim form.
		Completed claims forms are available for any lodged claims.
The location and timing of the activity will be communicated to local commercial fishers and local marine users.	**(IMP-02: EPS-02)** A notification is issued to fisheries stakeholders who operate in the activity area providing at least four weeks notice prior to the activity commencing.	Consultation database and emails verify that notifications were issued at least four weeks prior to the activity commencing.
	(IMP-02: EPS-03) Advice to AMSA AHO is provided at least four weeks (and to the JRCC 24-48 hours) prior to the activity area commencing.	Copies of notifications are available.
		Notice to Mariners listing the vessel names and location are issued prior to the activity commencing.
		AusCoast warnings listing the vessels' locations are issued by AMSA.

Impact consequence (residual)

Fishery	Consequence (environmental & financial)
NPF (Cth)	Negligible
MMF (WA)	Negligible
NDSMF (WA)	Negligible
KCMF (North Coast Crab Fishery) (WA)	Negligible
KPMF (WA)	Negligible
KGBF (WA)	Negligible
Spanish Mackerel Fishery (NT)	Negligible
Offshore Net and Line Fishery (NT)	Negligible
Demersal Fishery (NT)	Negligible

The consequence of underwater sound emissions on commercial fisheries is assessed as negligible because:

- Underwater sound emissions are temporary and of a short duration;
- There is low fishing effort in the activity area;
- The activity area does not represent a restricted area for commercial fishery species; and
- The control measures adopted are commensurate with the inherent level of impact consequence.

Demonstration of ALARP

A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted control measures and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.

Demonstration of Acceptability

<table>
<tr><td>Policy compliance</td><td colspan="2">EOG's Safety and Environmental Policy objectives are met.</td></tr>
<tr><td>Management system compliance</td><td colspan="2">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard</td><td colspan="2">The residual impact consequence is Level 2 (negligible), which is considered acceptable.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td>WAFIC, NT Fisheries and the NPFI raised concerns about the impacts of the activity on fish spawning, fishing productivity and displacement or disruption to commercial vessels. These concerns are addressed in Sections 7.1, 7.2, 7.3 and 7.14.</td></tr>
<tr><td>Stakeholders</td><td>During the EP public exhibition process, stakeholders did not express project-specific concerns about the effects of underwater sound on commercial fisheries.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS outlined in this EP align with the requirements of:
OPGGS Act 2006 (Cth):
Section 460 (Interference with other rights) – a person carrying on activities in an offshore GHG assessment permit … must carry on those activities in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seabed (and other matters)…….to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.
Marine Safety (Domestic Commercial Vessel) National Law Act 2012 (Cth):
Ensures safe operation of domestic vessels in Commonwealth, State and Territories and subordinate legislation Marine Order 505 (Certificates of Competency – National Law).</td></tr>
<tr><td rowspan="3">Industry practice</td><td colspan="2">The consideration and adoption of the control measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented for this activity.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity take into account the management measures listed for exploration in Section 4.3.1 of the guidelines, which include:
Issue a 'Notice to Mariners' through the relevant government agencies, detailing the area of operations (IMP-02: EPS-03).</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>There are no guidelines specifically regarding underwater sound for offshore activities.</td></tr>
</table>

	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of sound generation on marine life.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.5.5) have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Noise (item 74). The preparation of this EP meets the objectives of these guidelines, whereby sensitive areas for marine life are identified and activities are planned to avoid sensitive times of the year.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met with regard to: • Section 8.2 (Planning): Cetaceans (seasonal presence, migration areas, aggregation areas); • Section 8.7 (Aquatic life): Sighting and reporting (monitoring); and • Appendix 1: Recommended Mitigation Measures for Cetaceans during Geophysical Operations (via more stringent requirements contained in the EPBC Act Policy.
	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce disturbance to fishing operations or other marine users to ALARP and an acceptable level. • Reduce the impact on cetaceans and other marine life to ALARP and an acceptable level. • To reduce the impacts to benthic communities to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs	The activity area does not intersect any AMPs. Underwater sound generated by the activity will not reach levels above ambient sound at the nearest AMPs.

	Ramsar wetlands	Not relevant. The wetlands are not commercially fished.
	TECs	Not relevant. The wetlands are not commercially fished.
	Nationally threatened and migratory species	Not relevant. The commercial fisheries targets are not nationally threatened or migratory.
	Other matters	
	KEFs	Underwater sound generated by the activity will not reach levels above ambient sound at the nearest KEFs.
	NIWs	Underwater sound generated by the activity will not reach levels above ambient sound at the nearest NIWs.
	State marine parks	Underwater sound generated by the activity will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	Not relevant. The fish species subject to commercial fishing do not have these plans in place.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant) as outlined below:	
	A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	The timing of the activity has been selected to avoid the primary NPF and MMF fishing seasons.
	B. If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	The scientific literature cited throughout this section indicates serious or irreversible damage is unlikely to be triggered by the activity. Based on areas of most recent fishing effort, the MSS will not lead to serious or irreversible damage to commercial fisheries.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Impacts to commercial fisheries are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value.

	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	There will not be a loss of species diversity and abundance as a result of the activity.
	E. Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.
Statement of acceptability	EOG considers the impacts from underwater sound emissions to commercial fisheries to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence ratings are negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Underwater sound emissions from the activity will not have long-term or significant impacts on MNES; • The management of underwater sound emissions will ensure it is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of underwater sound emissions will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and • The management of underwater sound emissions will ensure it is not inconsistent with ESD principles.	
Environmental Monitoring		
• None required.		
Record Keeping		
• Consultation records. • Claim forms (completed and lodged).		

7.3. IMPACT 3 – Displacement of Other Marine Users

7.3.1. Hazard

The physical presence of the vessel undertaking the activity (and its towed/in-water equipment) necessitates the temporary displacement of other marine users from around the vessel and towed equipment so that they are not damaged. This will result in the temporary displacement of other marine users such as commercial fishing vessels and merchant vessels from areas in which they would normally operate.

Displacement of other marine users differs from interference with other marine users, which is addressed in Section 7.14.

7.3.2. Known and Potential Environmental Impacts

The known and potential impacts of the displacement of other marine users are:

- Diversion from a planned travel route and additional time to re-join the planned route;
- Increased fuel use (and cost) as a result of this diversion; and
- Temporary exclusion from fishing grounds.

7.3.3. EMBA

Other marine users will be excluded from operating within a radius of 1 nm of the vessel (an area of 3.1 nm^2) so as to avoid damage to towed/deployed equipment and minimise underwater sound interference with survey equipment.

Receptors in the EMBA may include:

- Commercial fishing vessels; and
- Merchant vessels.

7.3.4. Evaluation of Environmental Impacts

Merchant Shipping

As illustrated in Figure 5.54 and detailed in Table 5.16, the activity area and the immediate surrounds has recorded 35 vessel trips (tankers, cargo chips, fishing vessels, etc) over a 12-month period (August 2020 to July 2021) and therefore overlaps an area of low shipping traffic. This is primarily due to its location south of the major shipping routes travelling to and from the Port of Darwin (Figure 5.54).

The temporary exclusion of other marine users is likely to result in a negligible increase in travel time and fuel cost to individual marine users because of the very small exclusion zone and short-term nature of the activity. In the context of the marine voyages undertaken by vessels in the region, a negligible increase in travel time and fuel use in order to divert around the path of the vessel undertaking G&G activities will have a negligible consequence.

Fisheries

The primary fishery with recent fishing history in the activity area is the NPF. The activity window (April to August) overlaps the first month of the banana prawn fishing season (August). The shipping data presented in Table 5.16 indicates there were no fishing vessels recorded in the activity area in August 2020, with a single fishing vessel recorded in the months of December, June and July. This indicates that the likelihood of the activity disrupting or displacing commercial fishing vessels is likely to be negligible to nil.

Given the short duration of the activity, the small area of potential displacement and the low fishing intensity in the activity area, the consequence of temporary displacement to these fisheries will have a negligible consequence.

7.3.5. Impact Assessment

Table 7.14 presents the impact assessment for displacement with other marine users.

Table 7.14. Impact assessment for displacement of other marine users

<table>
<tr><th colspan="4">Summary</th></tr>
<tr><td>Summary of impacts</td><td colspan="3">Presence of activity vessel (and associated equipment) will temporarily displace other marine users (i.e., commercial fishing vessels, merchant shipping, etc) resulting in temporary exclusion in the area immediately around the vessel.</td></tr>
<tr><td>Extent of impacts</td><td colspan="3">Highly localised - 1 nm around vessel.</td></tr>
<tr><td>Duration of impacts</td><td colspan="3">Short-term – minutes for a third-party vessel detour.</td></tr>
<tr><td>Level of certainty of impacts</td><td colspan="3">HIGH – the impacts associated with displacement of other marine users is well understood.</td></tr>
<tr><td rowspan="4">Impact decision framework context</td><td>Decision type</td><td colspan="2">A - good industry practice required.</td></tr>
<tr><td>Activity</td><td colspan="2">Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.</td></tr>
<tr><td>Risk & uncertainty</td><td colspan="2">Risks are well understood, uncertainty is minimal.</td></tr>
<tr><td>Stakeholder influence</td><td colspan="2">No conflict with company values, no partner interest, no significant media interest.</td></tr>
<tr><td>Defined acceptable level</td><td colspan="3">Displacement of other marine users is no greater than the necessary for the reasonable exercise of rights afforded under the OPGGS Act. No unplanned interactions with other marine users.</td></tr>
<tr><th colspan="4">Impact Consequence (inherent)</th></tr>
<tr><td colspan="2">Receptor</td><td colspan="2">Consequence</td></tr>
<tr><td colspan="2">Merchant shipping</td><td colspan="2">Negligible</td></tr>
<tr><td colspan="2">Commercial fisheries</td><td colspan="2">Negligible</td></tr>
<tr><th colspan="4">Assessment of Proposed Control Measures</th></tr>
<tr><td>Control measure</td><td>Control type</td><td>Adopt</td><td>Justification</td></tr>
<tr><td>Do not conduct the activity in waters available to fisheries</td><td>Eliminate</td><td>No</td><td>EB: Eliminates the potential for displacement of fishers by conducting the activity only in waters that are closed to fishing.
C: The activity objectives could not be met if confined to areas closed to fishing.
Ev: There are low numbers of fishers working in the activity area and the area is closed to the NPF during the activity timing. The activity area does not represent critical fishing grounds for any WA-managed fisheries. The cost of implementing this control is grossly disproportionate to the environmental benefit.</td></tr>
<tr><td>Conduct the activity during the NPF JBG closure period</td><td>Eliminate</td><td>No</td><td>EB: Eliminates the potential for displacement of NPF fishers by conducting the activity only when JBG waters are closed to prawn fishing.</td></tr>
</table>

(1st December 2021 to 1st August 2022)			**C:** If a vessel of opportunity is only available during August, not taking this vessel has a lost opportunity cost. **Ev:** Data in 2020 indicates there were no fishing vessels recorded in the activity area during August (and very few at other times of the year, see Table 5.16). Removing the month of August from the activity window is therefore not commensurate with the low likelihood of displacing commercial fishing vessels.
Reduce the exclusion zone to the lowest area possible for safe operations **(IMP-04:EPS-01)**	Administrative	Yes	**EB:** The exclusion zone (and thus extent of displacement) is reduced to the lowest possible extent necessary to achieve its aim and is linked to the length of the towed equipment. **C:** No cost to publish exclusion zone in NTM. **Ev:** Reducing the extent of displacement to the lowest possible level necessary for safe operations outweighs the cost.
Communicate the required area of displacement for the duration of the activity **(IMP-04:EPS-02, -03)**	Administrative	Yes	**EB:** Informs other marine users of EOG's intentions, allowing time for planning so as to avoid or minimise displacement. **C:** Minimal cost to communicate with other marine users ahead of the activity through EOG notifications and the NTM. **E:** The benefit of avoiding or minimising displacement outweighs the minimal cost to implement this control measure.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Displacement is limited to the area necessary for safe operations.	**(IMP-04:EPS-01)** The exclusion zone is limited to 500 m around the PDSA vessel.	NTM notes the exclusion zone is not larger than 500 m.
	(IMP-04:EPS-02) EOG provides pre-activity notification to commercial fisheries at least one month prior to activity commencement to ensure they are aware of the activity timing and safety exclusion zone requirements.	Consultation records verify that notifications to fisheries were provides at least one month ahead of the activity starting.
	(IMP-04:EPS-03) EOG provides pre-activity notification to the AHO at least one month prior to activity commencement to enable the promulgation of the NTM.	NTM is issued prior to the commencement of the activity and includes activity vessel details, location and timing.

Impact Consequence (residual)	
Receptor	Consequence
Merchant shipping	Negligible

<table>
<tr><td colspan="2">Fisheries</td><td colspan="2">Negligible</td></tr>
<tr><td colspan="4">The impact of displacement of other marine users is assessed as negligible because:
• The activity will be of a short duration;
• The area of displacement is extremely small and will not result in negligible increased time and fuel use for third-party vessels to divert around the activity vessel; and
• Thorough consultation has been undertaken in the development of the activity to minimise the impact of temporary displacement.</td></tr>
<tr><th colspan="4">Demonstration of ALARP</th></tr>
<tr><td colspan="4">A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.</td></tr>
<tr><th colspan="4">Demonstration of Acceptability</th></tr>
<tr><td>Policy compliance</td><td colspan="3">EOG's Safety and Environmental Policy objectives are met.</td></tr>
<tr><td>EMS compliance</td><td colspan="3">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="3">The residual impact consequence is Level 2 (negligible), which is considered acceptable.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td colspan="2">The NPFI raised concerns about displacement of commercial fishing vessels (see Table 4.2). These concerns have been addressed in this section and EOG will continue to consult with marine users as project planning continued.</td></tr>
<tr><td>Stakeholders</td><td colspan="2">During the EP public exhibition process, stakeholders did not express project-specific concerns about displacement to other marine users.</td></tr>
<tr><td>Legislative context</td><td colspan="3">The EPS outlined in this table align with the requirements of:
• OPGGS Act 2006 (Cth).
  ○ Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation or fishing (among others) to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="3">The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity</td></tr>
<tr><td colspan="2">Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this hazard are in line with the management measures listed for offshore physical presence in Section 4.3.1 of the guidelines, which include:
• Develop exclusion zones in consultation with key stakeholders, including local fishing communities; raise awareness of exclusion zones with all stakeholders.
• Issue a 'Notice to Mariners' through the relevant government agencies, detailing the area of operations.</td></tr>
</table>

		• Ensure all vessels adhere to International Regulations for Preventing Collisions at Sea (COLREGS), which set out the navigation rules to be followed to prevent collisions between two or more vessels. • Optimise vessel use to ensure the number of vessels required and length of time that vessels are on site is as low as practicable.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines specifically regarding physical presence for offshore activities.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of displacement of other marine users.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There are no guidelines specifically regarding physical presence for activity vessels.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013).	Guidelines met with regard to: • Section 8.4 (Travel – water travel): Maintain a lookout for, and establish communications with local fishing boats, tourist diving vessels, etc, where possible to minimise interruption with their operations and equipment.
	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the impact on other marine resource users to ALARP and to an acceptable level. • To reduce risks to public safety to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs	This hazard will not intersect nearby AMPs.
	Ramsar wetlands	This hazard will not intersect any Ramsar wetlands.
	TECs	This hazard will not intersect any TECs.
	Nationally threatened and migratory species	This hazard will not have any impacts on threatened or migratory species.

	Other matters	
	KEFs	This hazard will not intersect any KEFs.
	NIWs	This hazard will not intersect any NIWs.
	State marine parks	This hazard will not intersect any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	None triggered by this hazard.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the impacts from displacement of other marine users to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is Level 2 (negligible); • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved; • Input from engagement with relevant persons has been considered and incorporated into the design of the activity; and • Relevant legislation and industry best practice will be complied with.	
Environmental Monitoring		
• Continuous bridge monitoring.		
Record Keeping		
• Consultation records. • NTM.	• Operational reports. • Incident reports.	

7.4. IMPACT 4 – Seabed Disturbance

7.4.1. Hazard

The PDSA activities that will result in seabed disturbance are:

- Seabed grab sampling and coring activities; and
- Cuttings discharge directly to the seabed (during borehole sampling).

Activities that *may* result in seabed disturbance (but have been included in the EIA section given the similarity of consequences) include:

- Dragging tow fish and shallow seismic streamers along the seabed or emergent features (as part of the geophysical investigation);
- Dropped objects (in-water towed equipment or deck equipment); and
- Vessel anchoring (if required in an emergency, but distant from the Blacktip pipeline).

7.4.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of this localised seabed disturbance as a result of geotechnical survey investigations and potential vessel anchoring are:

- Localised and temporary turbidity of the water column at the seabed;

- Localised physical removal of seabed sediments and physical disturbance of benthic habitat;
- Localised and temporary smothering of seabed habitats; and
- Displacement of a small area of seabed habitat by dropped object (if not recovered).

These impacts may result in temporary disturbance, displacement or smothering of benthic habitats and fauna.

There are no listed shipwrecks present within the activity area, so there will be no impacts to shipwrecks as a result of the geotechnical activities.

7.4.3. EMBA

The EMBA for seabed disturbance is likely to be within the immediate vicinity of the activity (e.g., tens of metres).

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Benthic fauna;
- Benthic habitat (sand substrates);
- Demersal and pelagic fish; and
- Turtles.

7.4.4. Evaluation of Environmental Impacts

Water turbidity

Turbidity occurs when seabed sediments are stirred up and is likely to result from sources listed in Section 7.4.1. Any turbidity created is likely to be within the limits of natural variability when considering the turbidity created by tides and crashing waves in the nearshore environment. This turbidity would temporarily inhibit light penetration into the water column but given its temporary nature would be unlikely to inhibit any macroalgae growth. Benthic fauna living in sediment (endobenthos) or on sediment (epibenthos) may be temporarily displaced by this turbidity.

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 activity 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 single anchor points is extremely small, and given that anchoring will not be necessary, unless in the event of an emergency (and not in the activity area), this is not expected to pose a threat to seabed habitats or fauna communities.

Given the dominance of soft sediments (sandy and muddy substrates) in the activity area and JBG more generally, it is expected that holes created by coring activities will rapidly collapse in on themselves, leaving only shallow pock marks in the seabed that will be rapidly filled in and colonised, as described above.

Physical disturbance

The area of seabed disturbance consists of the following which equates to an estimated total area of less than 5 m^2 to approximately 100 m^2 (depending on equipment and sample requirements) within the activity area:

- Seabed grab sampling – grab sample skims the seabed surface (likely to be 8 samples, a total volume of 4 m^3).
- Core sampling - piston coring (total footprint 0.018 m^2), vibrocoring (total equipment footprint up to 100 m^2) and/or box coring (total footprint 4 m^2).
- Borehole sampling - total footprint of 1.8 m^2.
- In-situ Penetration Testing - total footprint 0.008 m^2.

Given the seabed morphology in the region is typically characterised by extensive sediment plains and high sediment deposition with sparsely distributed epifauna, the area of impact will be highly localised and temporary, with recovery expected within weeks to months (e.g., cored holes will collapse and quickly fill in with sediment and recolonise with benthic fauna).

There are no known sensitive seabed features (e.g., islands, emergent reef systems, canyons, shipwrecks) or sensitive benthic primary producer habitats (e.g. areas of hard corals, seagrass, macroalgae or mangroves) present in the activity area. In addition, the activity area does not overlap any KEFs, so there will be no impacts to such features.

Dispersion and deposition of borehole cuttings

The area of seabed to be disturbed at each borehole site is very small and comprises of the borehole and the footprint of the cores/samples taken. As outlined in Section 2.5.1, each borehole will generate up to 3.2 m^3 of cuttings (dependent on depth of the borehole).

The discharge of these small volumes of core cuttings and adhered mud to the seabed will have negligible environmental impacts. Dispersion of cuttings across the seabed will be influenced by the prevailing currents and vertical settling forces, and a small proportion of cuttings (particularly fine material) could travel several hundred metres from the drilling location (Hinwood *et al*., 1994). There is potential for core cuttings to smother a small area of seabed (e.g., likely to be no greater than several square metres) and as such possibly generate anoxic conditions in the sediments over time. However, any smothering effects on the sparse benthic communities in the activity area would be highly localised. Given the small volumes of cuttings generated by the borehole sample, coarse and fine cuttings are unlikely to travel towards sensitive receptors, such as the rocky reef close to the shore (closest is 75 km from the activity area), in volumes that result in habitat smothering. As such, there are unlikely to be impacts to species dependent on those reefs for foraging (i.e., turtles, mantra ray).

To stabilise the boreholes, non-toxic, chemically inert water-based mud (WBM) will be used. This fluid consists of seawater containing guar gum (biodegradable) and/or bentonite (and barite chemically inert, non-bioavailable) as the viscosifier, and barite (as the weighting agents, which is inert). Drilling fluids will be discharged directly from the borehole to the marine environment. Because the WBM additives will contain no toxic ingredients, they will not pose a risk to water quality or to benthic or demersal biota.

Displacement of seabed habitat

Objects that may be dropped into the ocean capable of creating any substantial impact are restricted to large, non-buoyant equipment such as sea containers. Loss of such equipment overboard may be caused when items roll off the deck in poor ocean conditions (e.g., storms) or due to human error when equipment is deployed over the edge of the vessel (e.g., crane move).

Dropped objects would have the impact of smothering benthic habitat and fauna. Impacts from the loss of equipment overboard (assuming no buoyancy) would be the localised and temporary loss of a small area of benthic habitat. If the equipment lost overboard is solid and not recovered, it is likely to provide additional suitable substrate for benthic flora and fauna to colonise (much like subsea infrastructure, such as pipelines and wellheads provide).

7.4.5. Impact Assessment

Table 7.15 presents the impact assessment for seabed disturbance.

Table 7.15. Impact assessment for seabed disturbance

Summary			
Summary of impacts	Localised turbidity of the water column at the seabed, smothering of seabed habitat by borehole cuttings, seabed damage and displacement of a small area of seabed habitat.		
Extent of impacts	Localised – within the immediate vicinity of the activity (tens of metres).		
Duration of impacts	Temporary – duration of the activity and likely up to a week either side of the activity occurring.		
Level of certainty of impacts	HIGH – the impacts of disturbance to seabed sediments are well known.		
Impact decision framework context	Decision type	A - good industry practice required.	
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.	
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.	
Defined acceptable level	Seabed disturbance is limited to the areas required for sampling.		
Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Recover drill cuttings from the seabed.	Elimination	No	**EB:** Eliminates potential for benthic habitat smothering from cuttings deposition on the seabed. **C:** Significant additional cost (potentially hundreds of thousands of dollars) **CBA:** Additional cost and longer vessel time on location required to implement this control is not commensurate with the negligible consequences associated with the discharge of very small volumes of drill cuttings.
Do not use drilling muds or additives during borehole sampling.	Elimination	No	**EB:** Reduction in potential ecotoxicity. **C:** Significant cost to the survey design and data quality. **Ev:** Costs to the survey outweighs the benefits.

USE WBM fluids for borehole drilling rather than synthetic-based muds **(IMP-05:EPS-01, -02)**	Engineering	Yes	**EB:** Reduction in potential ecotoxicity. **C:** Minor cost in selection of WBM rather than synthetic-based muds. **Ev:** Environmental benefit outweighs the cost to implement the measure.
No anchoring in the activity area **(IMP-05:EPS-08)**.	Engineering	Yes	**EB:** Avoids potential multiple and repeat disturbances to the seabed. **C:** No additional cost due to the nature of the activity. **Ev:** The environmental benefits outweigh the costs of implementing the measure.
Take fewer seabed samples.	Engineering	No	**EB:** Impacts to the seabed are reduced. **C:** Significant cost to the quality of the survey data obtained. **Ev:** Costs to the survey outweighs the benefits.
Drill borehole samples to shallower depths.	Engineering	No	**EB:** Reduces disturbance to the seabed from borehole cuttings. **C:** Significant cost to the quality of the survey data obtained. **Ev:** Costs to the survey outweighs the benefits.
Use vessel procedures to conduct sampling to minimise the likelihood of lost equipment **(IMP-05:EPS-03, -04, -05, -06, -07)**	Administrative	Yes	**EB:** Ensures sampling is conducted in a controlled manner thereby reducing the likelihood of seabed disturbance from lost equipment. **C:** No additional cost due to the nature of the activity. **Ev:** The environmental benefits outweigh the costs of implementing the measure.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Only low toxicity, readily biodegradable and non-bioaccumulating WBM and additives will be used.	**(IMP-05:EPS-01)** The contractor will only use PLONOR, ‘D’/’E’ (non-CHARM) or ‘Gold’/’Silver’ (CHARM) OCNS-rated base fluids and additives in the drilling fluid system to minimise ecotoxicity impacts to marine fauna.	The Mud Chemical Inventory verifies that all chemicals are PLONOR, ‘D’/’E’ (non-CHARM) or ‘Gold’/’Silver’ (CHARM) OCNS-rated.
	(IMP-05:EPS-02) Where, for technical reasons an additive is required that has not been registered with CEFAS (and therefore does not have a rating), EOG will apply the CHARM or, in the case of non-CHARMable products, the OCNS process (https://www.cefas.co.uk/cefas-data-hub/offshore-chemical-notification-scheme/hazard-assessment-process/) to calculate the CHARM rating or OCNS grouping. Only additives with a hazard	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.

	quotient of <30 (gold/silver) or an OCNS grouping of D/E will be used.	
Avoid the loss of deployed equipment.	**(IMP-05:EPS-03)** The contractor's quality control/assurance procedures will be used to guide the deployment of deployed equipment so that damage to (and potential loss of) equipment caused by rough seas is avoided.	Daily reports record weather conditions and verify that towed equipment is not deployed during rough seas.
Avoid objects being dropped overboard.	**(IMP-05:EPS-04)** Large bulky items are securely fastened to or stored on the deck to prevent loss to sea.	A completed pre-departure inspection checklist verifies that bulky goods are securely sea-fastened.
	(IMP-05:EPS-05) The crane/A-frame 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.
	(IMP-05:EPS-06) The crane/A-frame 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.
	(IMP-05:EPS-07) 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 PMS.	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.
No anchoring in the activity area	**(IMP-05:EPS-08)** Vessel anchors are not used to hold position during the activity.	Operations reports verify that the vessel anchors were not used during the activity.
Impact Consequence (residual)		
Negligible		
The consequence of seabed disturbance is assessed as negligible because: • Seabed grab sampling and coring activities are extremely localised, thereby reducing temporary turbidity in water column; • Cored holes will collapse in on themselves and fill in quickly with sediments and recolonise with benthic fauna; • Very low volumes of drilling fluids and cuttings will be discharged during borehole sampling; and. • Vessels will not anchor during the activity.		
Demonstration of ALARP		
A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.		
Demonstration of Acceptability		
Policy compliance	EOG's Safety and Environmental Policy objectives are met.	

EMS compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual consequence is negligible, which is considered acceptable.	
Engagement	Relevant persons	There have been no objections or claims made by relevant persons regarding seabed disturbance.
	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns about seabed disturbance.
Legislative context	There is no legislation associated with seabed disturbance.	
Industry practice	The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this hazard are in line with the management measures listed for offshore marine use (physical disturbance) in Section 4.3.2 of the guidelines. In addition, this EP addresses the point of undertaking an environmental assessment to identify protected areas and local sensitivities.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	Not applicable. There is no guidance in these guidelines regarding seabed disturbance.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not provide environmental management guidance.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Not applicable. There is no guidance regarding seabed disturbance.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Not applicable. There is no guidance regarding seabed disturbance.
	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the risk of release of substances into the marine environment to ALARP and to an acceptable level.

		• To reduce the impacts from events such as spills and loss of equipment to an acceptable level and reduce the risk to ALARP. • To reduce the impacts to benthic communities to acceptable levels and to ALARP.
Environmental context	MNES	
	AMPs	Seabed disturbance in the activity area will not impact the conservation values of nearby AMPs.
	Ramsar wetlands	Seabed disturbance in the activity area will not impact any Ramsar wetlands.
	TECs	Seabed disturbance in the activity area will not impact any TECs.
	Nationally threatened and migratory species	Seabed disturbance in the activity area will not impact any threated or migratory species.
	Other matters	
	KEFs	Seabed disturbance in the activity area will not impact any KEFs.
	NIWs	Seabed disturbance in the activity area will not impact any NIWs.
	State marine parks	Seabed disturbance in the activity area will not impact any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	None triggered by this hazard.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the impacts from seabed disturbance to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Seabed disturbance will not have long-term or significant impacts on MNES; • The management of seabed disturbance is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of seabed disturbance is not inconsistent with the aims of relevant marine reserve management plans; and • The management of seabed disturbance is not inconsistent with ESD principles.	

Environmental Monitoring	
• None required.	
Record Keeping	
• Drilling mud chemical inventory. • Drilling mud MoC (if required). • PTWs. • Equipment pre-deployment inspections. • Handling and transfer procedure. • Completed handling and transfer checklists.	• Crane/A-frame operator qualification and training records. • PMS records. • Load ratings and load test certificates. • Daily reports. • Training records. • Incident reports.

7.5. IMPACT 5 – Routine Emissions – Light

7.5.1. Hazard

Light emissions will occur from the activity vessel. The following activities will result in artificial lighting:

- Vessel navigation lighting will be maintained while vessels are on location for maritime safety purposes; and
- Deck lighting will be maintained for the safety of personnel working on deck.

7.5.2. Known and Potential Environmental impacts

The known and potential impacts of lighting are:

- Light glow may act as an attractant to light-sensitive species (e.g., seabirds, turtles, squid, zooplankton), in turn affecting predator-prey dynamics (due to attraction to or disorientation from light); and
- Continuous lighting may result in localised alterations to normal marine fauna behaviours.

7.5.3. EMBA

According to the National Light Pollution Guidelines for Wildlife (DoEE, 2020), if there is important habitat for seabirds (e.g., foraging BIAs) and turtles (e.g., nesting beaches) within 20 km of a project, an EIA should be undertaken. The 20 km buffer is based on the observed grounding of seabirds in response to a light source at least 15 km away and observed disorientation of turtle hatchlings to a light source 18 km away (DoEE, 2020). Therefore, the EMBA for light emissions associated with vessel activities is considered to be a 20 km radius around the vessel, which is referred to as the 'light EMBA'.

Light-sensitive receptors that occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Turtles;
- Fish; and
- Seabirds.

7.5.4. Evaluation of Environmental Impacts

Merchant, fishing and petroleum industry vessels are common in the activity area. The lighting levels associated with the activity vessels are not considered to be significantly different from these sources, nor will it be a permanent additional contribution of artificial light in the JBG.

Turtles

Artificial light can disrupt critical behaviours in turtles such as adult nesting and hatchling orientation, sea finding and dispersal ability and can reduce the reproductive viability of turtle stocks (DoEE, 2020). Female turtles nest on sandy tropical and sub-tropical beaches predominantly at night where they rely on visual cues to select nesting beaches and orient on land. Most turtle hatchlings emerge at night and must rapidly orient for and find the ocean to avoid predation. Hatchlings orient for the ocean using both topographic and brightness cues, whereby they move toward the brighter oceanic horizon and away from the darkened silhouettes of the sand dunes on the beach (DoEE, 2020). This critical sea finding behaviour can be disrupted by artificial lights that disorient or misorient the movement of hatchling in a direction other than the sea, which often leads to mortality from predation, exhaustion or dehydration (DoEE, 2020).

The activity area is located 75 km from the nearest shoreline, which far exceeds the recommended 20 km buffer for artificial light applied to turtle nesting locations. Therefore, lighting from the activity vessels is not predicted to impact turtle hatchlings at any potential nesting locations. Although hatchlings have been found to be attracted to light sources in the nearshore environment (Wilson *et al*., 2018), the offshore waters of the activity area and its long distance from shorelines means that the impact of vessel lighting on hatchling dispersal will be negligible.

The light EMBA overlaps the following turtle BIAs (Figure 7.9):

- Green turtle – foraging;
- Flatback turtle – interesting; and
- Olive Ridley turtle – foraging.

These BIAs are associated with adult foraging turtles, so light emissions from the activity are anticipated to have a negligible consequence because lighting will not interfere with the behaviour of their prey and therefore disruption to normal foraging behaviour will not be negatively impacted. Light pollution is identified as a threat to turtles in the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c). An assessment of relevant interim recovery objectives and targets with the activity is provided in Table 7.16.

Table 7.16. Assessment of the relevant interim recovery objectives and targets of the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c) with the activity

Interim Objective or Target	Assessment
Interim Objective 3: Anthropogenic threats are demonstrably minimised.	
Target 3.1: Robust and adaptive management regimes that lead to a reduction in anthropogenic threats to marine turtles and their habitats are in place.	The EPS listed in Table 7.20 will reduce the impact of light emissions on turtles to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this recovery target.

Interim Objective or Target	Assessment
Target 3.2: Threat mitigation strategies are supported by high quality information.	The activity will not have any impacts on this recovery target.

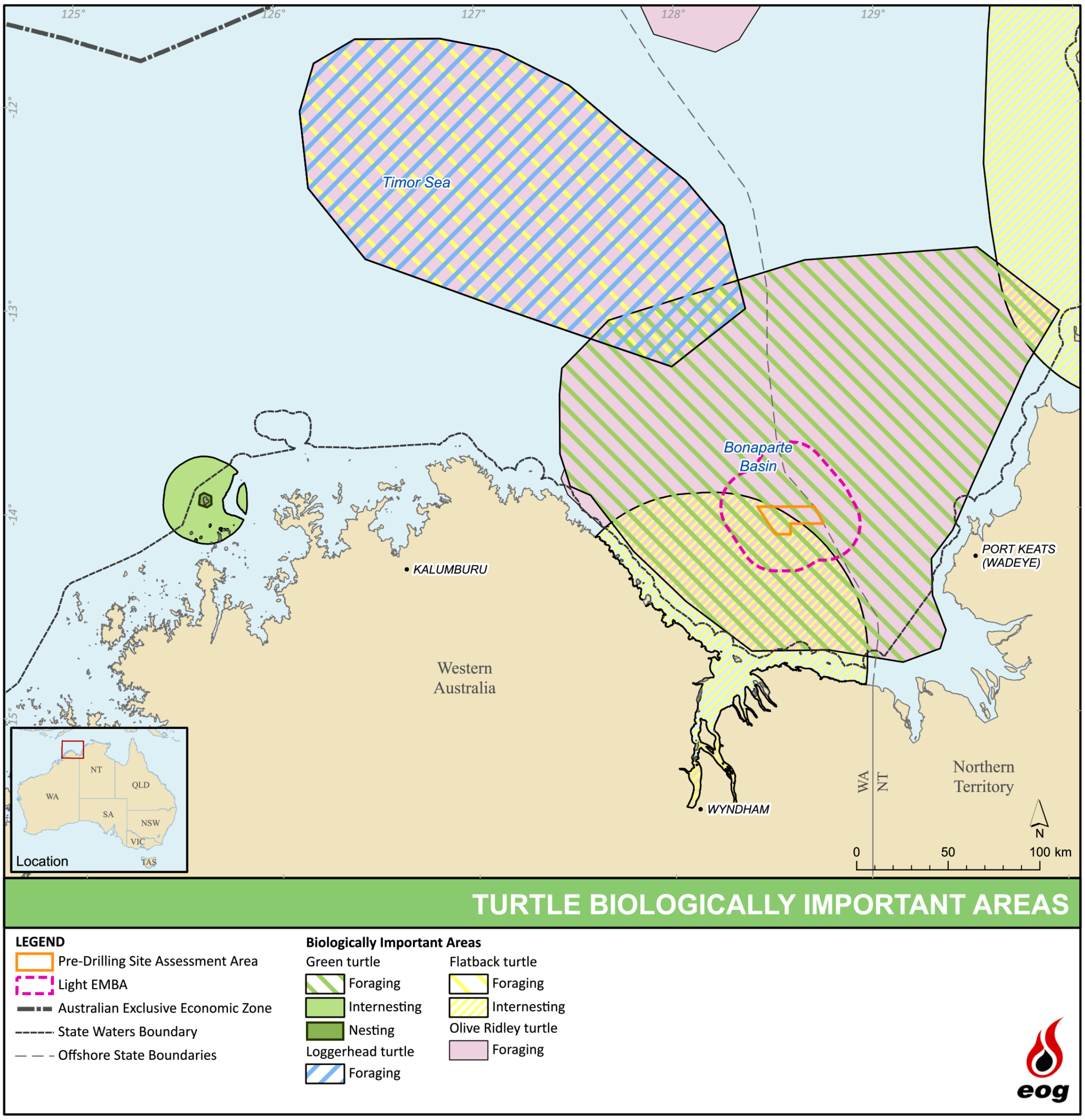


Figure 7.9. Turtle BIAs in the light EMBA

Fish and plankton

Fish and zooplankton may be directly or indirectly attracted to lights. 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.

Overall, an increase in fish activity around the vessel may occur at night-time, but this is highly localised and short-term and therefore expected to have negligible impacts to the local and regional foodweb.

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 and will therefore have a negligible impact.

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 the vessel, or mortality from starvation due to disrupted foraging at sea (Wiese *et al*., 2001 in DSEWPC, 2011; Rajkhowa, 2014). This disorientation may also result in entrapment, stranding, grounding and interference with navigation (DoEE, 2020). The DoEE (2020) notes that seabird fledglings may be affected by lights up to 15 km away. 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.

There are no seabird BIAs that are intersected by the light EMBA (Figure 7.10). Therefore, impacts to seabird breeding colonies from light emissions are not expected to occur. However, there is potential for foraging seabirds to be present at the time of the activity. Given the short duration of the activity and its distance from breeding colonies, the consequence of light emissions on seabird populations will be negligible.

Marine Parks

The activity area does not intersect any AMPs. However, the light EMBA overlaps 64 km^2 of the JBG AMP (IUCN Category VI). No other marine protected areas are intersected by the light EMBA (Figure 7.10).

The JBG AMP is part of the NMN and is included in the North Marine Parks Network Management Plan 2018 (DNP, 2018). The North Marine Parks Network Management Plan 2018 (DNP, 2018) identifies light emissions associated with habitat modification and marine pollution as a pressure on the AMP network. Table 7.17 provides an assessment of the North Marine Parks Network Management Plan 2018 objectives and stated management principles for IUCN Category VI protected areas with the activity.

Community

The distance of the closest point of the activity area from the nearest shoreline (75 km) and nearest town (Wadeye, 83 km) means that vessel lighting in the activity area will not be visible from land. Visual impacts to these communities from vessel lighting will not occur.

National Light Pollution Guidelines for Wildlife

Table 7.18 provides an assessment of the light management options for seabirds as outlined in Table 8 of the National Light Pollution Guidelines for Wildlife (DoEE, 2020). Where management options have been deemed as feasible, they have been assessed and adopted as a control measure and associated EPS have been developed (Table 7.20).

Table 7.19 provides an assessment of the light management options for turtle nesting beaches as outlined in Table 5 of the National Light Pollution Guidelines for Wildlife (DoEE, 2020) against the activity. Where management options have been deemed as feasible, they have been assessed and adopted as a control measure and associated EPS have been developed (Table 7.18).

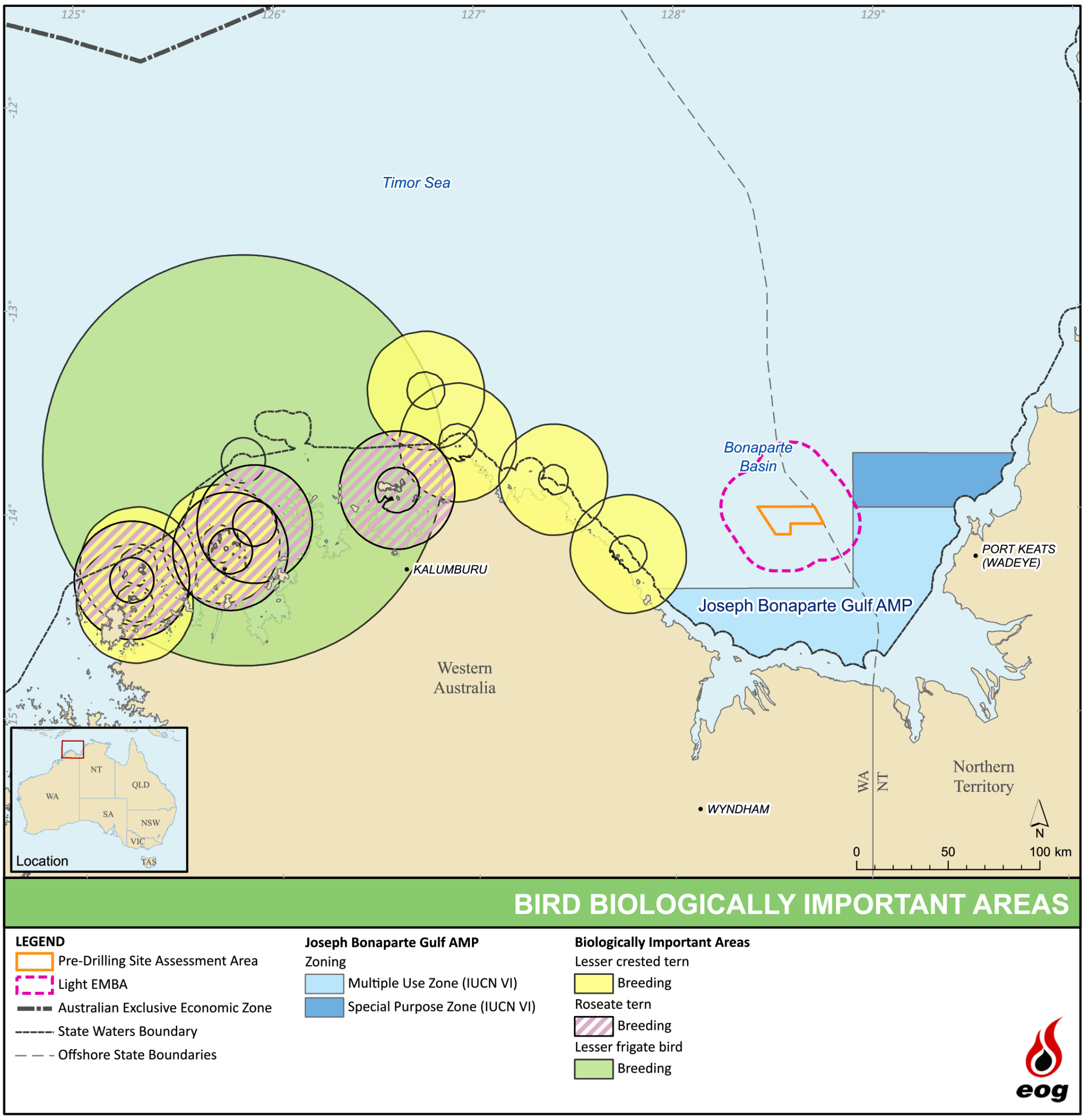


Figure 7.10. Seabird BIAs closest to the light EMBA

Table 7.17. Assessment of the activity with the North Marine Parks Network Management Plan 2018 objectives and stated management principles for IUCN Category VI protected areas

Stated objective or management strategy	Assessment
Objectives of the Management Plan	
(a) Protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the North Network.	The activity will be managed in a manner such that it is not inconsistent with these objectives.
(b) Ecologically sustainable use and enjoyment of the natural resources within marine parks in the North Network, where this is consistent with objective (a).	
IUCN Category VI Principles	
Improve knowledge and understanding of the conservation values of the Marine Reserves Network and of the pressures on those values.	The activity will not impact on this management action.
Minimise impacts of activities through effective assessment of proposals, decision-making and management of reserve-specific issues.	The EPS listed in Table 7.20 will minimise impacts to the JBG AMP. Therefore, the activity will not impact on this management action.
Protect the conservation values of the Marine Reserves Network through management of environmental incidents.	The activity will be managed so that impacts to the conservation values of the JBG AMP do not occur. DNP notification details are included in Table 9.2.
Facilitate compliance with this Management Plan through education and enforcement.	The activity will not impact on this management action.
Promote community understanding of, and stakeholder participation in, the management of the Marine Reserves Network.	The activity will not impact on this management action.
Support involvement of Indigenous people in management of Commonwealth Marine Reserves	The activity will not impact on this management action.
IUCN Category VI Principles	
The reserve or zone should be managed mainly for the sustainable use of natural ecosystems based on the following principles.	The activity will be managed in a manner such that it is not inconsistent with the IUCN Category VI Principles as listed in Schedule 1 of the North Marine Parks Network Management Plan 2018.
The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long term.	
Management practices should be applied to ensure ecologically sustainable use of the reserve or zone.	
Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.	

Table 7.18. Assessment of the light management options for seabirds from the National Light Pollution Guidelines for Wildlife (DoEE, 2020)

Management option	Achievable?	Justification
Implement management actions during the breeding season.	Yes	Achievable management actions are identified in this table and in Table 7.20 (adopted control measures and associated EPS).
Maintain a dark zone between the rookery and the light sources.	Yes	The nearest shoreline (and thus potential rookery location) is 75 km away on the southern coast of the JBG. As such, there is a large dark zone between the rookery and the activity area.
Turn off lights during fledgling season.	No	PDSA operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.20).
Use curfews to manage lighting.	No	As above.
Aim lights downwards and direct them away from nesting areas.	Yes	Where practicable, lights will be directed towards working areas for the safety of personnel (see Table 7.20).
Use flashing/intermittent lights instead of fixed beam.	No	PDSA operations are conducted 24-hours a day and light is necessary for personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.20).
Use motion sensors to turn lights on only when needed.	No	As above.
Prevent indoor lighting reaching outdoor environment.	Yes	Blinds will be lowered on portholes and windows at night where this does not interfere with safe work practices (see Table 7.20).
Manage artificial light on jetties, wharves, marinas, etc.	N/A	Not applicable to this activity.
Reduce unnecessary outdoor, deck lighting on all vessels and permanent and floating oil and gas installations in known seabird foraging areas at sea.	Yes	Lighting will be reduced to that required for safe operations and by maritime legislative requirements (see Table 7.20)
Night fishing should only occur with minimum deck lighting.	N/A	Not applicable - fishing is not permitted from the activity vessel.

Management option	Achievable?	Justification
Avoid shining light directly onto fishing gear in the water.	N/A	Not applicable - fishing is not permitted from the activity vessel.
Ensure lighting enables recording of any incidental catch, including by electronic monitoring systems.	N/A	Not applicable - fishing is not permitted from the activity vessel.
Avoid shining light directly onto longlines and/or illuminating baits in the water.	N/A	Not applicable - fishing is not permitted from the activity vessel.
Vessels working in seabird foraging areas during breeding season should implement a seabird management plan to prevent seabird landings on the ship, manage birds appropriately and report the interaction.	N/A	The activity vessel is equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew. Most seabirds in the region are migratory, with no breeding areas (i.e., islands) within 75 km of the activity area.
Use luminaires with spectral content appropriate for the species present.	No	The activity vessel is equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew. Most seabirds in the region are migratory, with no breeding areas (i.e., islands) within 75 km of the activity area. See Table 7.20 for adopted control and associated EPS.
Avoid high intensity light of any colour.	No	As above.
Shield gas flares and locate inland and away from seabird rookeries.	N/A	Not applicable – this activity does not involve flaring.
Minimise flaring on offshore oil and gas production facilities.	N/A	Not applicable – this activity does not involve flaring.
In facilities requiring intermittent night-time inspections, turn on lights only during the time operators are moving around the facility.	N/A	The activity vessel is equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew.
Ensure industrial site/plant operators use head torches.	No	PDSA operations are conducted 24-hours a day and lighting of all areas is necessary for personnel safety. As such, the use of head torches is not necessary. Lighting will be reduced so far as is practicable and in accordance with maritime requirements and personnel safety. See Table 7.20 for adopted control and associated EPS.

Management option	Achievable?	Justification
Supplement facility perimeter security lighting with computer monitored infrared detection systems.	N/A	Not applicable to this activity.
Tourism operations around seabird colonies should manage torch usage so birds are not disturbed.	N/A	Not applicable to this activity.
Design and implement a rescue program for grounded birds.	No	Due to the distance between the activity area and seabird rookeries, grounding of birds is unlikely to occur and thus a rescue program is not necessary.

Table 7.19. Assessment of the light management options for turtle nesting beaches from the National Light Pollution Guidelines for Wildlife (DoEE, 2020)

Management option	Achievable?	Justification
Implement light management actions during the nesting and hatching season.	Yes	Achievable management actions are identified in this table and in Table 7.20 (adopted control measures and associated EPS).
Avoid direct light shining onto a nesting beach or out into the ocean adjacent to a nesting beach.	Yes	The nearest shoreline (and thus potential nesting location) is 75 km away on the southern coast of the JBG. As such, the vessel lighting will not shine on to the beach or the ocean adjacent to the beach.
Maintain a dune and/or vegetation screen between the nesting habitat and inland sources of light.	N/A	Not applicable to this activity.
Maintain a dark zone between turtle nesting beach and industrial infrastructure	Yes	The nearest shoreline (and thus potential nesting location) is 75 km away on the southern coast of the JBG. As such, there is a large dark zone between the coast and the activity area.
Install light fixtures as close to the ground as practicable.	No	PDSA operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.20).
Use curfews to manage lighting.	No	PDSA operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.20).
Aim lights downwards and direct them away from nesting beaches.	Yes	Where practicable, lights will be directed towards working areas for the safety of personnel (see Table 7.20).
Use flashing/intermittent lights instead of fixed beam.	No	PDSA operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.20).
Use motion sensors to turn on lights only when needed.	No	PDSA operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.20).
Prevent indoor lighting reaching beach.	Yes	Blinds will be lowered on portholes and windows at night where this does not interfere with safe work practices (see Table 7.20).

Management option	Achievable?	Justification
Limit the number of beach access areas or construct beach access such that artificial light is not visible through the access point.	N/A	Not applicable to this activity.
Work collectively with surrounding industry/private land holders to address the cumulative effect of artificial lights.	N/A	Not applicable to this activity.
Manage artificial light at sea, including on vessels, jetties, marinas and offshore infrastructure.	Yes	Achievable management actions are identified in this table and in Table 7.20 (adopted control measures and associated EPS).
Reduce unnecessary lighting at sea.	Yes	Achievable management actions are identified in this table and in Table 7.20 (adopted control measures and associated EPS).
Avoid shining light directly onto longlines and/or illuminating baits in the water.	N/A	Not applicable to this activity – no fishing is allowed from the activity vessel.
Avoid lights containing short wavelength violet/blue light.	No	The activity vessel is equipped with lighting required under legislation to identify itself to other vessels, reduce the risk of at-sea collision and provide for the safety of its crew. Most seabirds in the region are migratory, with no breeding areas (i.e., islands) within 75 km of the activity area. See Table 7.20 for adopted control and associated EPS.
Avoid white LEDs.	No	As above.
Avoid high intensity light of any colour.	No	As above.
Shield gas flares and locate inland and away from nesting beach.	N/A	Not applicable to this activity.
Industrial/port or other facilities requiring intermittent night-time light for inspections should keep the site dark and only light specific areas when required.	No	PDSA operations are conducted 24-hours a day and light is necessary for navigational and personnel safety. Lighting will be reduced to the furthest extent possible for safe operations (see Table 7.20).
Industrial site/plant operators to use head torches.	No	PDSA operations are conducted 24-hours a day and lighting of all areas is necessary for personnel safety. As such, the use of head torches is not necessary. Lighting will be reduced so far as is

Management option	Achievable?	Justification
		practicable and in accordance with maritime requirements and personnel safety. See Table 7.20 for adopted control and associated EPS.
Supplement facility perimeter security lighting with computer monitored infra-red detection systems.	N/A	Not applicable to this activity.
No light source should be directly visible from the beach.	Yes	The nearest shoreline (and thus potential nesting location) is 75 km away on the southern coast of the JBG. As such, the vessel lighting will not be visible from the beach.
Manage light from remote regional sources (up to 20 km away).	Yes	The nearest shoreline (and thus potential nesting location) is 75 km away on the southern coast of the JBG. As such, the vessel lighting will not be visible from the beach.

7.5.5. Impact Assessment

Table 7.20 presents the impact assessment for light emissions.

Table 7.20. Impact assessment for light emissions

<table>
<tr><th colspan="4">Summary</th></tr>
<tr><td>Summary of impacts</td><td colspan="3">Light glow may act as an attractant to light-sensitive species (e.g., seabirds, turtles, fish, zooplankton), in turn affecting predator-prey dynamics (due to attraction to or disorientation from light).</td></tr>
<tr><td>Extent of impacts</td><td colspan="3">Localised for most marine fauna, and up to 15 km for turtle hatchlings and 20 km for seabirds.</td></tr>
<tr><td>Duration of impacts</td><td colspan="3">Temporary – short-term (duration of activity).</td></tr>
<tr><td>Level of certainty of impacts</td><td colspan="3">HIGH – the impacts of light glow on marine fauna are well known.</td></tr>
<tr><td rowspan="4">Impact decision framework context</td><td>Decision type</td><td colspan="2">A - good industry practice required.</td></tr>
<tr><td>Activity</td><td colspan="2">Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.</td></tr>
<tr><td>Risk & uncertainty</td><td colspan="2">Risks are well understood, uncertainty is minimal.</td></tr>
<tr><td>Stakeholder influence</td><td colspan="2">No conflict with company values, no partner interest, no significant media interest.</td></tr>
<tr><td>Defined acceptable level</td><td colspan="3">The impacts of light emissions to EPBC Act-listed threatened and migratory bird species and marine turtles are not inconsistent with their in-force recovery plans or wildlife conservation plans/advice.</td></tr>
<tr><th colspan="4">Impact Consequence (inherent)</th></tr>
<tr><td colspan="4">Negligible</td></tr>
<tr><th colspan="4">Assessment of Proposed Control Measures</th></tr>
<tr><td>Control measure</td><td>Control type</td><td>Adopt</td><td>Justification</td></tr>
<tr><td>Exclude night-time operations.</td><td>Eliminate</td><td>No</td><td>EB: Eliminates impact of night-time light emissions on sensitive species (e.g., seabirds and turtles foraging at night).
C: Would double the duration of the activity and therefore double activity costs.
Ev: Increased impacts in other areas due to a longer presence on location, including increase in waste discharges, air emissions, displacement of commercial fishers. Costs of extending the activity duration outweighs the benefits given the minor impacts.</td></tr>
<tr><td>Keep vessel external lighting to levels required for navigation, vessel safety and safety of deck operations (IMP-05:EPS-01).</td><td>Engineering</td><td>Yes</td><td>EB: This keeps light to the minimum required to meet legislated navigation requirements.
C: No additional activity costs. Vessel lighting is a legislative requirement for safe navigation and deck operations.
Ev: Good practice is well defined and established in Marine Orders (Part 30 and Part 59) for vessel</td></tr>
</table>

			operating at sea. Lighting is required to provide navigational safety and meet legislative requirements. Lighting is reduced to the lowest practicable level to allow for safe work practices and legislative compliance.
Lower blinds on portholes and windows at night **(IMP-05:EPS-02)**.	Engineering	Yes	**EB:** Reduces light spill to the marine environment. **C:** No additional cost. Involves only time to discuss this during crew inductions and in undertaking routine inspections. **Ev:** Good practice and well established in the industry. Environmental benefits can be achieved without cost.
Install lighting shields.	Engineering	No	**EB:** Reduces light spill to the marine environment through physical barriers. **C:** These are not standard fixtures on vessels. There will be significant time and cost to install these, and they may reduce safety of deck operations. **Ev:** External lighting is necessary for safe navigation and deck operations. The cost of this control measure outweighs the minimal benefit this control measure would have.
Use of lighting with wavelengths that are less intrusive to marine fauna.	Engineering	No	**EB:** Some marine fauna are less sensitive to particular light wavelengths. **C:** High cost of sourcing specialised globes. **Ev:** Lighting will be managed in accordance with the relevant Australian and international standards to ensure that personnel and vessel safety is not compromised. This control measure is unlikely to result in reduced impact due to the diversity of species present in the region; no single light wavelength can reduce risks for all fauna groups. This control measure would result in negligible benefit at a high cost.
Direct vessel lighting to working areas only **(IMP-05:EPS-03)**.	Engineering	Yes	**EB:** Reduces light spill to the marine environment. **C:** No additional costs. **Ev:** Good practice and well established in the industry. Environmental benefits can be achieved with minimal cost.
Periodically inspect lighting on-board to confirm it complies with lighting standards **(IMP-05:EPS-04)**.	Administrative	Yes	**EB:** Provides mechanism to inspect the implementation of control measures and their associated environmental benefits. **C:** Cost of time only. **Ev:** Good practice and well established in the industry. Environmental benefits can be achieved with minimal cost.

Environmental Controls and Performance Measurement

EPO	EPS	Measurement criteria
External vessel lighting conforms to that required by maritime safety standards.	**(IMP-05:EPS-01)** External vessel lighting is managed 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.
Lighting is reduced to limit the localised attraction of marine fauna.	**(IMP-05:EPS-02)** Blinds will be lowered on all activity vessel portholes and windows at night.	Completed environmental checklists and photos verify that blinds are drawn each night.
	(IMP-05:EPS-03) Lighting is directed to working areas (rather than overboard) to minimise light spill to the ocean.	Completed environmental checklists and photos verify that lighting standards are inspected and lighting is directed inboard where practicable.
	(IMP-05:EPS-04) Lighting on-board the activity vessel is periodically inspected to ensure it complies with lighting standards and relevant control measures.	

Impact Consequence (residual)

Negligible

The consequence of light emissions is assessed as negligible because:

- The activity is short-term;
- The vessel will be moving and will not be a permanent fixture;
- There are no seabird breeding colonies or turtle nesting beaches within the light EMBA;
- Wildlife potentially vulnerable to light (e.g., seabirds and turtles) will not be displaced from foraging habitat; and
- The control measures adopted are commensurate with the inherent level of impact consequence.

Statement of ALARP

A ‘negligible’ residual impact consequence is considered to be ALARP and a ‘lower order’ impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.

Demonstration of Acceptability

Policy compliance	EOG’s Safety and Environmental Policy objectives are met.	
EMS compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual impact consequence is negligible, which is considered acceptable.	
Engagement	Relevant persons	There have been no objections or claims made by relevant persons regarding light emissions.
	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns regarding light emissions.
Legislative context	The EPS align with the requirements of: • COLREGS 1972.	

	• *Navigation Act* 2012 (Cth): ○ Part 3 (Prevention of Collisions). ○ AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures). ○ AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment). ○ AMSA Marine Orders Part 30 (Prevention of Collisions). ○ AMSA Marine Order 58 (Safe Management of Vessels).	
Industry practice	The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to: • Light emissions - minimise external lighting to that required for navigation and safety of deck operations **(IMP-05:EPS-02, -03, -04)**.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines specifically regarding lighting for offshore activities.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of light emissions on marine life.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table are in accordance with these guidelines with regard to: • Ship collision (item 120). To avoid collisions with third-party vessels, offshore facilities should be equipped with navigational aids that meet national and international requirements, including navigational lights on vessels **(IMP-05:EPS-01)**.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	No guidelines provided regarding the management of light emissions.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys:

		• To reduce the impact on cetaceans and other marine life to ALARP and an acceptable level **(IMP-05:EPS-01 to IMP-05:EPS-04)**.
	Light-specific guidance	
	The National Light Pollution Guidelines for Wildlife (DoEE, 2020)	The EPS listed in this table meet the following management actions related to activities associated with the activity vessel: • Maintain a dark zone between the rookery and the light sources. • Aim lights downwards and direct them away from nesting areas **(IMP-05:EPS-03)**. • Prevent indoor light reaching outdoor environment **(IMP-05:EPS-02)**. • Reduce unnecessary outdoor, deck lighting on all vessels in known seabird foraging areas at sea **(IMP-05:EPS-02, -03)**. An assessment of the activity against the management actions of these guidelines is included in Table 7.18 for seabirds and Table 7.19 for turtles.
Environmental context	MNES	
	AMPs	The JBG AMP is intersected by the light EMBA. The light EMBA overlaps 64 km^2 of the JBG AMP. The adopted control measures and associated EPS listed in this table will reduce the effects of light pollution emitted from the vessels to the JBG AMP. Table 7.17 demonstrates that the activity will be conducted in a manner that is not inconsistent with the objectives and IUCN Category VI Principles for the JBG AMP.
	Ramsar wetlands	Localised and temporary light emissions will not reach any Ramsar wetlands.
	TECs	Localised and temporary light emissions will not reach any TECs.
	Nationally threatened and migratory species	The activity will be managed in a manner such that nationally threated and migratory species will not be impacted by localised and temporary light emissions.
	Other matters	
	KEFs	Localised and temporary light emissions will not reach any KEFs.
	NIWs	Localised and temporary light emissions will not reach any NIWs.
	State marine parks	Light emissions will not reach any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	Table 7.16 demonstrates that light emissions will not be inconsistent with the objectives of the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c).

ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).
Statement of Acceptability	EOG considers the impacts from light emissions to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Light emissions will not have long-term or significant impacts on MNES; • The management of lighting is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of lighting is not inconsistent with the aims of relevant marine reserve management plans; and • The management of lighting is not inconsistent with ESD principles.
Environmental Monitoring	
• None.	
Record Keeping	
• Vessel class certification. • Completed environmental inspections checklists. • Photos.	• Induction presentation. • Induction attendance sheet. • Incident reports.

7.6. IMPACT 6 – Routine Emissions – Atmospheric

7.6.1. Hazard

The use of fuel to power the vessel engines, generators, mobile and fixed plant and equipment, will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SOx) and nitrogen oxides (NOx).

The following activities generate atmospheric emissions:

- Combustion of MDO from the vessel engines, generators and fixed and mobile deck equipment;
- When transferring dry bulk products used for drilling (e.g., barite, bentonite), tank venting is necessary to prevent tank overpressure. The vent air will contain minor quantities of product particles, which will suspend in the air or settle on the sea surface.

7.6.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of atmospheric emissions are:

- Localised and temporary decrease in air quality due to gaseous emissions and particulates from MDO combustion; and
- Addition of GHG to the atmosphere (influencing climate change).

7.6.3. EMBA

The EMBA for atmospheric emissions associated is the local air shed, likely to be within hundreds of meters of the activity vessels, both horizontally and vertically.

Receptors that may occur within this EMBA, either as residents or migrants, are seabirds.

7.6.4. Evaluation of Environmental Impacts

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 SO_X and NO_X. Inhaling this particulate matter can cause or exacerbate health impacts to humans exposed to the particulate matter, such as offshore project personnel or residents of nearby towns (e.g., respiratory illnesses such as asthma) depending on the amount of particles inhaled. Similarly, the inhalation of particulate matter may affect the respiratory systems of fauna. In the activity area, this is limited to seabirds overflying the vessel/s.

Particulate matter released from the activity vessels is not likely to impact on the health or amenity of the nearest human coastal settlements (e.g., Port Keats (Wadeye) (NT) or Wyndam (WA)), as offshore 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 and therefore has a negligible impact consequence.

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 carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). While these emissions add to the GHG load in the atmosphere, which adds to global warming potential, they are tiny on a regional, national and global scale, representing an insignificant contribution to overall GHG emissions and therefore has a negligible impact consequence. The activity is similar to other shipping activities contributing to the accumulation of GHG in the atmosphere.

Tank venting

Tank venting is a necessary safety control, and any dust emissions will be negligible and limited to the immediate vicinity of the activity vessels. The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities.

7.6.5. Impact Assessment

Table 7.21 presents the impact assessment for atmospheric emissions.

Table 7.21. Impact assessment from atmospheric emissions

Summary	
Summary of Impacts	Decrease in air quality due to gaseous emissions and particulates from diesel combustion and contribution to the incremental build-up of GHG in the atmosphere (influencing climate change).
Extent of impacts	Localised (local air shed for air quality), widespread (for GHG).
Duration of impacts	Temporary (duration of activity) – emissions are rapidly dispersed and diluted.
Level of certainty of impact	HIGH – the impacts of atmospheric emissions are well known.

Impact decision framework context	Decision type	A - good industry practice required.	
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.	
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.	
Defined acceptable level	Atmospheric emissions are managed in accordance with legislated requirements.		
Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
No incineration of wastes from vessels during the activity.	Eliminate	No	**EB:** Eliminates a source of atmospheric emissions. **C:** Increased health risk from long-term onboard storage of wastes. If shore transfers are involved, there is an increase in fuel usage and other routine discharges and emissions. **Ev:** Health and safety risks outweigh the benefit given the high energy offshore locations. The low cost of onboard incinerations outweighs the high cost of transporting waste to shore.
Use incinerators and engines with higher environmental efficiency.	Substitution	No	**EB:** Reduces the volume of emissions and improves air quality. **C:** Activity vessel is not yet contracted, so it is unreasonable to commit a contractor to potentially swapping out equipment, likely at significant cost. **Ev:** Cost to implement control measure is disproportionate to the low environmental benefit.
Use low sulphur (<0.5% m/m) MDO **(IMP-06:EPS-01).**	Engineering	Yes	**EB:** Reduces SOx emissions to the environment. This has been a MARPOL requirement since the start of 2020. **C:** Some additional cost, but this is factored into the vessel contract. **Ev:** Environmental benefits can be achieved with little additional cost.
Implementation of a PMS for combustion equipment **(IMP-06:EPS-02)**.	Engineering	Yes	**EB:** Reduces the volume of emissions. **C:** Negligible; maintenance is part of routine vessel operations. **Ev:** Benefits of ensuring efficient vessel combustion outweighs the negligible cost.

IAPP certification **(IMP-06:EPS-03)**.	Engineering	Yes	**EB:** Reduces the volume of emissions. **C:** Negligible; certification and re-certification costs are factored into routine vessel operations. **Ev:** Benefits of ensuring vessels comply with emissions reduction standards outweighs the negligible cost.
SEEMP **(IMP-06:EPS-04).**	Engineering	Yes	**EB:** Improved energy efficiency reduces the volume of emissions. **C:** Negligible; certification and re-certification costs are factored into routine vessel operations. **Ev:** Benefits of ensuring vessels comply with emissions reduction standards outweighs the negligible cost.
Ozone Depleting Substances (ODS) procedure **(IMP-06:EPS-05).**	Engineering	Yes	**EB:** Reduces emissions associated with global warming. **C:** Negligible; maintenance of equipment with ODS potential (e.g., HVAC) is part of routine vessel operations. **Ev:** Benefits of ensuring vessels comply with ODS reduction standards outweighs the negligible cost.
Waste incineration managed in accordance MARPOL and Marine Orders **(IMP-06:EPS-06, -07, -08).**	Engineering	Yes	**EB:** Reduced impacts to air quality. **C:** Negligible; waste incineration in accordance with MARPOL requirements is part of routine vessel operations. **Ev:** Benefits of ensuring vessels comply with MARPOL requirements outweighs the negligible cost.
Monitor fuel use **(IMP-06:EPS-09).**	Administrative	Yes	**EB:** May minimise excessive fuel use and associated air emissions by rapidly detecting abnormalities with fuel consumption patterns. **C:** Negligible; such monitoring is part of routine vessel operations. **Ev:** Benefits of avoiding excessive fuel consumption and unnecessary air emissions outweighs the minimal cost.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Combustion systems operate in accordance with MARPOL Annex VI (Prevention of Air Pollution from	**(IMP-06:EPS-01)** 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 marine grade diesel.
	(IMP-06:EPS-02) All combustion equipment is maintained in accordance with the PMS (or equivalent).	PMS records verify that combustion equipment is maintained to schedule.

Ships) requirements.	**(IMP-06:EPS-03)** Vessels >400 gross tonnes possess equipment, systems, fittings, arrangements and materials that comply with the applicable requirements of MARPOL Annex VI.	IAPP Certificate is current.
	(IMP-06:EPS-04) 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.
	(IMP-06:EPS-05) Vessels >400 gross tonnes must ensure that firefighting and refrigeration systems are managed to minimise ODS.	ODS record book is available and current.
Solid combustible waste will only be burned within an incinerator, and only if logistics don't allow for the timely removal of waste from the vessel.	**(IMP-06:EPS-06)** Only a MARPOL VI-approved incinerator is used to incinerate solid combustible waste (food waste, paper, cardboard, rags, plastics).	IMO incinerator certificate verifies the incinerator meets MARPOL requirements.
	(IMP-06:EPS-07) Incineration is only conducted when the vessel is >12 nm from the shore.	Activity-specific discharges and emissions register indicates no incineration within 12 nm of the shore.
	(IMP-06:EPS-08) Oil and other noxious liquid substances will not be incinerated.	The Oil Record Book and Garbage Record Book verify that waste oil and other noxious liquid substances are transferred to shore for disposal.
Fuel use will be measured, recorded and reported.	**(IMP-06:EPS-09)** 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.
Impact Consequence (residual)		
Negligible		
The consequence of atmospheric emissions is assessed as negligible because: • The activity is of a temporary nature; • The activity area is located in a high energy offshore environment and air emissions will not impact on air quality in coastal towns; • The quantities of gaseous emissions are relatively small and will dissipate into the surrounding atmosphere; and • Management of atmospheric emissions will comply with legislated requirements.		
Demonstration of ALARP		
A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.		
Demonstration of Acceptability		
Policy compliance	EOG's Safety and Environmental Policy objectives are met.	

EMS compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual impact consequence is negligible, which is considered acceptable.	
Engagement	Relevant persons	There have been no objections or claims from relevant person regarding air emissions.
	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns about air emissions.

Legislative context	The EPS align with the requirements of:
	• *Navigation Act* 2012 (Cth):
	  ○ Chapter 4 (Prevention of Pollution).
	  ○ AMSA Marine Order Part 79 (Marine pollution prevention – air pollution).
	• *Protection of the Sea (Prevention of Pollution by Ships) Act* 1983 (Cth):
	  ○ Part IIID (Prevention of Air Pollution).
	  ○ AMSA Marine Orders Part 97 (Air Pollution), enacting MARPOL Annex VI (especially Regulations 6, 14, 16).
	• *National Greenhouse and Energy Reporting Act* 2007 (Cth).	

Industry practice	The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity.	

	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to:
		• Section 4.4.3 - Combustion emissions;
		  ○ Use of high efficiency equipment to minimise power demand **(IMP-06: EPS-04)**.
		  ○ Selection of low sulphur diesel **(IMP-06: EPS-01)**.
		  ○ Regular plant maintenance **(IMP-06: EPS-02)**.
		  ○ Regular maintenance and emission control devices on vehicles and machinery **(IMP-06: EPS-02)**.

	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	The EPS listed in this table meet these guidelines for offshore activities with regard to management of fugitive emissions (item 22). The BAT are met for the activity vessels.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of atmospheric emissions on marine life.
	Effective planning strategies for managing environmental risk	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance

	associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Air emissions (item 11). The overall objective to reduce air emissions (all IMP-07 EPS except EPS-07). • Air emissions (item 12). During equipment selection, air emission specifications should be taken into account, as should the use of very low sulphur content fuels and/or natural gas **(IMP-06: EPS-01)**.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met with regard to: • Section 8.6 (Hazardous materials): Use of MDO or marine gas oil (low sulphur content) **(IMP-06:EPS-01)**. • Section 8.6 (Hazardous materials): The exhaust systems should be serviced on a regular basis **(IMP-06: EPS-02)**. • Section 8.8 (Vessel operations): Engine fuel mixtures must be adjusted to maximise clean burning and reduce emissions **(IMP-06: EPS-01)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce GHG emissions to ALARP and an acceptable level (All IMP-07 EPS).
Environmental context	MNES	
	AMPs	Atmospheric emissions do not directly affect nearby AMPs.
	Ramsar wetlands	Atmospheric emissions do not directly affect any Ramsar wetlands.
	TECs	Atmospheric emissions do not directly affect any TECs.
	Nationally threatened and migratory species	Atmospheric emissions do not directly affect threated or migratory species.
	Other matters	
	KEFs	Atmospheric emissions do not directly affect any KEFs.
	NIWs	Atmospheric emissions do not directly affect any NIWs.
	State marine parks	Atmospheric emissions do not directly affect any state marine parks.

	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	The Recovery Plans and Conservation Advice for the blue, sei, fin and humpback whales list climate change as a key threat, though the most pervasive threats are whaling, vessel strike and entanglement. The Recovery Plan for Marine Turtles in Australia lists climate change as a key threat. Atmospheric emissions resulting from the activity are not inconsistent with this recovery plan.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the impacts from atmospheric emissions to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Atmospheric emissions from the activity will not have long-term or significant impacts on MNES; • The management of air emissions will ensure it is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of air emissions will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and • The management of air emissions will ensure it is not inconsistent with ESD principles.	
Environmental Monitoring		
• Fuel use.		
Record Keeping		
• Vessel PMS records. • Vessel fuel use records. • Vessel bunkering receipts. • Waste manifests (for incineration).	• ODS record book. • Oil record book. • Garbage record book. • Activity-specific discharges and emissions register.	

7.7. IMPACT 7 – Routine Discharges – Putrescible Waste

7.7.1. Hazard

The generation of food waste (putrescible waste) from the vessel galley will result in the overboard discharge of this waste. The average volume of putrescible waste discharged overboard depends on the number of Persons on Board (POB) at any time, and the types of meals prepared.

Based on a PDSA activity undertaken in Bass Strait in 2019 using two separate vessels, a typical small vessel undertaking geotechnical activities is likely to have about 20 POB, while a larger specialised geotechnical vessel is likely to have up to 50 POB. NERA (2018) estimates the volume of putrescible waste to be in the order of 1-2 kg per person per day. Assuming 20-50 people work on the activity vessel, an estimated 20-100 kg (0.02 – 0.1 m^3) of putrescible waste may be generated and discharged overboard daily.

7.7.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of putrescible waste discharges are:

- Temporary and localised increase in the nutrient content of waters surrounding the discharge point; and
- An associated increase in scavenging behaviour of marine fauna and seabirds (at the sea surface or within the water column).

7.7.3. EMBA

The EMBA for putrescible waste discharges 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, WA).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Pelagic fauna (plankton, fish, cetaceans and turtles); and
- Avifauna.

7.7.4. Evaluation of Environmental Impacts

The overboard discharge of macerated food wastes creates a localised and temporary increase in the nutrient load of near-surface waters. This in turn acts as 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, ensures that the impacts of such discharges are insignificant and therefore have a negligible impact consequence.

7.7.5. Impact Assessment

Table 7.22 presents the impact assessment for putrescible waste discharges.

Table 7.22. Impact assessment for putrescible waste discharges

Summary		
Summary of impacts	Increase in nutrient content of near-surface waters around the discharge point, which may lead to an increase of scavenging behaviour of pelagic fish and seabirds.	
Extent of impacts	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of impacts	Intermittent and temporary – until the discharge is completely consumed (likely to be several hours).	
Level of certainty of impacts	HIGH – the impacts of putrescible waste discharges on marine fauna are well known.	
Impact decision framework context	Decision type	A - good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.

	Risk & uncertainty	Risks are well understood, uncertainty is minimal.	
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.	
Defined acceptable level	Putrescible waste discharges to sea meet legislated requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health.		
Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Store all putrescible waste onboard for onshore disposal.	Eliminate	No	**EB:** Eliminates decreased water quality and scavenging behaviour by marine fauna. **C:** Additional cost due to onshore disposal, additional fuel usage required to transfer wastes to shore, increased health and safety risk involved with storing organic wastes onboard. **Ev:** Cost is disproportionate to the minor consequence and the fact that the discharges are permitted under legislation.
GMP **(IMP-07: EPS-01)**.	Engineering	Yes	**EB:** Reduces probability of garbage being inappropriately discharged to sea, reducing potential impacts to fauna. **C:** Negligible; part of routine vessel operations. **Ev:** Benefits of ensuring responsible and compliant garbage handling outweighs negligible cost.
Putrescible waste is treated as per MARPOL Annex V requirements prior to discharge **(IMP-07: EPS-02, -03, -04, -05).**	Engineering	Yes	**EB:** Reduces probability of putrescible waste being inappropriately discharged to sea, reducing potential impacts to fauna. **C:** Negligible; part of routine vessel operations. Occasional high costs of replacing the macerator. **Ev:** Benefits of ensuring responsible and compliant putrescible waste handling outweighs minimal costs.
Environmental induction for vessel crew **(IMP-07: EPS-06)**.	Administrative	Yes	**EB:** Reduced likelihood of inappropriate waste disposal to the sea. **C:** Negligible; part of routine vessel operations. **Ev:** Environmental benefits can be achieved with little additional cost.

Environmental Performance Objectives and Measurement		
EPO	EPS	Measurement criteria
Discharge of putrescible waste to sea only.	**(IMP-07: EPS-01)** A MARPOL Annex V-compliant GMP is in place (for vessels >100 GRT 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 onboard and kept current.

<table>
<tr><td rowspan="5"></td><td colspan="2">(IMP-07: EPS-02) A macerator is on board the vessels, functional, in use and set to macerate putrescible waste to a particle size ≤25 mm using to ensure rapid breakdown upon discharge.</td><td>PMS records verify that the macerator is functional and regularly maintained or replaced.</td></tr>
<tr><td colspan="2">(IMP-07: EPS-03) Records of food waste disposal to be maintained in a Garbage Record Book.</td><td rowspan="3">A Garbage Record Book is in place and verifies waste discharge locations and volumes.</td></tr>
<tr><td colspan="2">(IMP-07: EPS-04) Macerated putrescible waste (≤25 mm) is only discharged overboard when the vessel is >3 nm from the shoreline.</td></tr>
<tr><td colspan="2">(IMP-07: EPS-05) Un-macerated putrescible waste is only discharged overboard when the vessel is >12 nm from the shoreline.</td></tr>
<tr><td colspan="2">(IMP-07: EPS-06) Waste management and housekeeping requirements are communicated to all vessel crew to ensure discharges are in accordance with MARPOL Annex V.</td><td>Vessel induction includes waste management requirements.</td></tr>
<tr><th colspan="4">Impact Consequence (residual)</th></tr>
<tr><th colspan="4">Negligible</th></tr>
<tr><td colspan="4">The consequence of putrescible waste discharges is assessed as negligible because of:
The temporary duration of the activity;
The intermittent nature of the discharge;
The small discharge volumes;
Maceration of the waste prior to discharge;
High dilution and dispersal factor in open waters;
The long distance from shore;
Rapid consumption by fauna;
High biodegradability and low persistence of the waste; and
The absence of sensitive habitats in the activity area.</td></tr>
<tr><th colspan="4">Demonstration of ALARP</th></tr>
<tr><td colspan="4">A ‘negligible’ residual impact consequence is considered to be ALARP and a ‘lower order’ impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.</td></tr>
<tr><th colspan="4">Demonstration of Acceptability</th></tr>
<tr><td>Policy compliance</td><td colspan="3">EOG’s Safety and Environmental Policy objectives are met.</td></tr>
<tr><td>EMS compliance</td><td colspan="3">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="3">The residual impact consequence is negligible, which is considered acceptable.</td></tr>
<tr><td>Engagement</td><td>Relevant persons</td><td colspan="2">No objections or claims have been made by relevant persons with regard to putrescible waste discharges.</td></tr>
</table>

	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns with regard to putrescible waste discharges.

Legislative context	The EPS align with the requirements of:
	• *Navigation Act* 2012 (Cth):
	  o Chapter 4 (Prevention of Pollution).
	  o AMSA Marine Order 95 (Marine Pollution Prevention - garbage).
	• *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth):
	  o Section 26F (which implements MARPOL Annex V).	

Industry practice	The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to: • Section 4.5.1 - organic (food) waste from the kitchen should, at a minimum, be macerated to <25 mm prior to discharge to sea, in compliance with MARPOL Annex V requirements **(IMP-07: EPS-03 and -04)**.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	The EPS listed in this table meet these guidelines for offshore activities with regard to: • Environmental monitoring (item 26). The BAT are met for the activity with regard to monitoring waste streams.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of putrescible waste discharges on marine life.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Other waste waters (item 44). Food waste from the kitchen should, at a minimum, be macerated to acceptable levels and discharged to sea, in compliance with MARPOL requirements **(IMP-07: EPS-04)**.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines are met with regard to: • Section 8.5 (Waste Management): Vessels have a waste management plan in accordance with MARPOL Annex V **(IMP-07: EPS-01)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the volume of wastes produced to ALARP and to an acceptable level.

Environmental context	MNES	
	AMPs	Putrescible waste discharges will not impact the conservation values of nearby AMPs.
	Ramsar wetlands	Putrescible waste discharges will not intersect any Ramsar wetlands.
	TECs	Putrescible waste discharges will not intersect any TECs.
	Nationally threatened and migratory species	Putrescible waste discharges do not have any significant impacts on threated or migratory species.
	Other matters	
	KEFs	Putrescible waste discharges will not intersect any KEFs.
	NIWs	Putrescible waste discharges will not intersect any NIWs.
	State marine parks	This hazard does not intersect any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	The discharge of putrescible waste does not compromise the specific objectives or actions (regarding marine pollution) of any of the species Recovery Plans, Conservation Management Plans or Conservation Advice referenced in this EP.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the impacts from putrescible waste discharges to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Putrescible waste discharges will not have long-term or significant impacts on MNES; • Putrescible waste discharges are not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • Putrescible waste discharges are not inconsistent with the aims of relevant marine reserve management plans; and • The management of putrescible waste discharges is not inconsistent with ESD principles.	
Environmental Monitoring		
• Volume/weight of non-macerated waste sent ashore.		
Record Keeping		

• GMP. • PMS records. • Garbage Record Book.	• Training matrix. • Induction records.

7.8. IMPACT 8 - Routine Discharges – Sewage and Grey Water

7.8.1. Hazard

The use of ablution, laundry and galley facilities by vessel crew will result in the discharge of sewage and grey water. 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.

Based on a PDSA activity undertaken in Bass Strait in 2019 using two separate vessels, a typical small vessel undertaking geotechnical activities is likely to have about 20 POB, while a larger specialised geotechnical vessel is likely to have up to 50 POB.

AMSA (2016) states that most large vessels generate 5-15 m^3 wastewater/day, the majority of which is grey water (wastewater from showers, laundry, galley and wash basins). NERA (2017) estimates that the 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. Assuming 20-50 people working on the activity vessels, this equates to between 0.8 and 22.5 m^3 of sewage and grey water generated and discharged daily.

7.8.2. Known and Potential Environmental Impacts

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 vessels; and
- An associated increase in scavenging behaviour of marine fauna and seabirds (at the sea surface or in the water column).

7.8.3. EMBA

The EMBA for sewage and grey water discharges associated with vessel activities 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:

- Pelagic fauna (plankton, fish, cetaceans and turtles); and
- Seabirds.

7.8.4. Evaluation of Environmental Impacts

Water quality

Nutrients in sewage, such as phosphorus and nitrogen, may contribute to eutrophication of receiving waters (although usually only still, calm, inland waters), causing algal blooms, which can degrade aquatic habitats by reducing light levels and producing certain toxins, some of which are harmful to marine life and humans. Given the tidal movements and currents in open oceanic waters, eutrophication of receiving waters will not occur. Sewage will be treated through a Sewage Treatment Plant (STP) to a tertiary level, so there are no impacts relating to the release of chemicals and pathogens in untreated sewage.

Grey water 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 sewage and sullage discharges on the water quality at Scott Reef were monitored for a drill rig 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 rig 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). Conditions associated with this example at Scott Reef are considered conservative given the high numbers of personnel onboard a drill rig (typically 100-120) compared with vessels undertaking the activity.

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 of the treated effluent is unlikely to lead to oxygen depletion of the receiving waters (Black et al., 1994), as it will be treated prior to release. On release, surface water currents will assist with oxygenation of the discharge.

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 higher up the food chain (e.g., fish, reptiles, birds and cetaceans) are expected to be negligible.

7.8.5. Impact Assessment

Table 7.23 presents the impact assessment for the discharge of treated sewage and grey water.

Table 7.23 Impact assessment for the discharge of treated sewage and grey water

Summary		
Summary of impacts	Reduction in water quality around the discharge point, increase in nutrients.	
Extent of impacts	Localised – up to 50 m horizontally and 10 m vertically from the discharge point.	
Duration of impacts	Temporary – until the discharge is completely diluted (likely to be minutes to hours).	
Level of certainty of impact	HIGH – the impacts of sewage and grey water discharges to water quality are well known.	
Impact decision framework context	Decision type	A - good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.
Defined acceptable level	Sewage and grey water discharges to sea meet legislated requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health.	
Impact Consequence (inherent)		
Negligible		

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
No discharge of treated sewage and grey water at sea.	Eliminate	No	**EB:** Eliminates biodegradable waste stream that may result in decreased water quality and scavenging behaviour by marine fauna. **C:** Additional cost due to onshore disposal, increased health and safety risk involved with storing organic wastes onboard. **Ev:** Cost is grossly disproportionate to the minor consequence associated with the discharges that are permitted under legislation.
Routine discharges of treated sewage and grey water are managed in accordance with standard maritime practice	Engineering	Yes	**EB:** Reduces potential impacts of inappropriate discharge of sewage and ensures compliance with Marine Order 96 and MARPOL requirements as appropriate for vessel class. **C:** Negligible; part of routine vessel operations.

(IMP-08: EPS-01, -02, -03, -04)			**Ev:** Environmental benefits can be achieved with little additional cost.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Water pollution is avoided by treating and discharging sewage and grey water in accordance with Regulation 9 of MARPOL Annex IV.	**(IMP-08: EPS-01)** Where sewage is treated in a STP, the STP meets MARPOL standards.	ISPP certificate is valid and verifies the installation of a MARPOL-approved STP.
	(IMP-08: EPS-02) The STP is maintained in accordance with the vessel's PMS.	PMS records confirm that the STP is maintained to schedule.
	(IMP-08: EPS-03) In accordance with Regulation 11 of MARPOL Annex IV (as enacted by Marine Order 96), sewage is comminuted, disinfected and only discharged when: • Vessel is >3 nm from nearest land. • Sewage originating in holding tanks is discharged at a moderate rate while the vessel is proceeding en route at a speed not less than 4 knots.	Records verify that treated sewage is only discharged when the vessel is >3 nm from shore.
	(IMP-08: EPS-04) In the event of a STP malfunction or where a STP is not present on the vessel, untreated sewage and grey water is only discharged when the vessel is greater than 12 nm from shore in accordance with Regulation 11 of MARPOL Annex IV (enacted by AMSA Marine Orders Part 96, Sewage).	Activity-specific discharges and emissions register verifies that untreated sewage is only discharged when the vessel is greater than 12 nm from shore.

Impact Consequence (residual)

Negligible

The consequence of treated sewage and grey water discharges is assessed as negligible because of:

- The temporary nature of the activity;
- The consistent movement of the vessel;
- Low discharge volumes;
- Intermittent nature of the discharge;
- Treatment of the waste stream prior to discharge;
- High dilution and dispersal factor in open waters;
- The long distance from shore;
- High biodegradability and low persistence of the waste; and
- Absence of sensitive habitats in the activity area.

Demonstration of ALARP

A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.

Demonstration of Acceptability

Policy compliance	EOG's Safety and Environmental Policy objectives are met.	
EMS compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual impact consequence is negligible, which is considered acceptable.	
Engagement	Relevant persons	No objections or claims have been made by relevant persons regarding treated sewage and grey water discharges during the activity.
	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns with regard to sewage and grey water discharges.

Legislative context	The EPS align with the requirements of:
	• *Navigation Act* 2012 (Cth):
	  ○ Chapter 4 (Prevention of Pollution).
	  ○ AMSA Marine Order 95 (Marine Pollution Prevention - sewage).
	• *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth):
	  ○ Section 26D (which implements MARPOL Annex IV).	

Industry practice	The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this hazard are in line with the management measures listed in Section 4.5.1 - offshore discharges (sewage and grey water): • Grey and sewage water from showers, toilets, and kitchen facilities should be treated in an appropriate on-site marine sanitary treatment unit **(IMP-08: EPS-03)**. • Sewage units to be in compliance with MARPOL Annex V requirements **(IMP-08: EPS-01)**.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines for offshore activities with regard to managing sewage and grey water discharges.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of sewage and grey water discharges on marine life.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas	Guidelines met with regard to:

	Development (World Bank Group, 2015)	• Other waste waters (item 44). Grey and black water should be treated in an appropriate on-site marine sanitary treatment unit in compliance with MARPOL **(IMP-08: EPS-01, -03)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs	Sewage and grey water discharges will not impact the conservation values of the JBG AMP.
	Ramsar wetlands	Sewage and grey water discharges will not intersect any Ramsar wetlands.
	TECs	Sewage and grey water discharges will not intersect any TECs.
	Nationally threatened and migratory species	Sewage and grey water discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	KEFs	Sewage and grey water discharges will not intersect any KEFs.
	NIWs	Sewage and grey water discharges will not intersect any NIWs.
	State marine parks	Sewage and grey water discharges will not intersect any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	None triggered by this hazard.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of Acceptability	EOG considers the impacts from treated sewage discharges to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Sewage and grey water discharges will not have long-term or significant impacts on MNES; • The management of sewage and grey water discharges is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species;	

	• The management of sewage and grey water discharges is not inconsistent with the aims of relevant marine reserve management plans; and • The management of sewage and grey water discharges is not inconsistent with ESD principles.
Environmental Monitoring	
• None required.	
Record Keeping	
• ISPP certificate. • STP PMS records. • Activity-specific discharges and emissions register.	

7.9. IMPACT 9 - Routine Discharges – Cooling and Brine Water

7.9.1. Hazard

Seawater is used as a heat exchange medium for cooling machinery engines on vessels. 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) and is then discharged to the ocean at depth (not at surface). 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 vessels that may be used is unknown. Also unknown is the temperature at which the heat exchangers are designed to discharge the cooling water at (though this is generally several degrees Celsius above ambient sea temperature). The volume depends on the equipment being cooled, but for this activity, it is likely to be tens of cubic meters each day.

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 other 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.

7.9.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of cooling water and brine discharges are:

- Temporary and very localised increase in sea water temperature, causing thermal stress to marine biota;
- Temporary and very 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.

7.9.3. 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:

- Pelagic fauna (plankton, fish, cetaceans and turtles); and
- Avifauna.

7.9.4. Evaluation of Environmental Impacts

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 be dispersed by ocean currents. Walker and MacComb (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, 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 receptors are expected to be negligible.

Potential toxicity impacts

Scale inhibitors and biocide are likely to 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 in the industry 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 and thus have a negligible impact consequence.

7.9.5. Impact Assessment

Table 7.24 presents the impact assessment for the discharge of cooling and brine water.

Table 7.24. Impact 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 impacts	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.		
Duration of impacts	Temporary – duration of the activity.		
Level of certainty of impact	HIGH – the impacts of sea surface temperature and salinity increases on marine fauna are well known.		
Impact decision framework context	Decision type	A - good industry practice required.	
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.	
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.	
Defined acceptable level	Cooling water and brine discharges to sea meet legislated requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health.		
Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Store brine onboard prior to discharge onshore.	Elimination	No	**EB:** Eliminates impacts to the marine environment. **C:** Very high costs associated with vessel modifications to enable onboard storage. **Ev:** Cost outweighs the environmental benefit given the minor inherent consequence.
Low toxicity chemicals **(IMP-09: EPS-01)**.	Substitution	Yes	**EB:** Reduces potential water quality impacts through use of environmentally suitable chemicals. **C:** Low toxicity chemicals are generally more expensive than higher toxicity chemicals, but not by high margins. **Ev:** The minimal additional cost is outweighed by the environmental benefits.
Biocide dosing **(IMP-09: EPS-02)**.	Engineering	Yes	**EB:** Minimises the likelihood of out-of-specification discharges. **C:** Negligible; part of routine vessel operations.

			E: Environmental benefits can be achieved with negligible additional cost.
Freshwater generation volumes **(IMP-09: EPS-03)**.	Engineering	Yes	**EB:** Minimises the volume of brine discharges. **C:** Negligible; part of routine vessel operations. **E:** Environmental benefits can be achieved with negligible additional cost.
PMS **(IMP-09: EPS-04)**.	Engineering	Yes	**EB:** Minimises the likelihood of out-of-specification discharges. **C:** Negligible; part of routine vessel operations. **E:** Environmental benefits can be achieved with little additional cost.

Environmental Controls and Performance Measurement

EPO	EPS	Measurement criteria
Only the minimum required low-toxicity chemicals are used in the cooling and brine water systems.	**(IMP-09: EPS-01)** Only OCNS 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM)-rated chemicals (i.e., low toxicity) are used in the cooling and brine water systems.	Vessel chemical inventories records verify that biocides and scale inhibitors are of low toxicity.
	(IMP-09: EPS-02) Biocide dosing kept to a minimum in accordance with the equipment manufacturer's specifications	Review of PMS data with Chief Engineer verifies minimum biocide dosage.
The RO plant and equipment that requires cooling by water is well maintained.	**(IMP-09: EPS-03)** Freshwater generation will be limited to volumes necessary for operational requirements.	Review of tank volumes with Chief Engineer verifies minimum requirement for freshwater generation.
	(IMP-09: EPS-04) Plant and equipment that requires cooling by water is maintained in good working order in accordance with the vessels' PMS.	Vessel PMS records verify that equipment that requires cooling is maintained in accordance with OEM requirements.

Impact Consequence (residual)

Negligible

The consequence of cooling and brine water discharges is assessed as negligible because of the:

- Temporary nature of the activity;
- Vessel will be constantly moving;
- Low discharge volumes;
- Intermittent nature of the discharge;
- 'Consumption' of the chemicals prior to discharge;
- High dilution and dispersal factor in open waters; and
- Absence of sensitive habitats in the activity area.

Demonstration of ALARP

A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or

<table>
<tr><td colspan="3">alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.</td></tr>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td>Policy compliance</td><td colspan="2">EOG's Safety and Environmental Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>EMS compliance</td><td colspan="2">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="2">The residual impact consequence is negligible, which is considered acceptable.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td>No objections or claims have been made by relevant persons regarding cooling and brine discharges.</td></tr>
<tr><td>Stakeholders</td><td>During the EP public exhibition process, stakeholders did not express project-specific concerns regarding cooling and brine discharges.</td></tr>
<tr><td>Legislative context</td><td colspan="2">There are no legislative controls regarding cooling and brine water discharges.</td></tr>
<tr><td rowspan="5">Industry practice</td><td colspan="2">The consideration of the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry
(IOGP-IPIECA, 2020)</td><td>The EPS developed for this hazard are in line with the management measures listed for offshore discharges (cooling water and desalination brine) in Section 4.5.3 of the guidelines:
• Biocide dosing kept to a minimum in accordance with the equipment manufacturer's specifications (IMP-09: EPS-02).
• Freshwater generation to be limited to volumes necessary for operational requirements (IMP-09: EPS-03).</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>There are no guidelines for offshore activities with regard to managing cooling and brine water discharges.</td></tr>
<tr><td>Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)</td><td>Not applicable. The guidelines do not discuss the impacts of cooling water and brine discharges on marine life.</td></tr>
<tr><td>Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)</td><td>The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.</td></tr>
</table>

	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Cooling water (items 41 & 42). Antifouling chemical dosing to prevent marine fouling of cooling water systems should be carefully considered and appropriate screens to be fitted to the seawater intake to avoid entrainment and impingement of marine flora and fauna **(IMP-09:EPS-02)**. The cooling water discharge depth should be selected to maximise mixing and cooling of the thermal plume to ensure it is within 3°C of ambient seawater temperature within 100 m of the discharge point. • Desalination brine (item 43). Consider mixing desalination brine from the potable water system with cooling water or other effluent streams.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	No guidelines provided regarding management of cooling and brine water.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs	Cooling and brine water discharges will not impact the conservation values of nearby AMPs.
	Ramsar wetlands	Cooling and brine water discharges will not intersect any Ramsar wetlands.
	TECs	Cooling and brine water discharges will not intersect any TECs.
	Nationally threatened and migratory species	Cooling and brine water discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	KEFs	Cooling and brine water discharges will not intersect any KEFs.
	NIWs	Cooling and brine water discharges will not intersect any NIWs.
	State marine parks	Cooling and brine water discharges will not impact the conservation values of nearby AMPs.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	None triggered by this hazard.

ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).
Statement of Acceptability	EOG considers the impacts from cooling water and brine discharges to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Cooling water and brine discharges will not have long-term or significant impacts on MNES; • The management of cooling water and brine discharges is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of cooling water and brine discharges is not inconsistent with the aims of relevant marine reserve management plans; and • The management of cooling water and brine discharges is not inconsistent with ESD principles.
Environmental Monitoring	
• None required.	
Record Keeping	
• PMS records. • Potable water tank volumes. • Chemical inventories.	

7.10. IMPACT 10 – Routine Discharges – Bilge Water and Deck Drainage

7.10.1. Hazard

Bilge tanks on the vessels receive fluids from closed deck drainage and machinery spaces that may contain contaminants such as oil, detergents, solvents, chemicals and solid waste. An oily water separator (OWS) then treats 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 (as required, based on bilge tank storage levels). Where no OWS is present, these fluids are retained in tanks for onshore disposal.

Vessel 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 (e.g., hydraulic fluids, lubricating oils) or hydrocarbon spill or leak washed overboard.

7.10.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of the discharge of bilge water and deck drainage are:

- Temporary and localised reduction of surface water quality around the discharge point; and
- Acute toxicity to marine fauna through ingestion of contaminated water in a small mixing zone.

7.10.3. EMBA

The EMBA for bilge and deck water discharges is likely to be the top 10 m of the water column and less than 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 (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Pelagic fauna (plankton, fish, cetaceans and turtles); and
- Avifauna.

7.10.4. Evaluation of Environmental Impacts

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 (as per the EMBA) and thus have a negligible impact consequence.

Potential toxicity impacts

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 a vessel OWS malfunctions and discharges of off-specification water, toxicity impacts may occur to marine fauna swimming through the discharge, though this is only likely in a highly localised mixing zone (meaning that few individuals would be exposed), meaning it will have a negligible impact consequence.

7.10.5. Impact Assessment

Table 7.25 presents the impact assessment for the discharge of bilge water and deck drainage.

Table 7.25. Impact assessment for the discharge of bilge water and deck drainage

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 impacts	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of impacts	Intermittent during vessel operations.	
Level of certainty of impacts	HIGH – the impacts of oily water discharges to the ocean are well known.	
	Decision type	A - good industry practice required.

Impact decision framework context	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.
Defined acceptable level	Bilge water discharges and deck drainage meet legislated discharge requirements such that there are no adverse impacts to biodiversity, ecological integrity or human health.	

Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Store treated bilge onboard for disposal onshore.	Eliminate	No	**EB:** Eliminates oily water discharge, thereby eliminating potential impacts to water quality and marine fauna. **C:** Significant cost of re-designing and configuring storage space on vessels. **Ev:** Cost to implement control measures outweighs the benefit given the negligible inherent consequence.
Oily water treatment system **(IMP-10: EPS-01, -03, -04).**	Engineering	Yes	**EB:** Oily water is treated prior to discharge, thereby reducing impacts to water quality and marine fauna. Complies with Marine Order 91 and MARPOL requirements. **C:** Significant cost to install and minor costs to maintain, but part of routine vessel operations. **Ev:** Benefits to the marine environment outweigh the costs.
Maintain bilge water systems **(IMP-10: EPS-02).**	Engineering	Yes	**EB:** Efficient OWS ensures MARPOL requirements are met and impacts to water quality and marine fauna are minimised. **C:** Minor costs to maintain the OWS that is part of routine vessel operations. **Ev:** Benefits to the marine environment outweigh the costs.
Bunding of hydrocarbons and chemical storage areas **(IMP-10: EPS-07, -08)**	Engineering	Yes	**EB:** Increases likelihood that a spill will be caught and not discharged to the marine environment. **C:** Minor equipment installation and maintenance costs. **Ev:** Environmental benefit outweighs the costs.
SMPEP **(IMP-10: EPS-05, -09).**	Administrative	Yes	**EB:** Coordinated response to a spill reduces the area of impact to the marine environment.

			C: Minor equipment installation cost and maintenance costs, minor costs in time of training crew. **Ev:** Environmental benefit outweighs the costs.
Use of non-toxic, biodegradable deck cleaning product selection **(IMP-10: EPS-06).**	Administrative	Yes	**EB:** Improves quality of water discharge. **C:** Minor additional cost of environmentally acceptable deck cleaning products. **Ev:** Environmental benefit outweighs the minimal cost.
Availability of spill response kits **(IMP-10: EPS-10).**	Administrative	Yes	**EB:** Coordinated response to a spill reduces the area of impact to the marine environment. **C:** Minor equipment installation cost and maintenance costs, minor costs in time of training crew. **Ev:** Environmental benefit outweighs the minimal cost.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
No discharge of bilge water unless compliant with MARPOL Annex I requirements.	**(IMP-10: EPS-01)** For vessels >400 gross tonnes, all bilge water passes through a MARPOL-compliant OWS set to limit OIW to <15 ppm prior to overboard discharge.	IOPP certificate is current.
	(IMP-10: EPS-02) The OWS is maintained in accordance with the vessel PMS.	PMS records verify that the OWS is maintained to schedule.
	(**IMP-10: EPS-03)** The OWS is calibrated in accordance with the vessel PMS to ensure the 15 ppm OIW limit is met.	PMS records verify that the OWS is calibrated to schedule.
	(IMP-10: EPS-04) The residual oil from the OWS is pumped to tanks and disposed of onshore.	The Oil Record Book verifies that waste oil is transferred to shore.
Level 1 spills (<10 m^3) of oil or oily water overboard are rapidly responded to by the vessel contractor.	**(IMP-10: EPS-05)** The vessel-specific SMPEP is implemented in the event of an overboard spill of hydrocarbons or chemicals.	Incident report verifies that the SMPEP was implemented.
Planned open deck discharges are non-toxic.	**(IMP-10: EPS-06)** Deck cleaning detergents are biodegradable.	Safety Data Sheets (SDS) verify that deck cleaning agents are biodegradable.
Hydrocarbon or chemical spills to deck are prevented from being discharged overboard.	**(IMP-10: EPS-07)** Hydrocarbon and chemical storage areas (process areas) are bunded and drain to the bilge tank.	Site inspections (and associated completed checklists) verify that bunding is in place and piping and instrumentation diagrams (P&IDs) verify that, for

		vessels, they drain to the bilge tank.
	(IMP-10: EPS-08) 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.
Personnel are competent in spill response and have appropriate resources to respond to a spill.	**(IMP-10: EPS-09)** 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.
	(IMP-10: EPS-10) Fully stocked SMPEP response kits and scupper plugs or equivalent drainage control measures are readily available 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.

Impact Consequence (residual)
Negligible
The consequence of bilge water discharges and deck drainage is assessed as negligible because the: • Activity is of a temporary nature; • Vessels will be constantly moving; • Discharges will be intermittent; • Discharges will be low volume; • High energy offshore waters will aid in dilution of discharges; and • Activity area does not contain sensitive habitats.

Demonstration of ALARP
A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the impact to the point that any additional or alternative control measures either fail to lower the impact any further or are grossly disproportionate to the residual impact consequence.

Demonstration of Acceptability		
Policy compliance	EOG's Safety and Environmental Policy objectives are met.	
EMS compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual impact consequence is negligible, which is considered acceptable.	
Engagement	Relevant persons	There have been no objections or claims raised by relevant persons regarding bilge water discharges and deck drainage.

	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns bilge water discharges and deck drainage.

Legislative context	The EPS align with the requirements of:
	• *Navigation Act* 2012 (Cth):
	  ○ Chapter 4 (Prevention of Pollution).
	  ○ AMSA Marine Order 91 (Marine Pollution Prevention - oil).
	• *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth):
	  ○ Part II (Prevention of pollution by oil).
	  ○ Part III (Prevention of pollution by noxious substances).	

Industry practice	The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this hazard are in line with the management measures listed for offshore discharges (deck drainage and bilge water) in Section 4.5.2 of the guidelines: • Vessels must have an IOPP Certificate (for vessels >400 gross tonnes) and equipped with MARPOL/IMO-compliant oil/water treatment system (as appropriate to vessel class) **(IMP-10: EPS-01)**. • Hydrocarbon and chemical storage areas are to be bunded with no residues/spills permitted to enter the overboard drainage system unless it first goes through a closed drainage treatment system **(IMP-10: EPS-07, -08)**. • Vessels to maintain an Oil Record Book (applicable to vessels >400 gross tonnes), including the discharge of dirty ballast or cleaning water **(IMP-10: EPS-04)**. • Discharge into the sea of oil or oily mixtures is prohibited except when the OIW of the discharge without dilution does not exceed 15 ppm **(IMP-10:EPS-01, -03)**. • Contaminated deck drainage and bilge water to be contained and treated prior to discharge in accordance with EHS Guidelines for Offshore Oil and Gas Development 2015. If treatment to this standard is not possible, these waters should be contained and shipped to shore for disposal. • Extracted hydrocarbons from oil-in water separator systems to be stored in suitable containers and transported to shore for treatment and/or disposal by a certified waste oil disposal contractor **(IMP-10: EPS-04)**.
	Best Available Techniques Guidance	The EPS listed in this table meet these guidelines for offshore activities with regard to:

	Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	• Management of drain water (item 24). The BAT are met for vessel operations with regard to ensuring deck coaming is in place, maintaining a chemical inventory, implementing an inspection, maintenance and repair schedule and ensuring that personnel are trained in the use of spill kits **(IMP-10: EPS-09)**.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of bilge water and deck drainage discharges on marine life.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Other waste waters (item 44). Bilge waters from machinery spaces in vessels should be routed to the closed drain system or contained and treated before discharge to meet MARPOL requirements **(IMP-10: EPS-01)**. Deck drainage water should be routed to separate drainage systems. This includes drainage water from process and non-process areas. All process areas should be bunded to ensure that drainage water flows into the closed drainage system **(IMP-10: EPS-07)**.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met with regard to: • Section 8.5 (Waste management). • Section 8.6 (Hazardous materials). • Section 8.8 (Vessel operations).
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the risk of release of substances into the marine environment to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs	Bilge water and deck drainage discharges will not impact the conservation values of nearby AMPs.
	Ramsar wetlands	Bilge water and deck drainage discharges will not intersect any Ramsar wetlands.
	TECs	Bilge water and deck drainage discharges will not intersect any TECs.

	Nationally threatened and migratory species	Bilge water and deck drainage discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	KEFs	Bilge water and deck drainage discharges will not intersect any KEFs.
	NIWs	Bilge water and deck drainage discharges will not intersect any NIWs.
	State marine parks	Bilge water and deck drainage discharges will not intersect any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	None triggered by this hazard.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of Acceptability	EOG considers the impact from bilge water discharges and deck drainage to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual consequence rating is Level 2 (negligible); • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Bilge water discharges and deck drainage will not have long-term or significant impacts on MNES; • The management of bilge water discharges and deck drainage is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of bilge water discharges and deck drainage is not inconsistent with the aims of relevant marine reserve management plans; and • The management of bilge water discharges and deck drainage is not inconsistent with ESD principles.	
Environmental Monitoring		
• None required		
Record Keeping		
• PMS records. • IOPP certificate. • Oil Record Book. • Crew training records. • Inspection and checklist records.	• P&IDs. • SDS (for deck cleaning agents). • Incident reports. • SMPEP.	

7.11. RISK 1 – Accidental Discharge of Waste to the Ocean

7.11.1. Hazard

The handling and storage of materials and waste on board a vessel has the potential to result in accidental overboard disposal of hazardous and non-hazardous materials, waste, chemicals and fuel, creating marine debris and pollution.

Small quantities of hazardous and non-hazardous materials are used in routine operations and maintenance and waste is created, and then handled and stored on the vessels. In the normal course of operations, solid and liquid hazardous and non-hazardous materials and wastes will be stored until it is disposed of via port facilities for disposal at licensed onshore facilities. However, accidental releases to sea are a possibility, especially in rough ocean conditions 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 poor waste management (e.g., overfull bins), strong winds, high seas or crane operator error:

- 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 (defined as a substance or object that exhibits hazardous characteristics, is no longer fit for its intended use and requires disposal, and as outlined in Annex III to the Basel Convention, may be toxic, flammable, explosive and poisonous) 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 or could be lost as a result of hose connection failure, overfilling of tanks or emergency disconnection of hoses:

- 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.

7.11.2. Potential Environmental Risks

The risks of the release of hazardous and non-hazardous materials and waste to the ocean are:

- Marine pollution (littler and a temporary and localised reduction in water quality);
- Acute toxicity to marine fauna through ingestion or absorption;
- Injury and entanglement of individual animals (such as seabirds and seals); and
- Localised (and normally temporary) smothering or pollution of benthic habitats.

7.11.3. EMBA

The EMBA for the accidental disposal of hazardous and non-hazardous materials and waste is 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 susceptible to waste that may occur within this EMBA, either as residents or migrants, are:

- Benthic fauna;
- Benthic habitat;
- Pelagic fauna (fish, cetaceans and turtles); and
- Avifauna.

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 activity area or EMBA) are:

- The six turtle species (loggerhead, green, flatback, olive ridley, leatherback and hawksbill);
- Sawfish and river sharks;
- Seabirds (Australian noddy, osprey, shearwater); and
- Cetaceans (Australian snubfin dolphin, Australian humpback dolphin, PBW).

7.11.4. Evaluation of Environmental Risks

Non-hazardous Materials and Waste

If 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 (2015d) 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). Plastics have been implicated in the deaths of a number of marine species including marine mammals and turtles, due to ingestion.

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 benthic habitats in the activity area are broadly similar to those elsewhere in the region (e.g., extensive sandy seabed), so impacts to very localised areas of seabed will not result in the long-term loss of benthic habitat or species diversity or abundance. Seabed substrates can rapidly recover from temporary and localised impacts.

Hazardous Materials and Waste

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 the JBG, 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 activity 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 is likely to result in a small area of substrate becoming toxic and unsuitable for colonisation by benthic fauna. The benthic habitats of the activity area are broadly similar to those elsewhere in the region (e.g., extensive sandy seabed), 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 is disposed of at appropriately licensed facilities, by licenced contractors, so impacts such as illegal dumping or disposal to an unauthorised onshore landfill that is not lined are highly unlikely to result from the activity.

The conservation advice for the humpback whale (TSSC, 2015a) lists entanglement from marine debris as a threat to the species. Marine debris includes plastic garbage such as bags, bottles, ropes, derelict fishing gear and non-biodegradable floating materials list or disposed of at sea. There have been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion since 1998. The vast majority (92.2%) of cetacean incidents relate to entanglement (TSSC, 2015a), and humpback whales dominated the available records, with around 48 entanglement incidents recorded. An assessment of the entanglement management actions against the activity is provided in Table 7.26. Though the relevant management actions target the commercial fishing industry, the guiding principle of the management action has been applied to the activity.

Table 7.26. Assessment of the relevant management actions of the Approved Conservation Advice for the Humpback Whale (TSSC, 2015a)

Management Action	Assessment
Reducing commercial fishing entanglement	
Commonwealth and state governments with the pot and set net fishing industries to develop and implement codes of conduct to minimise interactions between commercial fishers and humpback whales.	The EPS listed in Table 7.30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a

Investigate alternative fishing techniques and technologies to reduce the risk of entanglement.	manner that is not inconsistent with these management actions.

The Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018) lists specific management actions and objectives. Given that the activity has the potential to contribute to marine debris, an assessment of the management actions and objectives has been provided in Table 7.27.

Table 7.27. Assessment of the objectives and management actions of the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018)

Objective and associated management actions	Assessment
1. *Contribute to long-term prevention of the incidence of marine debris*	
Establish a threat abatement plan (TAP) team to coordinate actions for the life of the TAP.	The activity will not have any impacts on this management action.
Limit the amount of single-use plastic material lost to the environment in Australia.	The EPS listed in Table 7.30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a manner that is not inconsistent with these management actions.
Encourage development of a circular economy in Australia.	The activity will not have any impacts on this management action.
Encourage innovation in recovery and waste treatment technologies.	The activity will not have any impacts on this management action.
Improve management of abandoned, lost and discarded fishing gear.	The activity will not have any impacts on this management action.
Improve shipping waste management.	The EPS listed in Table 7.30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a manner that is not inconsistent with these management actions.
2. *Understand the scale of impacts from marine plastic and microplastic on key species, ecological communities and locations*	
Update the list of marine debris impacted EPBC Act-listed vertebrate species as scientific evidence is published.	The activity will not have any impacts on this management action.
Monitor relevant ecological research to determine if further EPBC Act-listed ecological communities are threatened by marine debris.	The activity will not have any impacts on this management action.
Identify locations where aggregations of debris intersect with the temporal and spatial distribution of EPBC Act-listed species, especially during vulnerable life stages (e.g., whale and turtle migrations).	The activity will not have any impacts on this management action.
Build understanding related to plastic and microplastic pollution.	The activity will not have any impacts on this management action.

Objective and associated management actions	Assessment
Survey marine plastic pollution in the Southern Ocean, sub-Antarctic islands and other high value offshore island environments.	The activity will not have any impacts on this management action.
Determine the relevance of microplastics to the Australian Government's Science and Research Priorities and corresponding Practical Research Challenges.	The activity will not have any impacts on this management action.
3. *Remove existing marine debris*	
Support beach-based clean-up efforts.	The activity will not have any impacts on this management action.
Improve the effectiveness of Australian Government grants in relation to marine debris outcomes.	The activity will not have any impacts on this management action.
Remove derelict fishing gear from Australia's oceans and coasts.	The activity will not have any impacts on this management action.
Develop understanding of the potential for biological breakdown of plastic to prevent it entering the marine environment, or aid its removal.	The activity will not have any impacts on this management action.
4. *Monitor the quantities, origins, types and hazardous chemical contaminants of marine debris, and assess the effectiveness of management arrangements for reducing marine debris*	
Continue collection of data in long-term beach surveys.	The activity will not have any impacts on this management action.
Develop a nationally consistent monitoring system for land-based plastic pollution.	The activity will not have any impacts on this management action.
Maintain a national database for long-term marine debris beach survey data and promote standard methods for collecting and ongoing monitoring of beach clean-up debris.	The activity will not have any impacts on this management action.
Assess the effectiveness of Australia's product stewardship and waste management in reducing the levels of plastics entering the marine environment.	The activity will not have any impacts on this management action.
Continue to monitor persistent organic pollutant contamination using plastic resin pellets from Australian beaches.	The activity will not have any impacts on this management action.
Regularly assess mean surface plastic loads and associated hazardous chemical contaminants across Australian jurisdictions and territories.	The activity will not have any impacts on this management action.
Enhance collection of data related to ghost net retrievals from Commonwealth waters across northern Australia.	The activity will not have any impacts on this management action.

Objective and associated management actions	Assessment
Improve understanding of the impact and origins of ghost nets.	The activity will not have any impacts on this management action.
5. *Increase public understanding of the causes and impacts of harmful marine debris, including microplastic and hazardous chemical contaminants, to bring about behaviour change*.	
Raise the profile of marine debris impacts on marine vertebrate species, especially EPBC Act-listed threatened species.	The activity will not have any impacts on this management action.
Improve public communication about consumer waste and litter.	The activity will not have any impacts on this management action.

Marine debris is identified as a threat to turtles in the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c). As such, an assessment of relevant interim recovery objectives and targets with the activity is provided in Table 7.28.

Table 7.28. Assessment of the relevant interim recovery objectives and targets of the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c) with the activity

Interim Objective or Target	Assessment
Interim Objective 3: Anthropogenic threats are demonstrably minimised.	
Target 3.1: Robust and adaptive management regimes that lead to a reduction in anthropogenic threats to marine turtles and their habitats are in place	The EPS listed in Table 7.30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this recovery target.
Target 3.2: Threat mitigation strategies are supported by high quality information	The activity will not have any impacts on this recovery target.

Habitat degradation and modification (e.g., through the presence of marine debris following accidental discharge) are a listed threat in the Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015c). Threatened species addressed in this plan that are relevant to the activity include the largetooth sawfish, green sawfish, dwarf sawfish and the northern river shark. An assessment of the relevant objectives and management actions of the Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015c) with the activity is provided in Table 7.29.

Table 7.29. Assessment of the relevant recovery objectives and relevant actions of the Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015c) with the activity

Objective or management action	Assessment
Objective 5: Reduce and, where possible, eliminate adverse impacts of habitat degradation and modification on sawfish and river shark species	The EPS listed in Table 7.30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this objective.
Action 5a. Ensure all future developments will not significantly impact upon sawfish and river shark habitats critical to the survival of the species, or	The EPS listed in Table 7. 30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is

Objective or management action	Assessment
impede upon the migration of individual sawfish or river sharks.	conducted in a manner that is not inconsistent with this management action.
Action 5b. Determine the effect of river and estuarine barriers on the movements of sawfish and river sharks and undertake an audit of barriers to establish whether removal or modification is feasible to allow for the riverine migration of sawfish and river sharks.	The activity will not have any impacts on this management action.
Action 5c. Identify risks to important sawfish and river shark habitat and measures needed to reduce those risks.	The activity will not have any impacts on this management action.
Action 5d. Implement measures to reduce adverse impacts of habitat degradation and/or modification	The EPS listed in Table 7. 30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this management action.
Objective 6: Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life.	The EPS listed in Table 7. 30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this objective.
Action 6a. Assess the impacts of marine debris including ghost nets, fishing gear and plastics on sawfish and river shark species.	The activity will not have any impacts on this management action.
Action 6b. Partner with marine debris organisations to support initiatives that reduce marine debris likely to impact on sawfish and river sharks.	The activity will not have any impacts on this management action. The EPS listed in Table 7. 30 will reduce the likelihood of accidental discharge of wastes to the ocean to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this management action.

7.11.5. Risk Assessment

Table 7.30 presents the risk assessment for the accidental disposal of hazardous and non-hazardous materials and waste.

Table 7.30. Risk assessment for the unplanned discharge of solid or hazardous waste to the marine environment

Summary	
Summary of risk	Marine pollution (litter and a temporary and localised reduction in water quality), injury and entanglement of individual animals (such as seabirds, cetaceans, turtles and sawfish) and smothering or pollution of benthic habitats.
Extent of risks	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 risks	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.	
Risk decision framework context	Decision type	A - good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.
Defined acceptable level	No unplanned release of hazardous or non-hazardous solid waste or materials.	

Risk Assessment (inherent)		
Likelihood	Consequence	Risk rating
Occasional	Minor	Low

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Transfer wastes from the vessel to shore-based facilities during the activity.	Eliminate	No	**EB:** Reduces likelihood of accidental waste disposal through transfer to shore-based facilities, noting that there are risks of waste overboard during the transfer process. **C:** High costs for the use of a dedicated vessel to take waste, which also results in routine vessel impacts and risks. **Ev:** Cost to implement is grossly disproportionate to the benefit given the low inherent risk rating.
Vessel wastes are managed in accordance with the GMP **(RSK-01: EPS-01, -02, -03, -04).**	Engineering	Yes	**EB:** Reduces the likelihood of waste being discharged to sea, reducing potential impacts to marine fauna and water quality. **C:** Negligible; it is a standard MARPOL requirement. Minor administrative cost to produce documents and roll out to personnel. **Ev:** Benefits of ensuring responsible waste management outweighs the negligible cost.
Recover accidentally discharged wastes or lost equipment (if safe to do so) **(RSK-01: EPS-05)**	Administrative	Yes	**EB:** Removes debris from the environment, thereby reducing impacts to marine fauna and water quality. **C:** Potential down-time and equipment costs to retrieve materials. **Ev:** Environmental benefit of recovering marine debris outweighs the costs.
Chemical locker **(RSK-01: EPS-06).**	Administrative	Yes	**EB:** Separates hazardous substances in a designated area, making accidental discharge less likely.

			C: Negligible; it is a standard maritime requirement. Minor administrative cost to produce documents and roll out to personnel. **Ev:** Environmental benefit outweighs the negligible costs.
Dropped object prevention procedure **(RSK-01: EPS-07, -08, -09, -10, -11).**	Engineering	Yes	**EB:** Reduces the likelihood that materials will be accidentally lost overboard and impacts on marine fauna and water quality. **C:** Negligible; it is a standard maritime requirement. Minor administrative cost to produce documents and roll out to personnel. **Ev:** Environmental benefit outweighs the negligible costs.
Handling and storage procedures **(RSK-01: EPS-12, -13, -14, -15).**	Administrative	Yes	**EB:** Reduces the likelihood that materials will be accidentally lost overboard and impacts on marine fauna and water quality. **C:** Negligible; it is a standard maritime requirement. Minor administrative cost to produce documents and roll out to personnel. **Ev:** Environmental benefit outweighs the negligible costs.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
No unplanned release of hazardous or non-hazardous solid wastes or materials.	**(RSK-01: EPS-01)** A MARPOL Annex V-compliant GMP is in place for the vessel (if >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.
	(RSK-01: EPS-02) Waste is stored, handled and disposed of in accordance with the GMP. This includes measures including: • 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.	GMP is available and current. Inspections verify that waste is stored and handled according to its waste classification. Inspections 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 place for the management of onshore waste transport and disposal.

	• Correct segregation of solid and hazardous wastes.	
	(RSK-01: EPS-03) Vessel crews and visitors are inducted into waste management procedures to ensure they understand how to implement the GMP.	Induction and attendance records verify that all crew members are inducted.
	(RSK-01: EPS-04) Waste types and volumes are tracked and logged.	Waste tracker is available and current.
	(RSK-01: EPS-05) 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.
	(RSK-01: EPS-06) 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) so as to prevent discharge overboard.	Site inspection verifies that greases and chemicals are stored in a chemical locker.
Avoid objects being dropped overboard	**(RSK-01: EPS-07)** Large bulky items are securely fastened to or stored on the deck to prevent loss to sea.	A completed pre-departure inspection checklist verifies that bulky goods are securely sea-fastened.
	(RSK-01: EPS-08) The vessel PMS are implemented to ensure that lifting equipment remains in certification and fit for use at all times to minimise the risk of dropped objects.	PMS records verify that lifting equipment is maintained to schedule and in accordance with OEM requirements.
	(RSK-01: EPS-09) The 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.
	(RSK-01: EPS-10) 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.
	(RSK-01: EPS-11) 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 PMS.	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.
Chemicals and hydrocarbons are stored and transferred in a manner that	**(RSK-01: EPS-12)** 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

prevents bulk release.		lockers that drain to bilge tanks.
	(RSK-01: EPS-13) Vessel PMS is implemented to ensure the integrity of chemical and hydrocarbon storage areas and transfer systems are maintained in good order.	Vessel PMS records verify that chemical and hydrocarbon storage areas and transfer systems (e.g., bunds, tanks, pumps and hydraulic hoses) are maintained to schedule and in accordance with OEM requirements.
	(RSK-01: EPS-14) 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.
	(RSK-01: EPS-15) Crane transfers of bulk chemicals and hydrocarbons are undertaken in accordance with the vessel contractor lifting and loading procedure, or equivalent, and under a PTW.	PTW records verify that crane transfers of bulk chemicals and hydrocarbons are undertaken in accordance with the procedure.

Risk Assessment (residual)		
Likelihood	Consequence	Risk rating
Minor	Rare	Negligible

The risk of accidental discharge of waste to the ocean is assessed as negligible because:

- Volumes of waste generated on the vessel will be small due to the nature of the activity and its short duration; and
- Implementation of the control measures reduces the likelihood to accidental discharge of waste to the ocean to ALARP.

Demonstration of ALARP

A 'negligible' residual risk rating is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.

Demonstration of Acceptability		
Policy compliance	EOG's Safety and Environmental Policy objectives are met.	
EMS compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual risk is negligible, which is considered acceptable.	
Engagement	Relevant persons	No objections or claims have been raised by relevant persons regarding accidental discharge of wastes to the ocean.
	Stakeholders	During the EP public exhibition process, stakeholders did not express project-specific concerns regarding accidental discharge of wastes to the ocean.

Legislative context	The EPS align with the requirements of: • *Navigation Act* 2012 (Cth): ○ Chapter 4 (Prevention of Pollution). ○ Marine Orders Part 47. ○ Marine Orders Part 94 (Marine pollution prevention – packaged harmful substances). ○ Marine Orders Part 95 (Marine pollution prevention – garbage). • *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth): ○ Part III (Prevention of pollution by noxious substances). ○ Part IIIA (Prevention of pollution by packaged harmful substances). ○ Part IIIC (Prevention of pollution by garbage).	
Industry practice	The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this activity are in line with the management measures listed for hazardous waste and non-hazardous waste discharges in Sections 4.6.2 and 4.6.3 of the guidelines, which include: • Segregating hazardous and non-hazardous wastes prior to disposal **(RSK-01: EPS-01)**. • Managing hazardous waste in accordance with their SDS and tracking it to final destination. • Not deliberately discharging waste overboard.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	The EPS listed in this table meet these guidelines for offshore activities with regard to: • Risk management for handling and storage of chemicals (item 19). The BAT are met for the activity with regard to implementing chemical transfer procedures and ensuring chemicals are stored in separate, labelled containers.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the impacts of accidental waste discharge on marine life.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to:

		• Waste management (items 46). Materials should be segregated offshore and shipped to shore for reuse, recycling or disposal. A waste management plan should be developed and contain a mechanism allowing waste consignments to be tracked **(RSK-01: EPS-01)**. • Hazardous materials management (item 72). Principles relate to the selection of chemicals with the lowest environmental and health risks.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met with regard to: • Section 8.5 (Waste management): Measures for managing waste are addressed through the performance standards, mainly through the requirement for a GMP **(RSK-01: EPS-01)**. • Section 8.6 (Hazardous materials): Stipulations that fuel and oils are stored in appropriate areas are addressed in the performance standards **(RSK-01: EPS-12)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the risk of any unplanned release of material into the marine environment to ALARP and to an acceptable level **(All EPS for RSK-01)**.
	Waste management-specific	
	Guidelines for the Development of GMPs (IMO, 2012)	The vessels' GMPs are developed in accordance with these guidelines **(RSK-01: EPS-01)**.
	International Dangerous Goods Maritime Code (IMO, 2014)	The storage and handling of dangerous goods on the vessels is managed in accordance with this code.
Environmental context	MNES	
	AMPs	The unplanned discharge of solid or hazardous waste is highly unlikely to intersect nearby AMPs. The North Marine Parks Network Management Plan 2018 (DNP, 2018a) identifies marine debris as a threat to the AMP network. The EPS listed in this table aim to minimise the generation of marine debris and potential for accidental discharge and are aligned with the strategies outlined in the plan.
	Ramsar wetlands	The unplanned discharge of solid or hazardous waste is highly unlikely to reach Ramsar wetlands.

	TECs	The unplanned discharge of solid or hazardous waste is highly unlikely to reach any TECs.
	Nationally threatened and migratory species	The unplanned discharge of solid or hazardous waste is highly unlikely to have any impacts on threated or migratory species.
	Other matters	
	KEFs	The unplanned discharge of solid or hazardous waste will not affect any KEFs.
	NIWs	The unplanned discharge of solid or hazardous waste is highly unlikely to reach any NIWs.
	State marine parks	The unplanned discharge of solid or hazardous waste is highly unlikely to intersect any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	Assessments of the activity against the following species have been undertaken and presented earlier, and the control measures adopted ensure the activity will be conducted in a manner that is not inconsistent with each plan: • The conservation advice for humpback whales (TSSC, 2015a) - Table 7.26. • Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia's coasts and oceans (DoEE, 2018) - Table 7.27. • The Sawfish and River Shark Multispecies Recovery Plan (DoE, 2015c).
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the risk of accidental discharge of waste to the ocean to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual risk rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Accidentally discharged wastes will not have long-term or significant impacts on MNES; • The management of wastes is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of wastes is not inconsistent with the aims of relevant marine reserve management plans; and • The management of wastes is not inconsistent with ESD principles.	
Environmental Monitoring		

• Waste tracking.	
Record Keeping	
• Vessel contractor pre-qualification report/s. • GMP. • Garbage Record Book. • Crew induction and attendance records.	• Inspection records/checklists. • Shore-based waste contract. • Incident reports.

7.12. RISK 2– Vessel Collision or Entanglement with Megafauna

7.12.1. Hazard

The movement of the vessel throughout the activity area, together with the presence of towed/in-water equipment, has the potential to result in collision or entanglement with megafauna, this being cetaceans and turtles.

7.12.2. Potential Environmental Risks

The risks of vessel strike with megafauna are:

- Injury; and
- Death.

7.12.3. EMBA

The EMBA for vessel strike or entanglement with megafauna is the immediate area around the vessel and deployed equipment.

7.12.4. Evaluation of Environmental Risks

Cetaceans 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 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).

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, fin, bryde’s, pygmy, sperm, and pygmy sperm were identified as having interacted with vessels. The humpback whale exhibited the highest incidence of interaction. A number of these species may migrate through the waters of the activity area (see Section 5.3.5).
- Dolphins including the Australian humpback, common 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 activity area (see Section 5.3.5).
- 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 presence of turtles in the activity area and EMBA is considered likely.

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), though the data indicates this is more likely to be associated with container ships and fast ferries (WDCS, 2006). 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 (2015a) reports that there were two blue whale strandings in the Bonney Upwelling (western Victoria) 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 elicit 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 the vessel is operating within the activity area, it will be travelling very slowly or will be stationery, so the risk associated with fast moving vessels is eliminated for this activity.

The Conservation Management Plan for the Blue Whale (DoE, 2015a) lists entanglement as a threat to the species. Entanglement has the potential to cause physical injury that can result in loss of reproductive fitness, and mortality of individuals from drowning, impaired foraging and associated starvation, or infection or physical trauma (DoE, 2015a). These wounds can then expose the animal to infection and entanglement can also result in amputation (e.g., of a flipper or tail fluke), and death over a prolonged period. An assessment of the relevant management actions listed in this Conservation Management Plan against the activity is provided in Table 7.29. Though the specific management action targets commercial fisheries, the intent of the management actions has been applied to the activity.

The Conservation Management Plan for the Blue Whale (DoE, 2015a) lists vessel disturbance in the form of collisions to be a threat that may inhibit the recovery of the species. Entanglement (in the context of fishing nets, lines or ropes) has the potential to cause physical injury that can result in loss of reproductive fitness, and mortality of individuals from drowning, impaired foraging and associated starvation, or infection or physical trauma. There is an almost negligible risk of this occurring to megafauna with towed equipment as the equipment is likely to break under the weight of entanglement. An assessment of the relevant management actions listed in the Conservation Management Plan against the activity is provided in Table 7.31.

Table 7.31. Assessment of relevant management actions of the Conservation Management Plan for the Blue Whale (DoE, 2015a) with the activity

Management Action	Assessment
Relevant Interim Recovery Objectives	
4. Anthropogenic threats are demonstrably minimised.	Vessel disturbance in the form of collision is a threat to blue whales. The EPS listed in Table 7.37 will reduce the likelihood of vessel strike with blue whales to ALARP. Therefore, the activity will be managed in a manner that is not inconsistent with this interim recovery objective.
Relevant Interim Recovery Objective Targets	
Target 4.1: robust and adaptive management regimes leading to a reduction in anthropogenic threats to Australian blue whales are in place.	The EPS listed in Table 7.37 represent a robust and adaptive management regime for the activity with regard to blue whales. This results in a significant reduction in anthropogenic threats generated by the activity on blue whales. Therefore, the activity will be managed in a manner that is not inconsistent with this interim objective target.
Target 4.2: management decisions are supported by high quality information	The information presented throughout this section and the subsequent EIA presented in Table 7.37 is based on high

Management Action	Assessment
and high priority research projects identified in this plan are achieved or underway.	quality information, scientific literature and research projects. This in turn has informed the management decisions relevant to the activity. Therefore, the activity will be managed in a manner that is not inconsistent with this interim objective target.
Relevant Action Areas	
A.4. Minimising vessel collisions	The control measures adopted and associated EPS listed in Table 7.37 will reduce the likelihood of vessel strike with blue whales to ALARP. With control measures implemented, the activity will be managed in a manner that is not inconsistent with this management action.
Relevant Actions	
2. Ensure all vessel strike incidents are reported in the National Ship Strike Database.	Reporting of vessel strike incidents has been adopted for this activity and an appropriate EPS developed in Table 7.37. Therefore, the activity will be consistent with this action.
3. Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented.	This section of the EP provides an assessment of vessel strike risk and EPS have been adopted for the activity in Table 7.37. Therefore, the activity will be consistent with this action.

The Approved Conservation Advice for the Sei Whale (TSSC, 2015b) lists vessel strike as a threat with a minor consequence rating. An assessment of the listed management actions with the activity is provided in Table 7.30.

Table 7.32. Assessment of relevant management actions of the Approved Conservation Advice for the Sei Whale (TSSC, 2015b) with the activity

Management Action	Assessment
Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	Reporting of vessel strike incidents has been adopted as a control measure for this activity and an appropriate EPS developed in Table 7.37. Therefore, the activity will be consistent with this action.

The Approved Conservation Advice for the Fin Whale (TSSC, 2015c) lists vessel strike as a threat with a minor consequence rating. An assessment of the listed management actions with the activity is provided in Table 7.33.

Table 7.33. Assessment of relevant management actions of the Approved Conservation Advice for the Fin Whale (TSSC, 2015c) with the activity

Management Action	Assessment
Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	Reporting of vessel strike incidents has been adopted as a control measure for this activity and an appropriate EPS developed in Table 7.37. Therefore, the activity will be consistent with this action.

The Approved Conservation Advice for the Humpback Whale (TSSC, 2015a) lists vessel strike as a threat to the species. An assessment of the listed management actions with the activity is provided in Table 7.34.

Table 7.34. Assessment of relevant management actions of the Approved Conservation Advice for the Humpback Whale (TSSC, 2015a) with the activity

Management Action	Assessment
Maximise the likelihood that all vessel strike incidents are reported in the National Ship Strike Database. All cetaceans are protected in Commonwealth waters and, the EPBC Act requires that all collisions with whales in Commonwealth waters are reported. Vessel collisions can be submitted to the National Ship Strike Database at https://data.marinemammals.gov.au/report/shipstrike	Reporting of vessel strike incidents has been adopted for this activity as a control measure and an appropriate EPS developed in Table 7.37. Therefore, the activity will be consistent with this action.
Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike.	This section of the EP provides an assessment of vessel strike risk and EPS have been adopted for the activity in Table 7.37. Therefore, the activity will be consistent with this action.

Table 7.35 provides an assessment of the objectives and relevant management actions of the National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna (DoEE, 2017a) with the activity.

Table 7.35. Assessment of the objectives and relevant management actions of the National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna (DoEE, 2017a) with the activity

Relevant Objectives and Management Actions	Assessment
Relevant objectives	
Reduce the likelihood and severity of megafauna vessel collision.	The adopted EPS listed in Table 7.37 are aligned with best-practice mitigation measures, which will reduce the likelihood of vessel strike with megafauna to ALARP. Therefore, the activity will be consistent with this objective.
Identify and adopt best-practice mitigation measures and emerging technologies, and encourage the development of new mitigation measures.	
Management actions	
Develop a mitigation measures toolkit that provides guidance to stakeholders and managers on what measures are most suited to specific locations, species and vessel types.	The adopted EPS listed in Table 7.37 will reduce the likelihood of vessel strike with cetaceans to ALARP. Therefore, the activity will be consistent with these actions.
Develop and implement vessel strike management plans which identify appropriate mitigation measures in locations where the relative risk of vessel strike is higher, as determined by a risk assessment.	
Adaptive management principles, including the use of regular reviews are used during the implementation of mitigation measures.	

The Recovery Plan for Marine Turtles in Australia lists entanglement in marine debris as a threat that can lead to restricted mobility, starvation, infection, amputation and drowning (DoEE, 2017c). Table 7.36 presents an assessment of the relevant objectives and targets of the Recovery Plan for Marine Turtles in Australia with the activity.

Table 7.36. Assessment of the relevant interim recovery objectives and targets of the Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017c) with the activity

Interim Objective or Target	Assessment
Interim Objective 3: Anthropogenic threats are demonstrably minimised.	
Target 3.1: Robust and adaptive management regimes that lead to a reduction in anthropogenic threats to marine turtles and their habitats are in place	The EPS listed in Table 7.37 will reduce the likelihood of vessel strike with cetaceans to ALARP and ensure the activity is conducted in a manner that is not inconsistent with this recovery target.
Target 3.2: Threat mitigation strategies are supported by high quality information	The activity will not have any impacts on this recovery target.

7.12.5. Risk Assessment

Table 7.37 presents the risk assessment for vessel collision or entanglement with megafauna.

Table 7.37. Risk assessment for vessel collision or entanglement with megafauna

Summary		
Summary of risks	Injury or death of megafauna.	
Extent of risks	Localised – limited to individuals coming into contact with the vessel or towed/in-water equipment.	
Duration of risks	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.	
Risk decision framework context	Decision type	A - good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.
Defined acceptable level	No collision or entanglement with megafauna.	
Risk Assessment (inherent)		
Likelihood	Consequence	Risk rating
Occasional	Minor	Low
Assessment of Proposed Control Measures		

Control measure	Control type	Adopt	Justification
Eliminate the use of vessels and towed/in-water equipment.	Eliminate	No	**EB:** Eliminates the potential collision hazard. **C:** The activity could not proceed. **Ev:** The use of vessels and towed/in-water equipment is the only way in which the activity can proceed. The cost of not using it is the cost of not fulfilling exploration obligations associated with the exploration permit and potential future lost hydrocarbon production.
No night-time/low visibility operations.	Eliminate	No	**EB:** Reduces the likelihood of collision or entanglement with megafauna. **C:** Doubles the length of time required to complete the activity and subsequent costs, resulting in increased impacts and risks in other areas such as more routine discharges, greater collision risk due to additional time spent on-water, etc). **Ev:** Cost outweighs the environmental benefit given the low residual risk to marine megafauna populations.
Australian National Guidelines for Whale and Dolphin Watching (2017) **(RSK-02: EPS-01).**	Administrative	Yes	**EB:** Observation for megafauna reduces likelihood for potential collision or entanglement through directing the Vessel Master to slow down or move away to avoid megafauna. **C:** No additional cost for vessel crew to implement this control measure. **Ev:** Environmental benefits outweigh the costs.
Environmental induction **(RSK-02: EPS-02).**	Administrative	Yes	**EB:** Ensures personnel are aware of obligations, which in turn reduces the risk of interactions with megafauna. **C:** Negligible; it is a standard on-water requirement. Minor administrative cost to prepare induction and roll out to crew. **E:** Environmental benefit outweighs cost.
Implement procedure for interacting with marine fauna (EPBC Regulations Part 8) **(RSK-02: EPS-03).**	Administrative	Yes	**EB:** Reduce the likelihood of impacts to cetaceans. **C:** No additional costs to the activity. **Ev:** Environmental benefits outweigh the cost to implement.
Notification and reporting of collisions with megafauna **(RSK-02: EPS-04, -05).**	Administrative	Yes	**EB:** Reduces risk of physical impacts to cetaceans from the activity vessels. **C:** No additional costs. **Ev:** Environmental benefit can be achieved without costs.
Environmental Controls and Performance Measurement			

EPO	EPS	Measurement criteria
No collision or entanglement with megafauna.	**(RSK-02: EPS-01)** Through constant bridge watch, vessels comply with the *Australian National Guidelines for Whale and Dolphin Watching for Vessels* (DoEE, 2017) when working within the activity area. This means: • 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 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.	Daily operations reports note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision or entanglement.
	(RSK-03: EPS-02) Vessel crew has completed an environmental induction covering the above-listed requirements for vessel and megafauna interactions.	Induction and attendance records verify that all crews have completed an environmental induction.
	(RSK-02: EPS-03) Vessel crew undertake observation for megafauna during daylight hours and record all interactions.	Daily operations reports note megafauna interactions.
Vessel strike or entanglement is reported to regulatory authorities.	**(RSK-02: EPS-04)** 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.
		Incident report is available within the OMS.
	(RSK-02: EPS-05) Entanglement of megafauna is reported to the Wildcare Helpline on (08) 9474 9055 (for cetaceans travelling towards WA) or the Marine Wild Watch Hotline on 1800 453 941 (for cetaceans travelling towards the NT) as soon as possible. No attempts to disentangle megafauna should be made by vessel crew.	Incident report verifies contact was made with the Wildcare Helpline or Marine Wild Watch Hotline.

Risk Assessment (residual)		
Likelihood	Consequence	Risk rating
Rare	Minor	Negligible

The risk of vessel strike or entanglement with megafauna is assessed as negligible because:

- The activity is temporary in nature;
- The activity is not a known aggregation area or key migration route for megafauna; and

<table>
<tr><td colspan="3">

- Implementation of the EPS will reduce the likelihood of vessel collision or entanglement with megafauna to ALARP.

</td></tr>
<tr><th colspan="3">Demonstration of ALARP</th></tr>
<tr><td colspan="3">A ‘negligible’ residual risk rating is considered to be ALARP and a ‘lower order’ impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.</td></tr>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td>Policy compliance</td><td colspan="2">EOG’s Safety and Environmental Policy objectives are met.</td></tr>
<tr><td>EMS compliance</td><td colspan="2">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="2">The residual risk is negligible, which is considered acceptable.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td>No objections or claims have been raised by relevant persons regarding vessel strike or entanglement with megafauna.</td></tr>
<tr><td>Stakeholders</td><td>During the EP public exhibition process, stakeholders did not express project-specific concerns regarding vessel strike or entanglement with megafauna.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS align with the requirements of:
• EPBC Act 1999 (Cth):
  ○ Section 199 (failing to notify taking of listed species or listed ecological community).
• EPBC Regulations 2000 (Cth):
  ○ Part 8 (Interacting with cetaceans and whale watching).
  ○ AMSA Marine Notice 2016/15 – Minimising the risk of collisions with cetaceans.</td></tr>
<tr><td rowspan="4">Industry practice</td><td colspan="2">The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity are in line with the management measures listed for collision with marine fauna in Section 4.7.5 of the guidelines:
• Monitoring for the presence and movement of large cetaceans and pinnipeds so that avoidance can be taken when marine fauna is observed to be on a collision course with vessels (RSK-02: EPS-03).</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>There are no guidelines for offshore activities with regard to minimising the risk of collisions with megafauna.</td></tr>
<tr><td>Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)</td><td>Not applicable. The guidelines do not discuss the impacts of vessel strike or entanglement on marine life.</td></tr>
</table>

	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.4) have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met with regard to: • Section 8.7 (Aquatic life): Reporting incidents involving aquatic life to the appropriate authorities **(RSK-02: EPS-04, -05)**.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There are no guidelines regarding minimising the risk of vessel strike or entanglement with megafauna.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the risks to the abundance, diversity, geographical spread and productivity of marine species to ALARP and to an acceptable level (all RSK-02 EPS).
	Megafauna collision-specific	
	The Australian Guidelines for Whale and Dolphin Watching (DoEE, 2017b)	The EPS listed in this table are aligned with the requirements of these guidelines.
	National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE, 2017a).	The EPS listed in this table are aligned with objective 3 of this strategy, which is to reduce the likelihood and severity of megafauna vessel collisions.
Environmental context	MNES	
	AMPs	The risk of collisions with megafauna does not have any effect on nearby AMPs.
	Ramsar wetlands	The risk of collisions with megafauna does not have any effect on Ramsar wetlands.
	TECs	The risk of collisions with megafauna does not have any effect on TECs.
	Nationally threatened and migratory species	The low speed of the vessel, along with the temporary nature of the activity, makes it unlikely that vessel strike or entanglement with megafauna will occur. Table 7.31 to Table 7.36 provide an assessment of the relevant management actions of the: • Conservation Management Plan for the Blue Whale (DoE, 2015a);

		• Approved Conservation Advice for the Sei Whale (TSSC, 2015b); • Approved Conservation Advice for the Fin Whale (TSSC, 2015c); • Conservation advice for the humpback whale (TSSC, 2015a); • Recovery Plan for Marine Turtles in Australia, DoEE, 2017c); and • National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna (DoEE, 2017a). The EPS adopted for the activity will reduce the likelihood of vessel collision or entanglement to ALARP, thereby enabling the activity to be conducted in a manner that is not inconsistent with these plans.
	Other matters	
	KEFs	The risk of collisions with megafauna does not have any effect on KEFs.
	NIWs	The risk of collisions with megafauna does not have any effect on NIWs.
	State marine parks	The risk of collisions with megafauna does not have any effect on state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	Vessel collisions (and/or entanglements) are listed as a threat to cetaceans in the: • Conservation Management Plan for the Blue Whale (DoE, 2015a); • Conservation advice for the sei whale (TSSC, 2015b); • Conservation advice for the fin whale (TSSC, 2015c); and • Conservation advice for the humpback whale (TSSC, 2015a). The EPS listed in this table aim to minimise the risk of vessel strike and entanglement with megafauna. Table 7.31 to Table 7.36 provide an assessment of the activity against the management actions relevant to vessel strike and demonstrate that the activity will be managed in a manner such that it is not inconsistent with the relevant management actions of these plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Defined acceptable level	EOG considers the risks of collision and entanglement with megafauna to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual risk rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved.	

	• Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Accidentally discharged wastes will not have long-term or significant impacts on MNES; • The management of wastes is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of wastes is not inconsistent with the aims of relevant marine reserve management plans; and • The management of wastes is not inconsistent with ESD principles.
Environmental Monitoring	
• MMO and vessel crew sightings.	
Record Keeping	
• Vessel crew induction presentation and attendance records. • Megafauna sighting records. • Incident reports.	

7.13. RISK 3 – Introduction and Establishment of Invasive Marine Species

7.13.1. Hazard

The DAWR (2018) defines marine pests (referred to in this EP 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 activity area:

- Discharge of vessel ballast water containing foreign species; and
- Translocation of foreign species through biofouling on vessel hulls, niches (e.g., thruster tunnels, sea chests) or in-water equipment (e.g., sub-bottom profilers, shallow seismic array, etc).

The vessel 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.

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).

The DAWR estimates that ballast water is responsible for 30% of all marine pest incursions into Australian waters (DAWR, 2018). The DAWR 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 (2018) notes that the movement of vessels and marine infrastructure is the primary pathway for the introduction of IMS.

7.13.2. 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;
- Depletion of commercial fish stocks (and associated socio-economic effects); and
- Changes to conservation values of protected areas.

7.13.3. EMBA

The EMBA for IMS introduction is anywhere within the activity area (wherever vessel movements occur), though if IMS survive the introduction and go on to colonise and spread, this EMBA could extend to large parts of the ocean.

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 fish.

7.13.4. Evaluation of Environmental Risks

Successful IMS invasion requires the following three steps:

1. Colonisation and establishment of the marine pest on a vector (e.g., vessel hull) in a donor region (e.g., home port).
2. Survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g., activity 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 (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.

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 (which is similar to the immersible geophysical and geotechnical equipment associated with this activity) means that they do not typically pose a threat for biofouling accumulation and translocation, though biofouling can be present in streamer joints and the gaps of collar joints.

The Interactive Map for Marine Pests in Australia (DAFF, 2021) does not identify any known pests within the Port of Darwin. Given that this is the largest port of the region a likely staging ground for the activity, the likelihood of marine pest introduction from this port is low.

The National Strategic Plan for Marine Pest Biosecurity (2018-2023) (DAWR, 2018) has five objectives and associated management activities. An assessment of the objectives and management activities of the National Strategic Plan for Marine Pest Biosecurity (2018-2023) is provided in Table 7.38.

Table 7.38. Assessment of the objectives and management activities of the National Strategic Plan for Marine Pest Biosecurity (2018-2023)

Objectives and Activities	Assessment
Objective 1: Minimise the risk of marine pest introductions, establishment and spread	The adopted EPS listed in Table 7.39 are aligned with best-practice mitigation measures, which will reduce the likelihood of introduction of IMS to ALARP. Therefore, the activity will be consistent with this objective.
1.1. Implement nationally consistent domestic ballast water regulations under the Biosecurity Act 2015 (Cwlth).	The adopted EPS listed in Table 7.39 are aligned with best-practice mitigation measures, which will reduce the likelihood of introduction of IMS to ALARP. Therefore, the activity will be consistent with these management activities.
1.2. Ensure the use of ballast water management systems in Australian waters meets accepted environmental standards.	
1.3. Investigate regulatory options to manage biosecurity risks associated with biofouling on vessels.	The activity will not have any impact on this management activity.
1.4. Review the National Biofouling Management Guidelines for marine sectors and update as required.	The activity will not have any impact on this management activity.
1.5. Investigate the benefits of an intelligence-gathering framework to monitor marine pest risk pathways and expand the International Biosecurity Intelligence System as appropriate.	The activity will not have any impact on this management activity.
Objective 2: Strengthen the national marine pest surveillance system	The activity will not have any impact on this objective.
2.1. Develop a national marine pest surveillance strategy.	The activity will not have any impact on this management activity.
2.2. Investigate Australia's current passive surveillance capability for marine pests and recommend possible improvements.	The activity will not have any impact on this management activity.
2.3. Promote tailored education and awareness materials to engage marine pest observer groups in passive surveillance activities.	The activity will not have any impact on this management activity.

Objectives and Activities	Assessment
2.4. Develop validation guidelines for marine pest molecular detection methods.	The activity will not have any impact on this management activity.
2.5. Validate molecular detection methods (including sampling methodology) for selected high-priority marine pest species.	The activity will not have any impact on this management activity.
2.6. Audit, maintain and share a database of marine pest identification capability.	The activity will not have any impact on this management activity.
2.7. Review surveillance information management needs and ensure an appropriate information system is in place.	The activity will not have any impact on this management activity.
2.8. Perform an audit of marine pest surveillance activities and data sets relevant to Australia.	The activity will not have any impact on this management activity.
Objective 3: Enhance Australia's preparedness and response capability for marine pest introductions	The activity will not have any impact on this objective.
3.1. Plan and implement a national program of marine pest emergency response exercises.	The activity will not have any impact on this management activity.
3.2. Develop a benefit–cost analysis framework to guide response efforts in the event of a nationally significant marine pest incursion.	The activity will not have any impact on this management activity.
3.3. Identify marine pest emergency response training needs.	The activity will not have any impact on this management activity.
3.4. Review the national Emergency Marine Pest Plan (EMP Plan) framework.	The activity will not have any impact on this management activity.
3.5. Plan and implement procedures to develop and update the EMP Plan rapid response manuals and related guidance materials.	The activity will not have any impact on this management activity.
Objective 4: Support marine pest biosecurity research and development	The activity will not have any impact on this objective.
4.1. Periodically review the national marine pest biosecurity research and development priorities.	The activity will not have any impact on this management activity.
4.2. Promote research coordination through the national marine pest research network.	The activity will not have any impact on this management activity.
4.3. Review the economic, environmental and social impacts of marine pests in Australia.	The activity will not have any impact on this management activity.
4.4. Conduct risk analyses of marine pest vectors and pathways, and make	The activity will not have any impact on this management activity.

Objectives and Activities	Assessment
recommendations for improved management.	
4.5. Assess the effectiveness of current management options for biofouling in niche areas.	The activity will not have any impact on this management activity.
Objective 5: Engage stakeholders to better manage marine pest biosecurity	The activity will not have any impact on this objective.
5.1. Identify and build a profile of marine pest biosecurity stakeholders.	The activity will not have any impact on this management activity.
5.2 Develop a national stakeholder engagement strategy for MarinePestPlan 2018–2023 and the Marine Pest Sectoral Committee.	The activity will not have any impact on this management activity.
5.3. Design a targeted national campaign to improve awareness of marine pest biosecurity risks, management actions and shared responsibilities.	The activity will not have any impact on this management activity.
5.4. Review, update and maintain the www.marinepests.gov.au website.	The activity will not have any impact on this management activity.
5.5. Establish an independent national marine pest network.	The activity will not have any impact on this management activity.

7.13.5. Risk Assessment

Table 7.39 presents the risk assessment for the introduction of IMS.

Table 7.39. Risk assessment for the introduction of IMS

Summary		
Summary of risks	Reduction in native marine species diversity and abundance, displacement of native marine species, socioeconomic 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.	
Risk decision framework context	Decision type	A - good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.

	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.
Defined acceptable level	No introduction of IMS.	

Risk Assessment (inherent)		
Likelihood	Consequence	Risk rating
Rare	Minor	Negligible

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Use only a locally sourced vessel for the geophysical investigations.	Elimination	Likely	**EB:** Eliminates the potential for introduction of IMS from foreign waters. **C:** The geophysical activities do not require a large purpose-built vessel, so there is a greater likelihood of contracting a smaller, locally or regionally-based vessel. There is no cost to the project in adopting this approach. **Ev:** There are significant schedule and capability implications for the activity by restricting the choice of vessel. On balance, this control The cost to implement is disproportionate to the risk if other controls are adopted.
Use only a locally sourced vessel for the geotechnical investigations.	Elimination	No	**EB:** Eliminates the potential for introduction of IMS from foreign waters. **C:** Significant limitation on the activity. There are no specialist geotechnical vessels based in Australia, so vessels must be sourced opportunistically if they are in-country when required, or else internationally (e.g., southeast Asia). Where possible, a vessel can be contracted once it has completed another activity in Australian waters, thereby minimising IMS risks. However, this cannot be guaranteed. **Ev:** There are significant implications for the activity by restricting the choice of vessel. The cost to implement is disproportionate to the risk if other controls are adopted.
International Anti-fouling System (IAFS) Certificate **(RSK-03: EPS-02).**	Engineering	Yes	**EB:** Ensures that the activity vessels have an anti-fouling coating and associated certificate to reduce the likelihood of transfer of IMS from the hull to the activity area. **C:** Significant cost to vessel contractor to have the vessel inspected and anti-fouling paint applied (generally every 5 years). Cost is passed on to EOG via vessel day rate. **Ev:** Environmental benefit outweighs the cost.

Biofouling Management Plan and Biofouling Record Book **(RSK-03: EPS-01, -03).**	Administrative	Yes	**EB:** Provides for operational guidance to vessels for planning and actions required to manage vessel biofouling, in addition to outlining measures for the control and management of vessel biofouling in accordance with IMO Guidelines. Thereby reducing the likelihood of IMS transfer and establishment in the activity area. **C:** Small cost involved with personnel undertaking inspections and audits. **Ev:** Environmental benefit outweighs the cost.
IMS risk assessment **(RSK-03: EPS-04).**	Administrative	Yes	**EB:** Reduces the likelihood of introducing IMS. **C:** Small cost involved with EOG's consultants and contractors undertaking this desktop assessment. **Ev:** Environmental benefit outweighs the cost.
Cleaning of immersible equipment **(RSK-03: EPS-05).**	Administrative	Yes	**EB:** Reduces the likelihood of introducing IMS. **C:** Small cost involved in cleaning and verification during inspection. **Ev:** Environmental benefit outweighs cost.
Ballast water management plan. **(RSK-03: EPS-06, -07).**	Administrative	Yes	**EB:** Reduces likelihood of introducing IMS. **C:** Small costs associated with preparing and implementing the ballast water management plan and with maintaining record books and logs. **Ev:** Environmental benefit outweighs cost.
Incident reporting **(RSK-04: EPS-08).**	Administrative	Yes	**EB:** Alerts authorities to the known or potential introduction of IMS, thereby allowing authorities to deal with (or remove) the threat early so as to minimise environmental impacts. **C:** No cost. **Ev:** Environmental benefit outweighs the cost.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Biofouling		
No introduction of IMS through hull fouling.	**(RSK-03: EPS-01)** Vessels are managed in accordance with the *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry* (AQIS, 2009) and the to ensure they present a low biofouling risk. This means: • Biofouling risk is assessed. • Conducting in-water inspection by divers or inspection in drydock if deemed necessary (based on risk assessment). • Cleaning of hull and internal seawater systems, 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 to enter the activity area.
	(RSK-03: EPS-02) Vessels >400 gross tonnes carry a current IAFS Certificate that is	IAFS Certificate is available and current.

	complaint with Marine Order Part 98 (Anti-fouling Systems).	
	(RSK-03: EPS-03) Vessels are managed in accordance with the *Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species* (IMO, 2011), which involves ensuring that vessels: • Maintain a Biofouling Management Plan; • Maintain a Biofouling Record Book; • Install and maintain an anti-fouling system; • Undertake in-water inspections (and in-water hull cleaning, if appropriate); and • Instruct crews on the application of biofouling management procedures.	Vessel contractor Biofouling Management Plan and Biofouling Record Book are available and current.
	(RSK-03: EPS-04) An IMS risk assessment is undertaken based on the following: • Inspecting the IAFS certificate to ensure currency. • Reviewing recent vessel inspection/audit reports to ensure that the risk of IMS introduction is low. • Reviewing 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 (DoA/DoE, 2015). • Implementing the biofouling guidance provided in Part 5 of the Offshore Installation Biosecurity Guideline (DAWR, 2019, v1.3).	IMS risk assessment document verifies that the biofouling risk evaluation took place and that the IMS risk is 'low.'
Immersible equipment does not introduce IMS to the activity area.	**(RSK-03: EPS-05)** Immersible equipment is cleaned (e.g., biofouling is removed from in-water geophysical equipment) prior to initial use in the activity area.	Records are available to verify that immersible equipment was cleaned prior to use.
Ballast water		
No introduction of IMS through ballast water.	**(RSK-03: EPS-06)** Vessels fulfil the requirements of the *Australian Ballast Water Management Requirements* (DAWR, 2020, v8). This includes requirements to: • Carry a valid Ballast Water Management Plan (BWMP). • Submit a Ballast Water Report (BWR) through the Maritime Arrivals Reporting System (MARS).	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.

	◦ If intending to discharge internationally-sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival. ◦ If intending to discharge Australian-sourced ballast water, seek a low-risk exemption through MARS. • Hold a Ballast Water Management Certificate (BWMC). • Ensure all ballast water exchange operations are recorded in a Ballast Water Record System (BWRS).	An electronic Pre-Arrival Report (ePAR) is available and signed off by DAWR.
	(RSK-03: EPS-07) As above, except a BWR is not required for domestic journeys (i.e., when moving between Australian ports and 200 nm of the coastline). *Note: ballast water management is not required between Australian ports if:* • *Ballast water is taken up and discharged in the same place.* • *Potable water is used as ballast.* • *Ballast water was taken up on the high seas only.* • *The vessel receives a risk-based exemption from ballast water management.*	As above, except for the BWR.
Reporting		
Known or suspected non-compliance with biosecurity measures are reported to regulatory agencies.	**(RSK-03: EPS-08)** Non-compliant discharges of domestic ballast water are to be reported to the DAWR immediately (contact details in Section 8.7.2).	Incident report notes that contact was made with the DAWR regarding non-compliant ballast water discharges.

Risk Assessment (residual)		
Likelihood	Consequence	Risk rating
Remote	Minor	Negligible

The risk of the introduction and establishment of IMS is assessed as negligible because:

- The control measures adopted are effective in reducing the risk to ALARP.

Demonstration of ALARP
A 'negligible' residual risk rating is considered to be ALARP and a 'lower order' impact. The adopted EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.

Demonstration of Acceptability	
Policy compliance	EOG's Safety and Environmental Policy objectives are met.
OEMS compliance	Chapter 8 outlines the EP implementation strategy to be employed for this activity.
Risk matrix standard compliance	The residual risk is negligible, which is considered acceptable.

<table>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td colspan="2">No objections or claims have been raised by relevant persons regarding the introduction and establishment of IMS.</td></tr>
<tr><td>Stakeholders</td><td colspan="2">During the EP public exhibition process, stakeholders did not express project-specific concerns regarding the introduction and establishment of IMS.</td></tr>
<tr><td>Legislative context</td><td colspan="3">The EPS align with the requirements of:
Biosecurity Act 2015 (Cth):
Chapter 4 (Managing biosecurity risk).
Chapter 5, Part 3 (Management of discharge of ballast water).
Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 (Cth):
Part 2 (Application or use of harmful anti-fouling systems).
Part 3 (Anti-fouling certificates and anti-fouling declarations).
Marine Order 98 (Marine pollution – anti-fouling systems).</td></tr>
<tr><td rowspan="6">Industry practice</td><td colspan="3">The consideration and alignment of EPS to the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.</td></tr>
<tr><td colspan="2">Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity are in line with the management measures listed for the introduction of IMS in Section 4.7.6 of the guidelines:
Complying with the International Convention on the Control of Harmful Anti-fouling Systems on Ships (RSK-03: EPS-02).
Ensuring vessels of appropriate class have IAFS certificates (RSK-03: EPS-02).
Ensuring compliance with local regulatory guidelines.</td></tr>
<tr><td colspan="2">Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>There are no guidelines for offshore activities with regard to minimising the risk of introducing IMS.</td></tr>
<tr><td colspan="2">Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)</td><td>Not applicable. The guidelines do not discuss the impacts of sound generation on marine life.</td></tr>
<tr><td colspan="2">Effective planning for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)</td><td>The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.</td></tr>
<tr><td colspan="2">Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)</td><td>There are no guidelines regarding preventing the introduction of IMS.</td></tr>
</table>

	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	There is no guidance regarding preventing the introduction of IMS.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the risk of introduction of marine pests to ALARP and to an acceptable level (All RSK-03 EPS). • To reduce the impacts to benthic communities to ALARP and to an acceptable level.
	IMS-specific	
	Australian Ballast Water Management Requirements (DAWR, 2020, v8)	The EPS in this table reflect the guidance regarding ballast water management in the DAWR guide.
	Anti-Fouling and In-Water Cleaning Guidelines (DoA/DoE, 2015).	The EPS in this table reflect the general guidance regarding managing fouling in the DoA/DoE guidelines, which have since been updated in the aforementioned DAWR (2020) quarantine guide.
	Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species (IMO, 2011)	The EPS in this table reflect the guidance regarding minimising the transfer of IMS from biofouling.
	National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (DAFF, 2009)	The EPS in this table reflect the guidance regarding biofouling management in the DAFF guide.
Environmental context	MNES	
	AMPs	The North Marine Parks Network Management Plan 2018 (DNP, 2018) identifies invasive species introduction via ballast water in shipping, fishing vessels and other vessels as a potential biosecurity pressure to the AMP network. The implementation of the EPS make it unlikely that IMS will be introduced to the activity area and spread to nearby AMPs.
	Ramsar wetlands	The risk of introducing IMS is highly unlikely to affect Ramsar wetlands.
	TECs	The risk of introducing IMS is highly unlikely to affect TECs.
	Nationally threatened and migratory species	The threatened and migratory species within the EMBA are all highly mobile species. There are no EPBC Act-listed benthic species listed as occurring in the activity area; these are generally more

		susceptible to the effects of IMS than mobile fauna.
	Other matters	
	KEFs	The risk of introducing IMS is highly unlikely to affect KEFs.
	NIWs	The risk of introducing IMS is highly unlikely to affect NIWs.
	State marine parks	This hazard does not intersect any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	The National Strategic Plan for Marine Pest Biosecurity (2018-2023) (DAWR, 2018) has five objectives. The EPS listed in this table are aligned with the plan's objective to minimise the risk of marine pest introductions, establishment and spread (noting that the other four objectives do not apply to the activity).
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
	Is there a threat of serious or irreversible environmental damage?	Possibly, but the EPS aim to avoid this.
	Is there scientific uncertainty as to the environmental damage?	Yes. Individual species fill different ecological niches and understanding how one or more species are likely to behave outside their native habitat is generally unknown until it occurs.
Statement of acceptability	EOG considers the risks of introducing IMS to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual risk rating is negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • The management of IMS is not inconsistent with the aims of the National Strategic Plan for Marine Pest Biosecurity; and • The management of IMS is not inconsistent with ESD principles.	

Environmental Monitoring

- None required.

Record Keeping

- Vessel contractor pre-qualification reports.
- Biofouling risk assessment.
- Ballast water risk assessments.
- BWMP.
- BWR.
- BWMC.
- BWRS.
- IAFS Certificates.
- DAWR-signed ePARs.

7.14. RISK 4 – Interference with Other Marine Users

7.14.1. Hazard

The presence of the activity vessels may result in unplanned interference with other marine users and equipment, such as commercial fishing gear and merchant shipping.

7.14.2. Known and Potential Environmental Impacts

The known and potential impacts of interference with other marine users are:

- Collision potential with third-party vessels (and damage in the case of collision); and
- Damage to or loss of fishing equipment and/or loss of commercial fish catches.

7.14.3. EMBA

The EMBA for interference with other marine users is anywhere within the activity area (wherever vessel movements occur), and more specifically the immediate around the two intersecting vessels or equipment.

Receptors in the EMBA include:

- Recreational vessels;
- Commercial fishing vessels; and
- Merchant vessels.

7.14.4. Evaluation of Environmental Impacts

Collision with other marine users

Interference from the vessel undertaking the activity with other marine users is unlikely, mostly because of the low shipping traffic in and around the activity area (see Section 7.3.4 and Section 5.6.6), consultation undertaken prior to the activity with relevant persons, implementation of a safety zone around the vessel, the slow-moving nature of the vessel and its high visibility.

In the event of interference with other marine users that results in a 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, an MDO spill may eventuate (the environmental consequences of which are addressed in Section 7.16).

Damage to or loss of fishing equipment

Interference from the vessel undertaking the activity with commercial fishing vessels is unlikely, for the same reasons stated above.

As such, it is unlikely that fishing gear (e.g., trawl nets used in the NPF, marker buoys and ropes for demersal fishing gear) would be damaged. In the event that third-party vessels breach the safety zone around by the vessel, there is potential for fishing gear to become entangled in the towed geophysical equipment or deployed geotechnical equipment, resulting in damage or loss. In addition to the cost of repairing or replacing this equipment, it could also result in the loss of income from caught fish during that fishing expedition.

7.14.5. Risk Assessment

Table 7.40 presents the impact assessment for interference with other marine users.

Table 7.40. Risk assessment for interference with other marine users

<table>
<tr><th colspan="4">Summary</th></tr>
<tr><td>Summary of risks</td><td colspan="3">Presence of vessel (and associated equipment) potentially resulting in vessel-to-vessel collision, damage to or loss of fishing equipment and loss of commercial fish catches.</td></tr>
<tr><td>Extent of risks</td><td colspan="3">Highly localised (immediately around vessels).</td></tr>
<tr><td>Duration of risks</td><td colspan="3">Short-term (minutes for a third-party vessel detour) to long-term (vessel collision).</td></tr>
<tr><td>Level of certainty of risks</td><td colspan="3">HIGH – the impacts associated with interference with other marine users is well understood.</td></tr>
<tr><td rowspan="4">Risk decision framework context</td><td>Decision type</td><td colspan="2">A - good industry practice required.</td></tr>
<tr><td>Activity</td><td colspan="2">Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.</td></tr>
<tr><td>Risk & uncertainty</td><td colspan="2">Risks are well understood, uncertainty is minimal.</td></tr>
<tr><td>Stakeholder influence</td><td colspan="2">No conflict with company values, no partner interest, no significant media interest.</td></tr>
<tr><td>Defined acceptable level</td><td colspan="3">No interference with other marine users.</td></tr>
<tr><th colspan="4">Impact Consequence (inherent)</th></tr>
<tr><td>Likelihood</td><td>Consequence</td><td colspan="2">Risk rating</td></tr>
<tr><td>Occasional</td><td>Minor</td><td colspan="2">Low</td></tr>
<tr><th colspan="4">Assessment of Proposed Control Measures</th></tr>
<tr><td>Control measure</td><td>Control type</td><td>Adopt</td><td>Justification</td></tr>
<tr><td>Exclusion (Safety) zone
(RSK-04: EPS-01).</td><td>Engineering</td><td>Yes</td><td>**EB:** Prevents damage to the vessel's towed/in-water equipment and the other party's equipment.
C: Minimal cost to prepare and issue notices to marine users.
Ev: Benefits to safety for all parties outweighs the minimal costs.</td></tr>
<tr><td>Navigation equipment and procedures
(RSK-04: EPS-02, -05, -06, -10).</td><td>Engineering</td><td>Yes</td><td>**EB:** Reduces the risk of collisions with other marine users.
C: While the costs of navigation equipment are significant, it is standard on vessels and the costs of maintaining it are minimal. It is a requirement of maritime law.
Ev: The safety benefits of having navigation equipment and procedures outweighs the cost.</td></tr>
<tr><td>Constant bridge watch
(RSK-04: EPS-03).</td><td>Administrative</td><td>Yes</td><td>**EB:** Reduces the risk of collisions with other marine users or their equipment (e.g., marker buoys).</td></tr>
</table>

			C: No additional cost. **Ev:** Environmental benefits can be achieved with no additional cost.
Crew qualifications **(RSK-04: EPS-04).**	Administrative	Yes	**EB:** Reduces the risk of vessel collision by ensuring crew possess appropriate qualifications to operate the vessel. **C:** Negligible; it is a standard maritime requirement that crew possess such qualifications. **Ev:** Environmental benefits can be achieved with negligible additional cost.
Stakeholder notifications **(RSK-04: EPS-07, -11).**	Administrative	Yes	**EB:** Ensures other marine users are aware of the activity and thus reduces likelihood of collision and interference. **C:** Minimal costs associated with EOG personnel preparing and issuing notifications and responding to stakeholders. **Ev:** Benefits outweigh the minimal cost.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
The EPS listed in 'displacement of other marine users' (see Section 7.3) also apply to this risk. Additional controls are provided here.		
No incidents or complaints of spatial conflict with third-party vessels or fishing equipment.	**(RSK-04: EPS-01)** An exclusion zone around the vessel and towed equipment is established for the duration of the activity and communicated to other marine users.	NTM is issued prior to the activity and includes details of the safety exclusion zone.
	(RSK-04: EPS-02) The vessel is 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 Automatic Identification System [AIS]) is functional and in use.
	(RSK-04: EPS-03) Visual and radar watch is maintained on the bridge of the vessel at all times.	
	(RSK-04: EPS-04) The Vessel Master and deck officers have a valid SCTW certificate 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.
	(RSK-04: EPS-05) The Vessel Master issues warnings (e.g., radio warning, flares, lights/horns) to third-party vessels approaching the safety exclusion zone in	Radio operations communications log verifies that warnings to third-party vessels approaching the

	order to prevent a collision with the vessel and deployed equipment.	safety exclusion zone have been issued when necessary.
	(RSK-04: EPS-06) The vessel will display the appropriate lights and day shapes for a vessel with restricted ability to manoeuvre during activity operations.	Visual confirmation (and associated completed checklists) verifies that these measures are in place during activity start.
	(RSK-04: EPS-7) EOG notifies relevant persons ahead of the activity so that third-party marine users are aware of vessel location and timing.	Stakeholder correspondence verifies that EOG contacted relevant persons about the timing and location of the activity.
	(RSK-04: EPS-8) All incidents of spatial conflict with other marine users will be reported in the EOG incident register.	The incident register is current.
	(RSK-04: EPS-9) Fishing is prohibited from activity vessels.	Induction and attendance records verify that all crew members are aware of the commitment.
Vessel-to-vessel collisions are managed in accordance with vessel-specific emergency procedures.	**(RSK-04: EPS-10)** 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.
	(RSK-04: EPS-11) Vessel collisions will be reported to 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 were notified of a vessel collision.

Impact Consequence (residual)

Likelihood	Consequence	Risk rating
Rare	Minor	Negligible

The risk of interference with other marine users is assessed as negligible because:

- The activity will be temporary in nature;
- There is low shipping activity in and around the activity area;
- Thorough consultation has been undertaken with relevant persons to understand the risks and avoid potential interference; and
- The control measures adopted significantly reduce the likelihood of an incident of interference.

Demonstration of ALARP

A ‘low’ residual risk rating is considered to be ALARP and a ‘lower order’ risk. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.

Demonstration of Acceptability

Policy compliance	EOG’s Safety and Environmental Policy objectives are met through implementation of this EP.

<table>
<tr><td>EMS compliance</td><td colspan="2">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="2">The residual risk is negligible, which is considered acceptable.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td>No objections or claims have been raised by relevant persons regarding interference with other marine users. As part of the consultation process (see Section 4.8), and in response to WAFIC's expectation of zero recreational fishing from any vessel, there will be no fishing permitted from vessels (RSK-04: EPS-09).</td></tr>
<tr><td>Stakeholders</td><td>During the EP public exhibition process, stakeholders did not express project-specific concerns regarding interference with other marine users.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS outlined in this table align with the requirements of:
• OPGGS Act 2006 (Cth).
o Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation or fishing (among others).
• Navigation Act 2012 (Cth).
o Chapter 6 (Safety of navigation), particularly Part 3 (Prevention of collisions).
o AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures).
o AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment).
o AMSA Marine Order Part 30 (Prevention of Collisions).</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="2">The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this hazard are in line with the management measures listed for offshore physical presence in Section 4.3.1 of the guidelines, which include:
• Develop exclusion zones in consultation with key stakeholders, including local fishing communities; raise awareness of exclusion zones with all stakeholders (RSK-04: EPS-01).
• Issue a 'Notice to Mariners' through the relevant government agencies, detailing the area of operations (RSK-04: EPS-01).
• Ensure all vessels adhere to International Regulations for Preventing Collisions at Sea (COLREGS), which set out the navigation rules to be followed to prevent collisions between two or more vessels.
• Optimise vessel use to ensure the number of vessels required and length of time that vessels are on site is as low as practicable.</td></tr>
</table>

	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines specifically regarding physical presence for offshore activities.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	Not applicable. The guidelines do not discuss the risk of interference with other marine users.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There are no guidelines specifically regarding physical presence for activity vessels.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013).	Guidelines met with regard to: • Section 8.4 (Travel – water travel): Maintain a lookout for, and establish communications with local fishing boats, tourist diving vessels, etc, where possible to minimise interruption with their operations and equipment **(RSK-04: EPS-03)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the impact on other marine resource users to ALARP and to an acceptable level. • To reduce risks to public safety to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs	This hazard will not affect nearby AMPs.
	Ramsar wetlands	This hazard will not affect any Ramsar wetlands.
	TECs	This hazard will not affect any TECs.
	Nationally threatened and migratory species	This hazard will not have any impacts on threatened or migratory species.
	Other matters	
	KEFs	This hazard will not affect any KEFs.
	NIWs	This hazard will not affect any NIWs.
	State marine parks	This hazard will not affect any state marine parks.

	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	None triggered by this hazard.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the risk of interference with other marine users to be acceptable because: • It will adhere to the company's Safety & Environment Policy; • The residual consequence rating negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; and • Relevant legislation and industry best practice will be complied with.	
Environmental Monitoring		
• Continuous bridge monitoring.		
Record Keeping		
• Stakeholder communication records. • NTM. • Crew qualifications.	• Radio communication logs. • Incident reports. • Induction presentation and attendance sheets.	

7.15. RISK 5 - Damage to Subsea Infrastructure

7.15.1. Hazard

Eni's Blacktip gas pipeline is located 1.4 km northeast of the activity area (see Section 5.6.5 and Figure 5.53). There is no other known subsea infrastructure in the activity area (such as oil and gas wells and communications cables). The vessel and/or towed equipment may contact and damage the pipeline if:

- Freeboard (clearance between the pipeline and the vessel hull or towed equipment) is insufficient or drags across the pipeline;
- The geotechnical equipment is deployed over the pipeline; or
- Pulses or peak particle velocities created by the geophysical activity are greater than the tolerances of the pipeline.

7.15.2. Potential Environmental Risks

The risks of damage to the Blacktip gas pipeline are:

- Loss of pipeline integrity (due to pipeline movement or reduction in wall thickness), which would be unlikely to lead to a loss of hydrocarbons.
- Disruption to commercial petroleum production activities (i.e., temporary suspension of production from any of the Blacktip wells).

7.15.3. EMBA

The EMBA for damage to the Blacktip pipeline is the pipeline itself. Receptors most at risk within this EMBA are:

- The pipeline infrastructure; and
- The contracted vessels.

7.15.4. Evaluation of Environmental Risks

The G&G activities will not take place over the Blacktip pipeline.

As such, the only way that borehole sampling, coring or grab sampling equipment could be deployed directly over the pipeline is due to a failure of the vessel positioning system. This is unlikely given the various redundancies in place to mitigate for such failures.

In the highly unlikely event that geotechnical equipment is deployed directly over the pipeline because all redundancies fail, there is a high likelihood that the pipeline would be damaged. If the damage is:

- Minor (i.e., does not rupture the pipeline, such as damage only to the concrete coating) – there is no environmental impact, but there would be financial impacts to Eni involved in repairing the pipeline (with costs being higher if it involves temporarily ceasing production in order to conduct those repairs). Damage to pipeline coating may hasten the corrosion of the steel pipeline.
- Major (i.e., involves pipeline rupture) – there is environmental impact associated with a gas and condensate release (this has not been modelled because it is not considered a credible scenario). The financial costs associated with pipeline rectification works and lost production from the Blacktip field would likely be several million dollars.

7.15.5. Risk Assessment

Table 7.41 presents the impact assessment for damage to third-party subsea infrastructure.

Table 7.41. Risk assessment for damage to subsea infrastructure

Summary		
Summary of risks	Loss of Blacktip gas pipeline integrity and lost field production.	
Extent of risks	Highly localised – immediately around the pipeline.	
Duration of risks	Long-term if damage requiring repair does occur (suspension of production from gas field while the pipeline is repaired).	
Level of certainty of risks	HIGH – the impacts associated with interference with other marine users is well understood.	
Risk decision framework context	Decision type	A - good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.
Defined acceptable level	No damage to the Blacktip gas pipeline.	
Impact Consequence (inherent)		

Likelihood	Consequence	Risk rating
Rare	Moderate	Low

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Consultation with Eni prior to the activity **(RSK-05: EPS-01)**	Administrative	Yes	**EB:** Reduces the likelihood of incident between the two operations. **C:** No cost to hold and discuss operations. **Ev:** Environmental benefits outweigh the minor cost to implement.
No G&G activity over the pipeline **(RSK-05: EPS-02)**	Engineering	Yes	**EB:** Avoids the likelihood of damage to the pipeline. **C:** No cost to the activity given that future drilling could not occur in close proximity to the pipeline. **Ev:** Environmental benefits outweigh the minor cost to implement.
Pipeline coordinates **(RSK-05: EPS-03)**	Administrative	Yes	**EB:** Accurately mapping the location of the gas pipeline significantly reduces the likelihood of damage to it from geotechnical investigations. **C:** No additional cost to locate the exact pipeline location during the geophysical component of the site investigations. **Ev:** Environmental benefits outweigh the cost to implement.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
No damage to the Blacktip gas pipeline.	**(RSK-05: EPS-01)** EOG will consult with Eni Australia to understand the implications of operating near the pipeline.	Consultation records verify discussions between EOG and Eni.
	(RSK-05: EPS-02) There will be no G&G activities over the gas pipeline.	Daily reports confirm the location of G&G activities as not occurring over the pipeline.
	(RSK-05: EPS-03) EOG will ensure that the vessel contractor/s has the coordinates of the Blacktip gas pipeline marked in its navigation system to ensure that no G&G activities are conducted within 500-m of the pipeline.	Navigation display verifies that the correct pipeline coordinates are loaded into the GPS.

Impact Consequence (residual)		
Likelihood	Consequence	Risk rating
Remote	Minor	Negligible

The risk of damage to the Blacktip gas pipeline is assessed as low because:

- The location of the pipeline is currently known, and is not located within the PDSA area;

<table>
<tr><td colspan="3">• Consultation has been undertaken with Eni to incorporate their concerns into the design of the activity; and
• The control measures adopted significantly reduce the likelihood of an incident of interference.</td></tr>
<tr><th colspan="3">Demonstration of ALARP</th></tr>
<tr><td colspan="3">A ‘low’ residual risk rating is considered to be ALARP and a ‘lower order’ risk. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.</td></tr>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td>Policy compliance</td><td colspan="2">EOG’s Safety and Environmental Policy objectives are met.</td></tr>
<tr><td>EMS compliance</td><td colspan="2">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="2">The residual risk is low, which is considered acceptable.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td>No objections or claims have been raised by relevant persons regarding damage to the Blacktip gas pipeline. EOG’s consultation with Eni has led to the refinement of the PDSA area such that it does not overlap the pipeline.</td></tr>
<tr><td>Stakeholders</td><td>During the EP public exhibition process, stakeholders did not express project-specific concerns regarding damage to the Blacktip gas pipeline.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS outlined in this table align with the requirements of:
• OPGGS Act 2006 (Cth).
  ○ Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation or fishing (among others).
• Navigation Act 2012 (Cth).
  ○ Chapter 6 (Safety of navigation), particularly Part 3 (Prevention of collisions).
  ○ AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures).
  ○ AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment).
  ○ AMSA Marine Order Part 30 (Prevention of Collisions).</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="2">The consideration and alignment of EPS with the mitigation measures outlined in the below-listed guidelines and codes of practice demonstrates that BPEM will be implemented for this activity</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this hazard are in line with the management measures listed for offshore physical presence in Section 4.3.1 of the guidelines, which include:
• Develop exclusion zones in consultation with key stakeholders, including local fishing communities; raise awareness of exclusion zones with all stakeholders.</td></tr>
</table>

		• Optimise vessel use to ensure the number of vessels required and length of time that vessels are on site is as low as practicable.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines specifically regarding third-party subsea infrastructure.
	Guidelines for the conduct of offshore drilling hazard site surveys (IOGP, 2017)	The EPS listed in this table have been designed with consideration of the seabed impact and risks listed in Appendix A of the Guideline.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the activity design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There are no guidelines specifically regarding third-party subsea infrastructure.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013).	Guidelines met with regard to: • Section 8.4 (Travel – water travel): Maintain a lookout for, and establish communications with local fishing boats, tourist diving vessels, etc, where possible to minimise interruption with their operations and equipment.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the impact on other marine resource users to ALARP and to an acceptable level. • To reduce risks to public safety to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs	This hazard will not affect nearby AMPs.
	Ramsar wetlands	This hazard will not affect any Ramsar wetlands.
	TECs	This hazard will not affect any TECs.
	Nationally threatened and migratory species	This hazard will not have any impacts on threatened or migratory species.
	Other matters	
	KEFs	This hazard will not affect nearby KEFs.
	NIWs	This hazard will not affect any NIWs.

	State marine parks	This hazard will not affect any state marine parks.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	None triggered by this hazard.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the risk of interference with other marine users to be acceptable because: • It will adhere to the company's Safety & Environment Policy; • The residual risk rating is low; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; and • Relevant legislation and industry best practice will be complied with.	
Environmental Monitoring		
• Continuous bridge monitoring.		
Record Keeping		
• Stakeholder consultation records. • SIMOPs records	• Operations reports. • Pipeline coordinates	

7.16. RISK 6 - Marine Diesel Oil Release

7.16.1. Hazard

A release of MDO may occur from the vessel. An MDO release may occur as a result of:

- A vessel-to-vessel collision.

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 waters of the activity area are deep and bathymetry mapping indicates there are no sub-surface features (such as reefs or shoals) that present a risk of vessel grounding, so this risk has been discounted for this risk assessment.

MDO properties

The following points summarise the nature and behaviour of MDO, based on NOAA (2012) and 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 IOPC Fund definition (i.e., greater than 5% boiling above 370°C) (Table 7.42).

- 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 25–50% 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, it is common for the residues of MDO spills after weathering to contain n-alkanes, iso-alkanes and naphthenic hydrocarbons.
- Minor quantities of PAHs will be present.
- When spilled on water, MDO spreads very quickly to a thin film and generally has a low viscosity 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 MDO 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 crude 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

To understand the risks posed by an MDO spill, EOG commissioned RPS to undertake OSTM using the scenario of a surface release of 160 m^3 of MDO within the activity area over a duration of 6 hours (RPS, 2021) for each of the three distinct seasons in the region:

- Summer (October to February);
- Transitional (March and September); and
- Winter (April to August).

The modelling was undertaken using the MDO properties outlined in Table 7.42 to Table 7.43. Table 7.44 outlines the key OSTM inputs for the MDO spill scenario.

Table 7.42. Boiling points for MDO

	Volatiles	Semi-volatiles	Low Volatiles	Residual Oil
Boiling Point (°C)	< 180	180-160	160-380	> 380
MDO (%)	6.0	34.6	54.4	5.0
Persistence	Non-persistent			Persistent

Table 7.43. Physical characteristics of MDO

Characteristic	Details
Density (kg/m^3)	829.1 at 25°C
API	37.6
Dynamic viscosity (cP)	4.0 at 25°C
Pour point (°C)	-14
Oil property category	Group II
Oil persistence classification	Light persistent oil

Table 7.44. Summary of the MDO spill OSTM inputs

Parameter	Details
Oil Type	MDO
Total spill volume	160 m^3
Release type	Sea surface
Release duration	6 hours
Release rate	26.66 m^3/hr
Simulation duration	28 days
Number of simulations	100 per season (300 in total)
Surface oil concentration thresholds (g/m^2)	1 g/m^2 – low exposure 10 g/m^2 – moderate exposure 50 g/m^2 – high exposure
Shoreline load threshold (g/m^2)	10 g/m^2 – low exposure 100 g/m^2 – moderate exposure 1,000 g/m^2 – high exposure
Dissolved aromatic dosages to assess potential exposure (ppb)	10 ppb – low exposure 50 ppb – moderate exposure 400 ppb – high exposure
Entrained oil dosages to assess potential exposure (ppb)	10 ppb – low exposure 100 ppb – high exposure

Exposure Values

The outputs of the OSTM are used to assess the environmental risk if a credible hydrocarbon spill scenario occurred, by defining which areas of the marine environment could be exposed to hydrocarbon concentrations that exceed exposure values that may result in impact to sensitive receptors. The degree of impact will depend on the sensitivity of the biota contacted, the duration of the exposure and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon.

The OSTM considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks:

- Surface hydrocarbons;
- Entrained hydrocarbons;
- Dissolved hydrocarbons; and
- Shoreline accumulated hydrocarbons.

The modelling used defined hydrocarbon exposure values, as relevant for risk assessment and oil spill planning, for the various hydrocarbon phases. To ensure conservatism in the environmental assessment process, the exposure values applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Exposure values applied for surface, entrained, dissolved and shoreline accumulated hydrocarbons used in the modelling study are summarised in Table 7.44. The adopted exposure values are based primarily on the exposure values defined in NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019).

Spill Location

For this assessment, 100 random spill locations were selected within the activity area (Figure 7.11). Note that the modelling was undertaken when the PDSA extended slightly further north (encompassing another 100 km^2) than the current design.

Spill Volume

AMSA's Technical Guidelines for preparing Contingency Plans for Marine and Coastal Facilities (AMSA, 2015) indicates that an appropriate spill size for a vessel collision (a non-oil tanker) should be based on the volume of the largest tank. EOG has used this guidance in determining the volume to be modelled for this study.

Given that the vessel for this activity has yet to be contracted, the exact volume of MDO cannot be provided. So, a search of vessel specifications for key vessel operators supporting the oil and gas industry was undertaken. This reveals:

- G&G vessels – based on fuel tank plans for vessels that recently undertook G&G activities in Bass Strait, the largest fuel tank in the *Fugro Mariner* geotechnical vessel is 118 m^3.
- Drilling support vessels – based on fuel tank plans for the drilling support vessels used in a drilling campaign offshore Victoria and the North West Shelf, the largest fuel tanks in the MMA *Vision*, MMA *Coral*, MMA *Leeuwin* and MMA *Vision* are 70 m^3, 87 m^3 and 159 m^3, respectively.

As such, a spill volume of 160 m^3 was selected as the most representative of the largest vessel fuel tank.

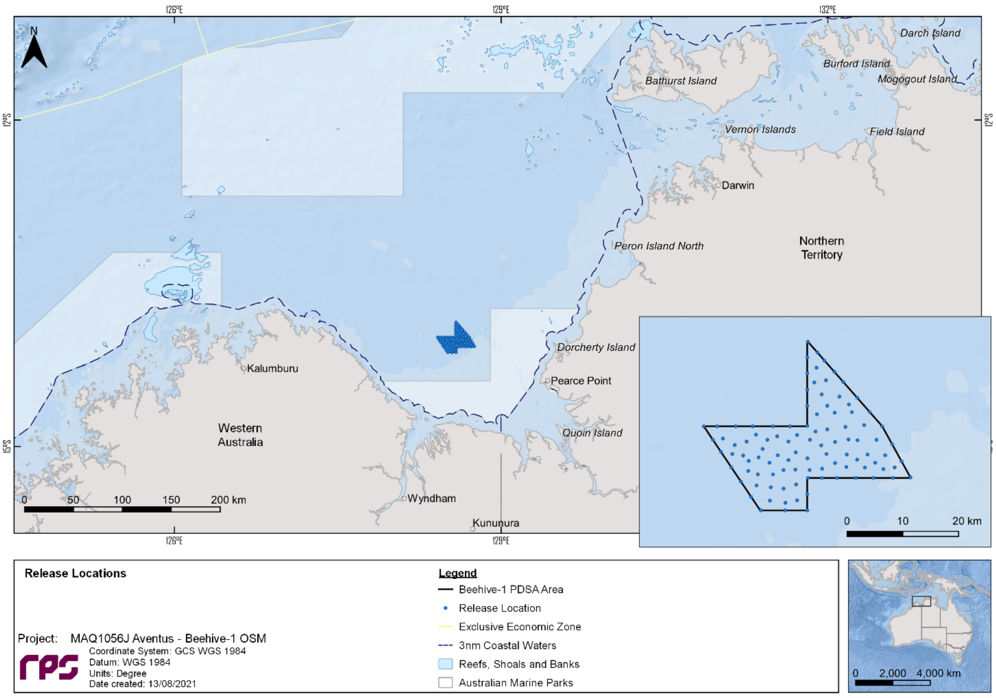


Figure 7.11. Randomly selected spill locations within the activity area used in the OSTM

Sea Surface Results

A summary of the sea surface OSTM results for the MDO spill scenario is presented in Table 7.45. Figure 7.12 to Figure 7.14 present the zones of potential floating oil exposure under summer, transitional and winter conditions, respectively. The sea surface OSTM results indicate that low exposure contact may be made with Joseph JBG AMP and the carbonate bank and terrace system of the Sahul Shelf KEF during summer conditions.

Figure 7.15 presents the spill simulation with the largest extent of sea surface hydrocarbons, illustrating the largest swept area.

Weathering results for this MDO spill scenario are illustrated in Figure 7.16, indicating that under constant wind speed, 40.9% of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate. Evaporation of the residual compounds will slow significantly, followed by a more gradual decay via biological and photochemical processes.

Table 7.46 presents the probability of exposure from sea surface hydrocarbons under the MDO spill scenario for all seasonal conditions.

Table 7.45. Summary of the sea surface results for the MDO spill scenario

Distance and direction	Zones of potential sea surface exposure		
	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (>50 g/m^2)
Summer			

Maximum distance from centre of activity area	42.2 km	27.6 km	20.7 km
Direction	East-southeast	East-southeast	North
Transitional period			
Maximum distance from centre of activity area	35.4 km	26.7 km	18.9 km
Direction	East-southeast	East-southeast	North
Winter			
Maximum distance from centre of activity area	38.1 km	24.2 km	18.8 km
Direction	North-northeast	West-northwest	North

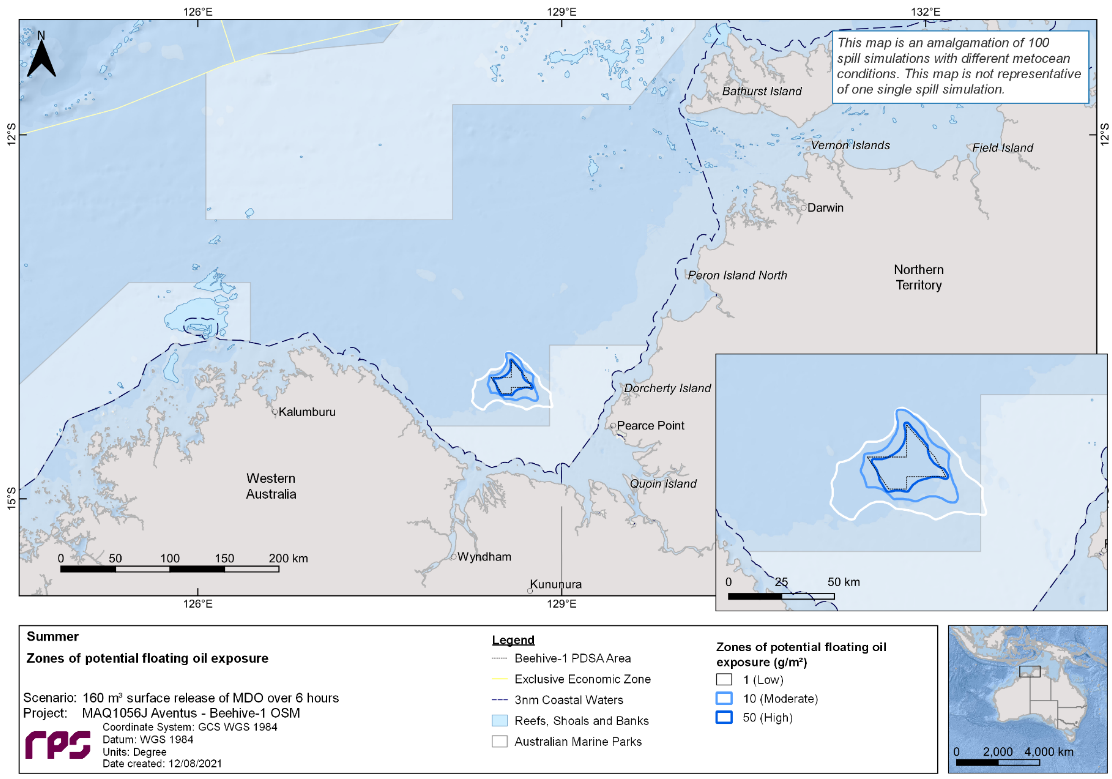


Figure 7.12. Zones of potential floating oil exposure, in the event of a 160 m³ of MDO over 6 hours, tracked for 28 days during summer conditions

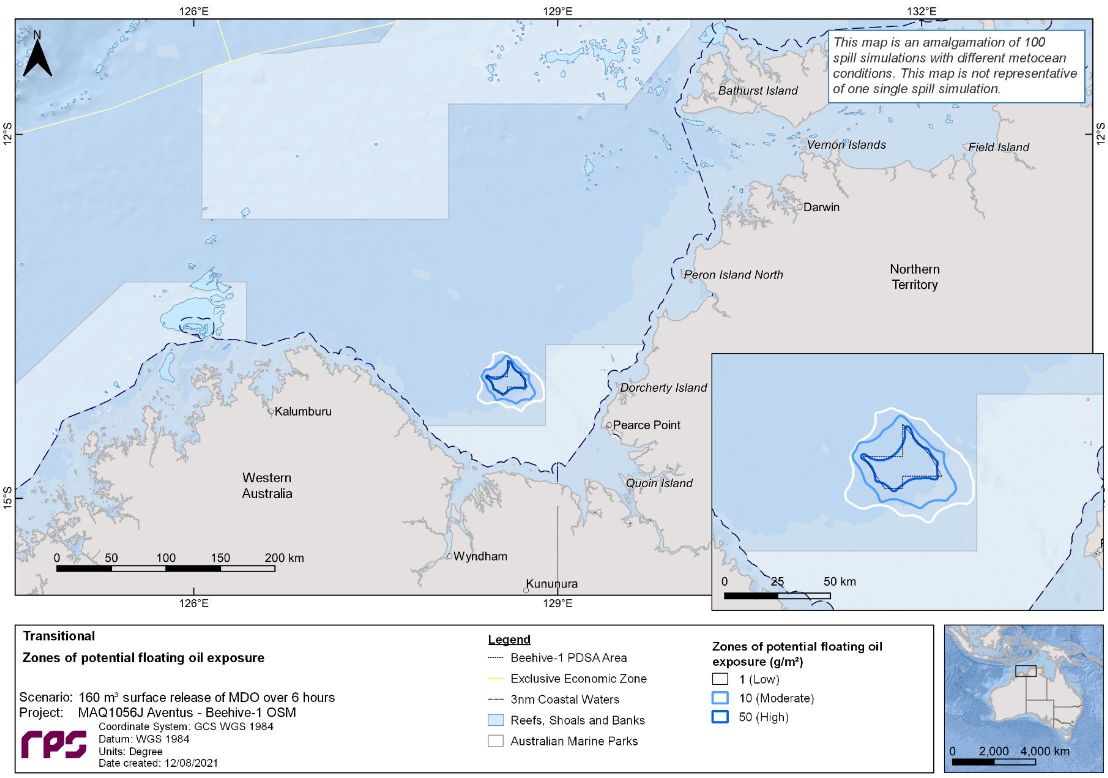


Figure 7.13. Zones of potential floating oil exposure, in the event of a 160 m^3 of MDO over 6 hours, tracked for 28 days during transitional conditions

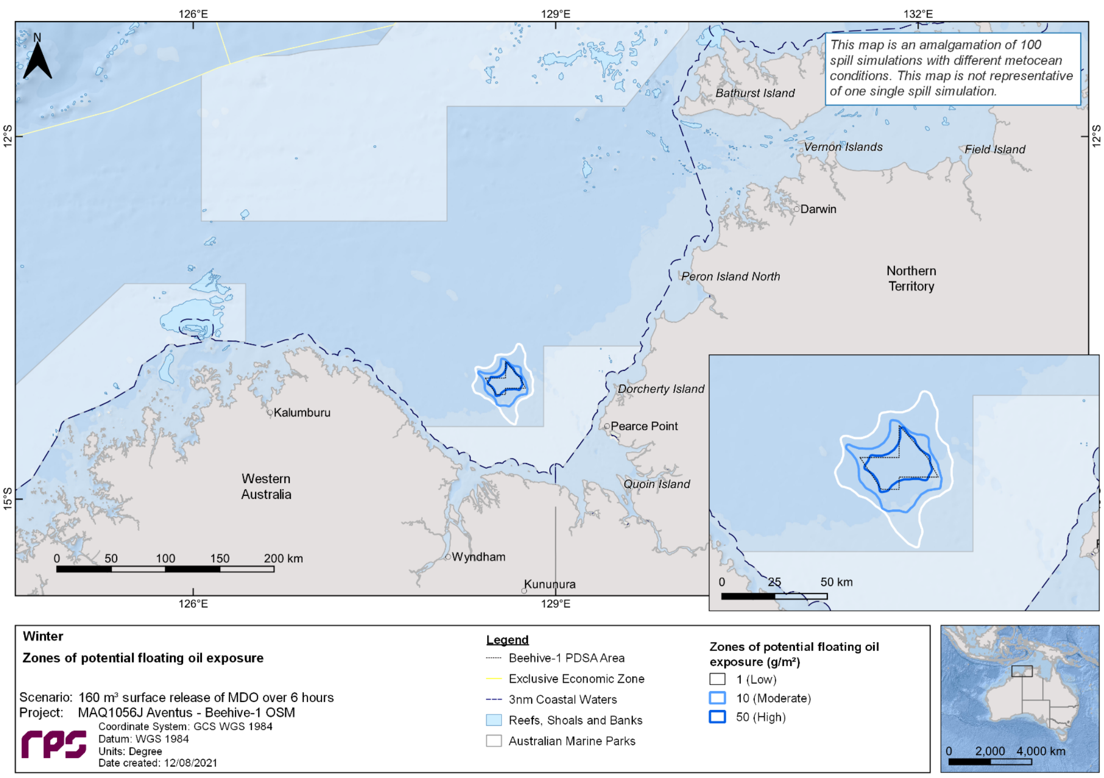


Figure 7.14. Zones of potential floating oil exposure, in the event of a 160 m^3 of MDO over 6 hours, tracked for 28 days during winter conditions

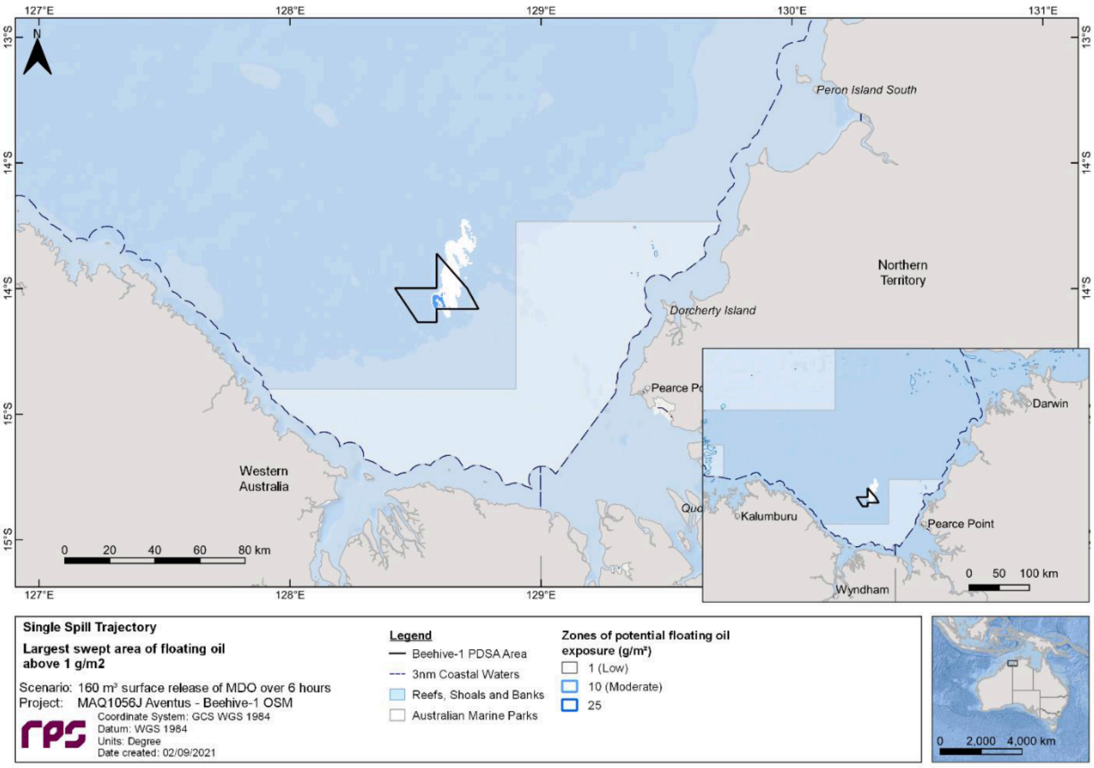


Figure 7.15. Zones of potential floating oil exposure (and shoreline exposure) for the trajectory with the largest swept area of floating oil above 1 g/m² based on a 160 m³ surface release of MDO over 6 hours, tracked for 28 days

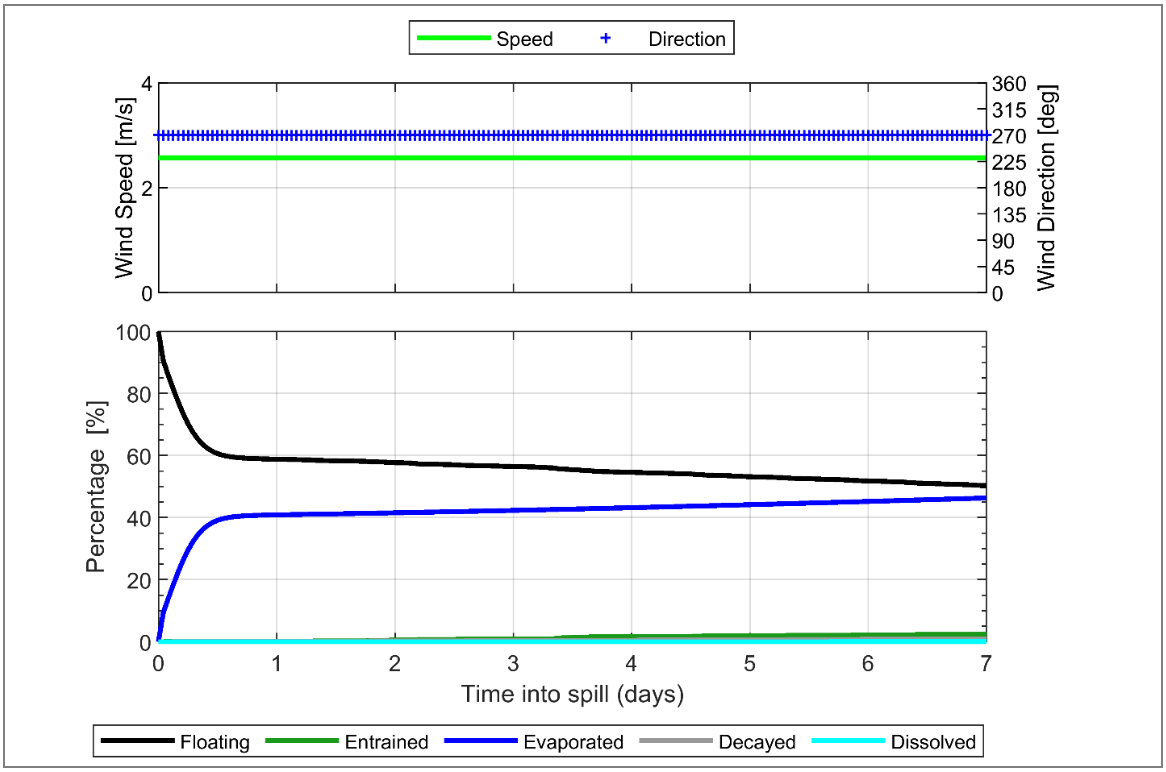


Figure 7.16. Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 25 °C water temperature and 29 °C air temperature

Table 7.46. Probability of exposure to sea surface waters from a 160 m³ MDO release over 6 hours and tracked for 28 days based on 100 spill trajectories during summer, transitional and winter conditions

Receptor	Summer						Transitional						Winter					
	Probability (%) of floating oil exposure			Minimum time before floating oil exposure (hours)			Probability (%) of floating oil exposure			Minimum time before floating oil exposure (hours)			Probability (%) of floating oil exposure			Minimum time before floating oil exposure (hours)		
	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High
JBG AMP	1	-	-	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbonate bank and terrace system of the Sahul Shelf KEF	1			1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Dashed line indicates that the threshold concentration was not reached.

Shoreline Results

Table 7.47 presents a summary of the predicted potential shoreline accumulation during seasonal conditions. The probability of accumulation to any shoreline at, or above, the low threshold (10-100 g/m^2) was 4% (summer) and 6% (transitional and winter) and the minimum time before shoreline accumulation at, or above, the low threshold ranged between 13.42 hours (winter) to 20.96 hours (summer). The maximum volume ashore for a single spill trajectory ranged between 1.0 m^3 (winter) and 3.9 m^3 (transitional) and maximum length of shoreline contacted at the low threshold was 1.5 km, 10.1 km and 1.5 km, respectively for summer, transitional and winter conditions.

There was no shoreline accumulation recorded above the moderate (100-1,000 g/m^2) or high (≥1,000 g/m^2) shoreline threshold.

Table 7.48 to Table 7.50 summarises the shoreline accumulation on individual receptors for each seasons. The shoreline assessment identified the Thamarrurr, Victoria Daly and Whale Flat shorelines as the sectors with a potential low (10-100 g/m^2) shoreline accumulation during summer conditions while the Wyndham - East Kimberley shoreline was predicted to be exposed to a potential low shoreline accumulation during the transitional and winter months. Wyndham - East Kimberley recorded the earliest shoreline contact (13.42 hours) during winter conditions and the longest length (10.1 km) of shoreline accumulation above the low threshold and maximum volume of oil ashore (3.9 km) during transitional conditions.

The maximum potential shoreline loading results for this scenario under summer, transitional and winter conditions are illustrated in Figure 7.17 to Figure 7.19.

The worst case scenario depicting the minimum time before shoreline accumulation above the low threshold as identified during winter is shown in Figure 7.20.

Table 7.47. Summary of the shoreline contact results above 10 g/m^2 in the event of a 160 m^3 MDO spill over 6 hours and tracked for 28 days during seasonal conditions

Shoreline statistics		Summer	Transitional	Winter
Probability of accumulation on any shoreline		4%	6%	6%
Absolute minimum time for visible oil to shore		20.96 days	14.79 days	13.42 days
Maximum volume of hydrocarbons ashore		1.1 m^3	3.9 m^3	1.0 m^3
Average volume of hydrocarbons ashore		0.8 m^3	1.6 m^3	0.6 m^3
10 g/m^2 loading	Maximum shoreline length	1.5 km	10.1 km	1.5 km
	Average shoreline length	1.0 km	2.9 km	0.8 km
100 g/m^2 loading	Maximum shoreline length	-	-	-
	Average shoreline length	-	-	-
1,000 g/m^2	Maximum shoreline length	-	-	-
	Average shoreline length	-	-	-

Dashed line indicates that the threshold concentration was not reached.

Table 7.48. Summary of oil accumulation on individual shoreline sectors. Results are based on a 160 m³ surface release of MDO over 6 hours, tracked for 28 days, during summer conditions

Shoreline sector	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High
Thamarrurr	2	-	-	20.96	-	-	< 1	22	0.5	0.8	1	-	-	1.5	-	-
Victoria Daly	1	-	-	24.88	-	-	< 1	21	0.1	0.5	1	-	-	1	-	-
Whale Flat	1	-	-	23.5	-	-	< 1	11	0.1	0.5	1	-	-	1	-	-
Wyndham - East Kimberley	-	-	-	-	-	-	< 1	10	< 0.1	< 0.1	-	-	-	-	-	-

Dashed line indicates that the threshold concentration was not reached.

Table 7.49. Summary of oil accumulation on individual shoreline receptors. Results are based on a 160 m³ surface release of MDO over 6 hours, tracked for 28 days, during transitional conditions

Shoreline sector	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High
Thamarrurr	-	-	-	-	-	-	< 1	5	-	-	-	-	-	-	-	-
Victoria Daly	-	-	-	-	-	-	< 1	5	-	-	-	-	-	-	-	-
Whale Flat	-	-	-	-	-	-	< 1	< 1	-	-	-	-	-	-	-	-
Wyndham - East Kimberley	6	-	-	14.79	-	-	< 1	76	1.6	3.9	2.9	-	-	10.1	-	-

Dashed line indicates that the threshold concentration was not reached.

Table 7.50. Summary of oil accumulation on individual shoreline receptors. Results are based on a 160 m³ surface release of MDO over 6 hours, tracked for 28 days, during winter conditions

Shoreline sector	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High
Thamarrurr	-	-	-	-	-	-	< 1	1	-	-	-	-	-	-	-	-
Victoria Daly	-	-	-	-	-	-	< 1	5	-	-	-	-	-	-	-	-
Whale Flat	-	-	-	-	-	-	< 1	< 1	-	-	-	-	-	-	-	-
Wyndham - East Kimberley	6	-	-	13.42	-	-	< 1	21	0.6	1	0.8	-	-	1.5	-	-

Dashed line indicates that the threshold concentration was not reached.

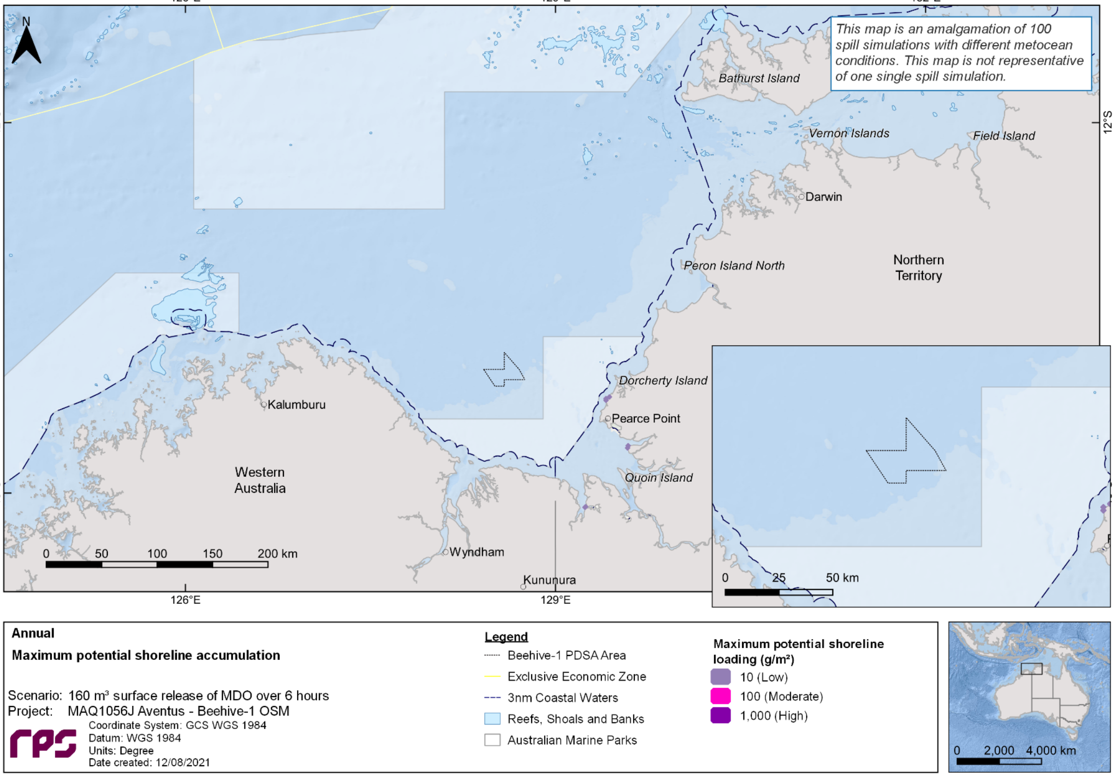


Figure 7.17. Maximum potential shoreline loading, in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days during summer conditions

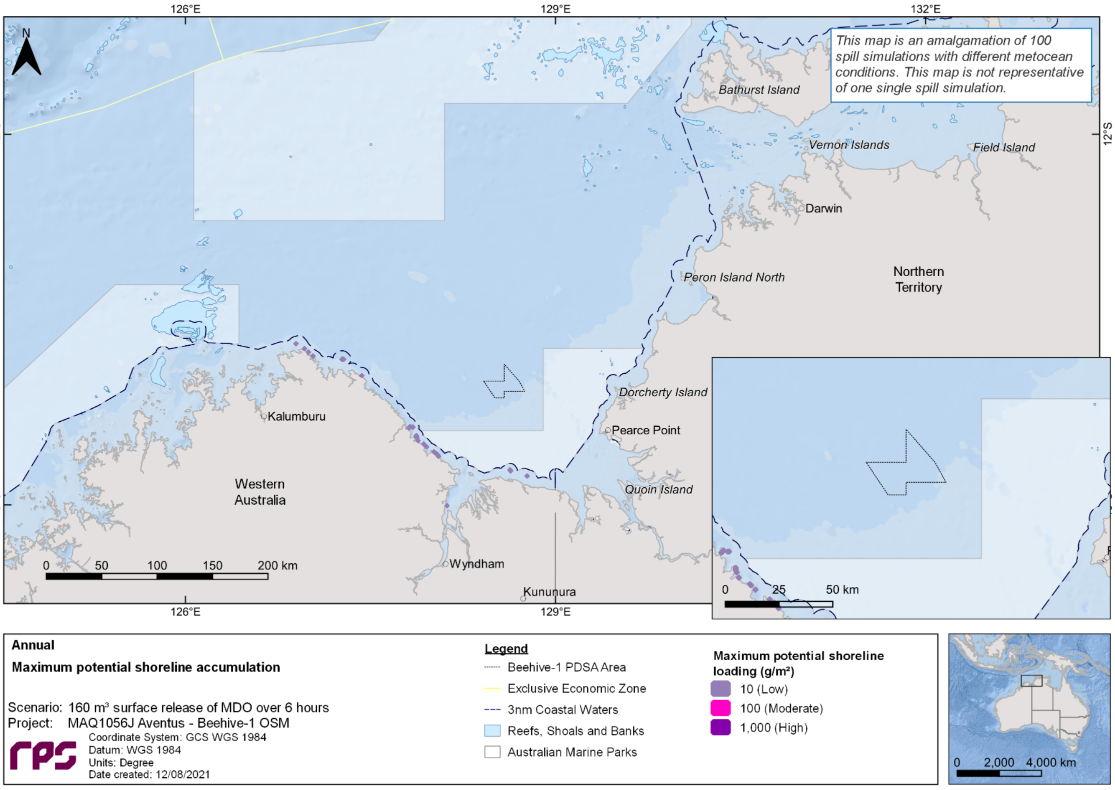


Figure 7.18. Maximum potential shoreline loading, in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days during transitional conditions

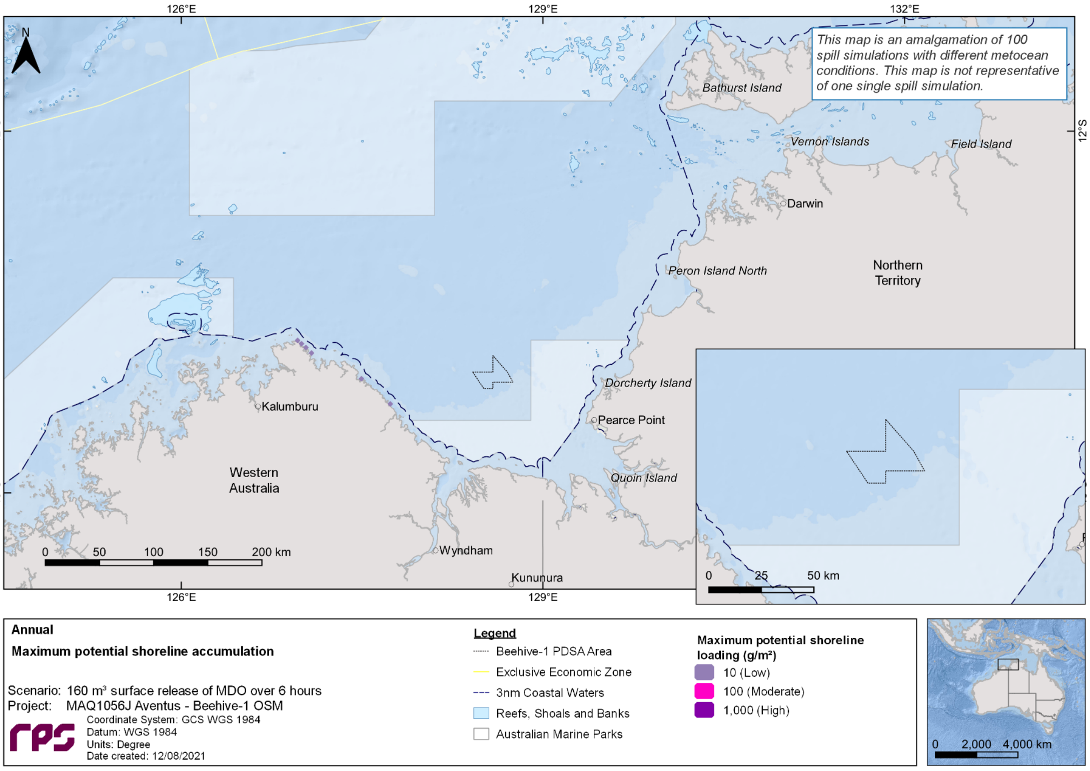


Figure 7.19 Maximum potential shoreline loading, in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days during winter conditions

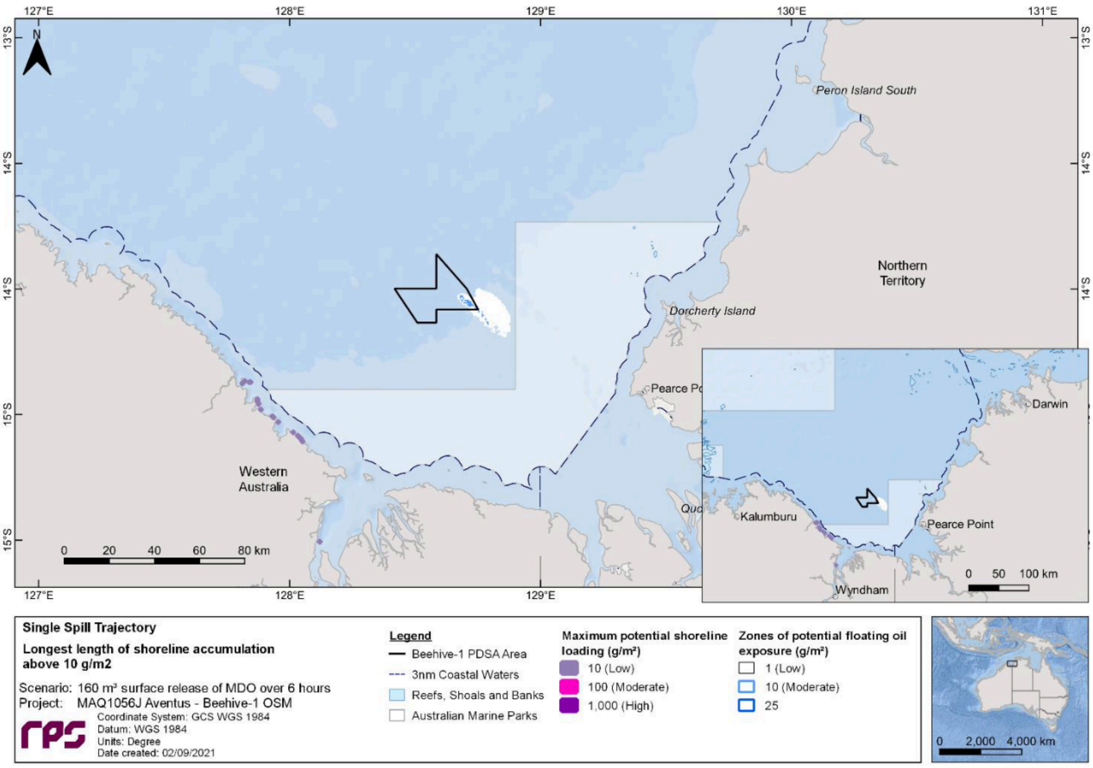


Figure 7.20. Zones of potential floating oil and shoreline accumulation, for the trajectory with the longest length of shoreline accumulation above 10 g/m^2 in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days

Entrained Hydrocarbon Results

Table 7.51 presents the probability of exposure to individual receptors from entrained hydrocarbons at the low (10-100 ppb) and high (≥ 100 ppb) exposure levels in the 0-10 m depth layers for the seasonal conditions.

In the surface depth layer (0-10 m), high exposure by entrained hydrocarbons was predicted for the JBG AMP (summer and transitional). In addition, the carbonate bank and terrace system of the Sahul Shelf KEF was predicted to be exposed to entrained hydrocarbons at, or above the low and high thresholds, during all three seasons modelled.

Figure 7.21 to Figure 7.23 illustrate the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layers at the low (10-100 ppb) and high (≥100 ppb) exposure levels, for each season, respectively.

The worst-case scenario depicting the largest area of entrained hydrocarbons above 10 ppb (low threshold) as identified during winter conditions is shown in Figure 7.24.

Under variable wind speeds, where the winds are of greater strength on average, entrainment of MDO into the water column is predicted to increase. Approximately 24 hours after the spill, 60.1% of the oil mass is forecast to have entrained and a further 38.4% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<1%). The residual compounds will tend to remain entrained beneath the surface under conditions that generate wind waves (approximately >6 m/s).

Table 7.51. Probability of entrained hydrocarbons exposure to marine based receptors in the 0–10 m depth layer. Results are based on a 160 m3 surface release of MDO over 6 hours, tracked for 28 days, during seasonal conditions

Receptor		Summer			Transitional			Winter		
		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure		Maximum instantaneous entrained hydrocarbon exposure	Probability of instantaneous entrained hydrocarbon exposure	
			Low	High		Low	High		Low	High
AMP	JBG	196	37	5	124	25	1	70	10	-
	Kimberley	1	-	-	16	3	-	21	6	-
KEF	Carbonate bank and terrace system of the Sahul Shelf	157	5	1	128	21	1	364	53	14
MP	North Kimberley	33	4	-	39	6	-	43	21	-
Reefs, shoals and banks	Bassett-Smith Shoal	-	-	-	3	-	-	14	2	-
	Branch Banks	-	-	-	12	1	-	16	3	-
	East Holothuria Reef	-	-	-	13	2	-	13	1	-
	Emu Reefs	64	12	-	9	-	-	3	-	-
	Holothuria Banks	-	-	-	16	3	-	18	4	-
	Howland Shoals	20	9	-	13	3	-	3	-	-
	Otway Bank	-	-	-	12	1	-	11	1	-
	Penguin Shoal	-	-	-	9	-	-	15	2	-
Nearshore Waters	Daly	18	3	-	-	-	-	-	-	-
	Dorcherty Island	19	4	-	12	2	-	1	-	-
	Quoin Island	7	-	-	12	1	-	4	-	-
	Thamarrurr	23	8	-	12	2	-	4	-	-
	Victoria Daly	8	-	-	11	1	-	7	-	-
	Wyndham - East Kimberley	27	2	-	25	4	-	40	18	-
State Waters	NT Sate Waters	35	13	-	30	5	-	19	3	-
	WA State Waters	33	4	-	36	6	-	43	21	-

Dashed line indicates that the threshold concentration was not reached.

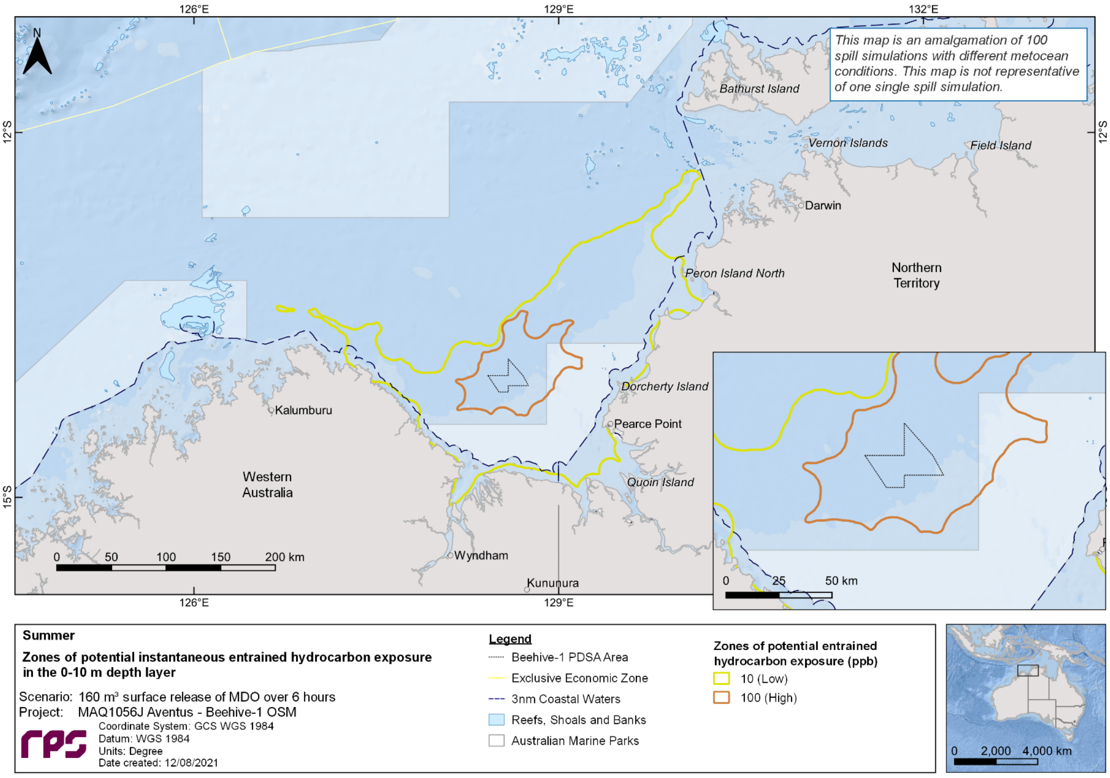


Figure 7.21. Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days, during summer conditions

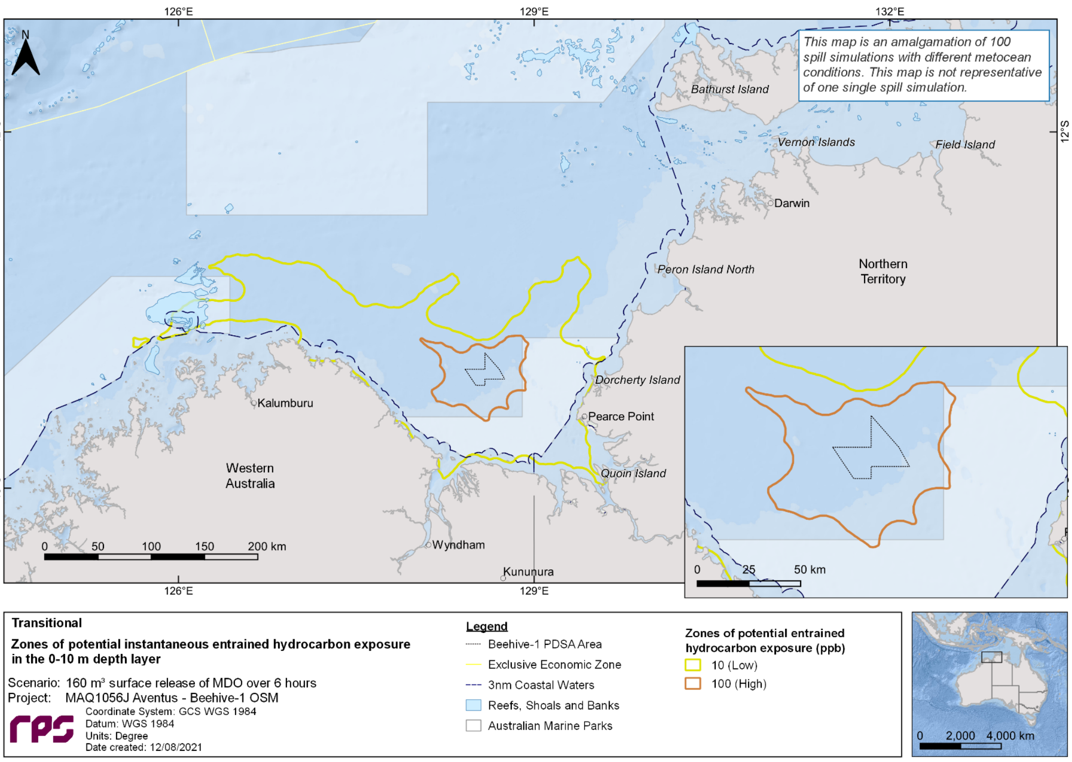


Figure 7.22. Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days, during transitional conditions

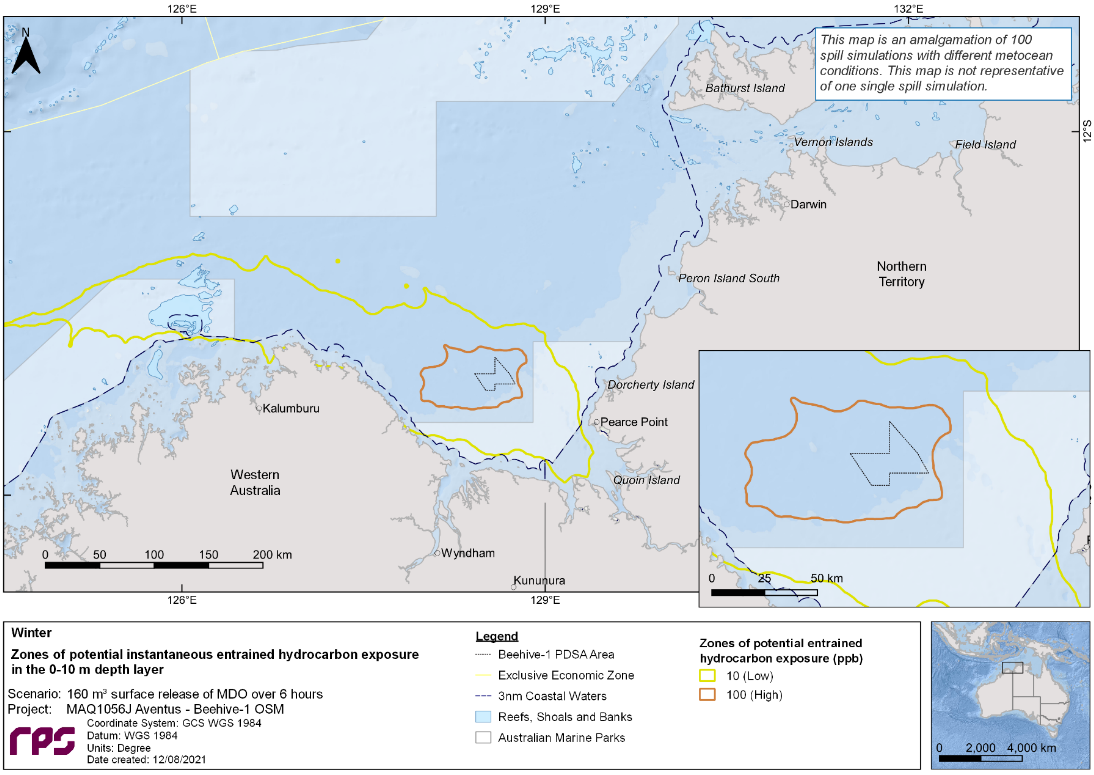


Figure 7.23. **Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 160 m³ surface release of MDO over 6 hours, tracked for 28 days, during winter conditions**

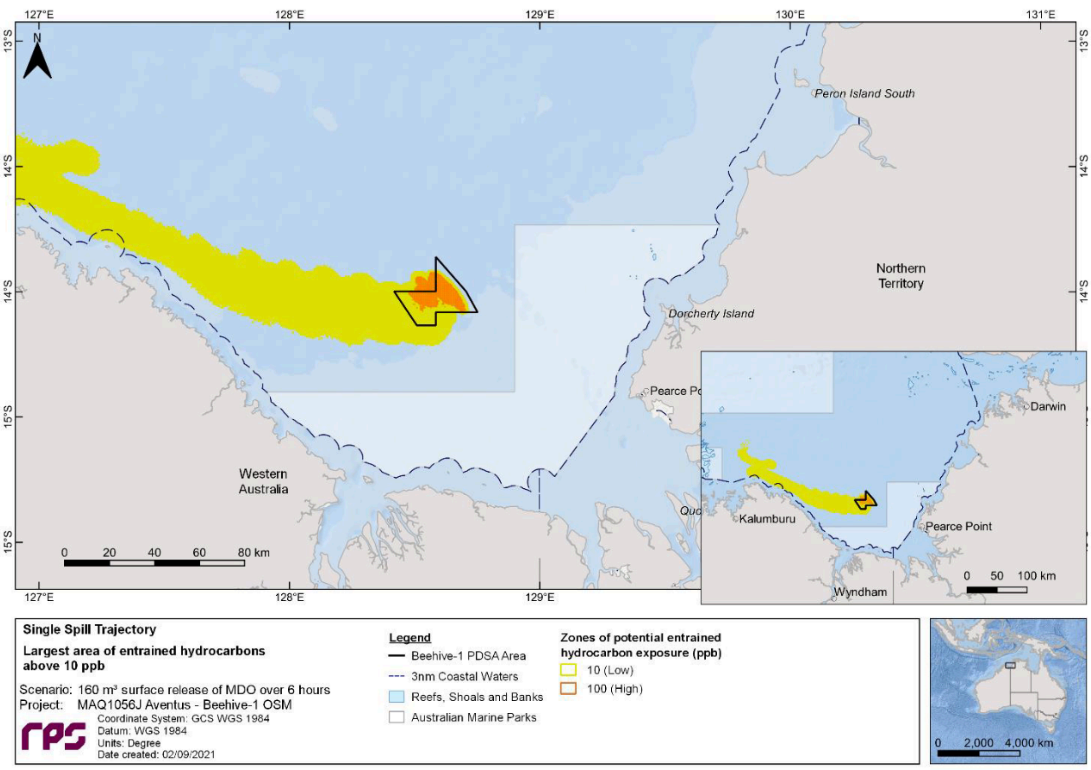


Figure 7.24. **Zones of potential entrained hydrocarbon exposure, for the trajectory with the largest area of entrained hydrocarbons above 10 ppb, in the event of a 160 m³ surface release of MDO over 6 hours, tracked for 28 days, during winter conditions**

Dissolved Hydrocarbon Results

Table 7.52 summarises the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m depth layer during seasonal conditions.

In the surface depth layer (0-10 m), low exposure to dissolved hydrocarbons was recorded for the JBG AMP during summer conditions. Additionally, low exposure to dissolved hydrocarbons was predicted for the JBG AMP during the transitional months, whilst a potential low exposure during transitional and winter conditions was shown for the Carbonate bank and terrace system of the Sahul Shelf KEF.

Figure 7.25 to Figure 7.27 presents the zones of potential dissolved hydrocarbon exposure in the 0-10 m depth layer for the low (10-50 ppb), moderate (50-400 ppb) and high (≥400 ppb) exposure levels (NOPSEMA, 2019) for each season.

The worst-case scenario depicting the largest area of entrained hydrocarbons above 10 ppb (low threshold) as identified during winter conditions is shown in Figure 7.28.

Table 7.52 Probability of exposure to individual receptors from dissolved hydrocarbons in the 0–10 m depth layer. Results are based on a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days during seasonal conditions

Receptor	Summer				Transitional				Winter			
	Maximum instantaneous dissolved hydrocarbon exposure	Probability of instantaneous dissolved hydrocarbon exposure			Maximum instantaneous dissolved hydrocarbon exposure	Probability of instantaneous dissolved hydrocarbon exposure			Maximum instantaneous dissolved hydrocarbon exposure	Probability of instantaneous dissolved hydrocarbon exposure		
		Low	Mod	High		Low	Mod	High		Low	Mod	High
JBG AMP	26	1	-	-	13	1	-	-	6	-	-	-
Carbonate bank and terrace system of the Sahul Shelf KEF	2	-	-	-	14	1	-	-	21	3	-	-

Dashed line indicates that the threshold concentration was not reached.

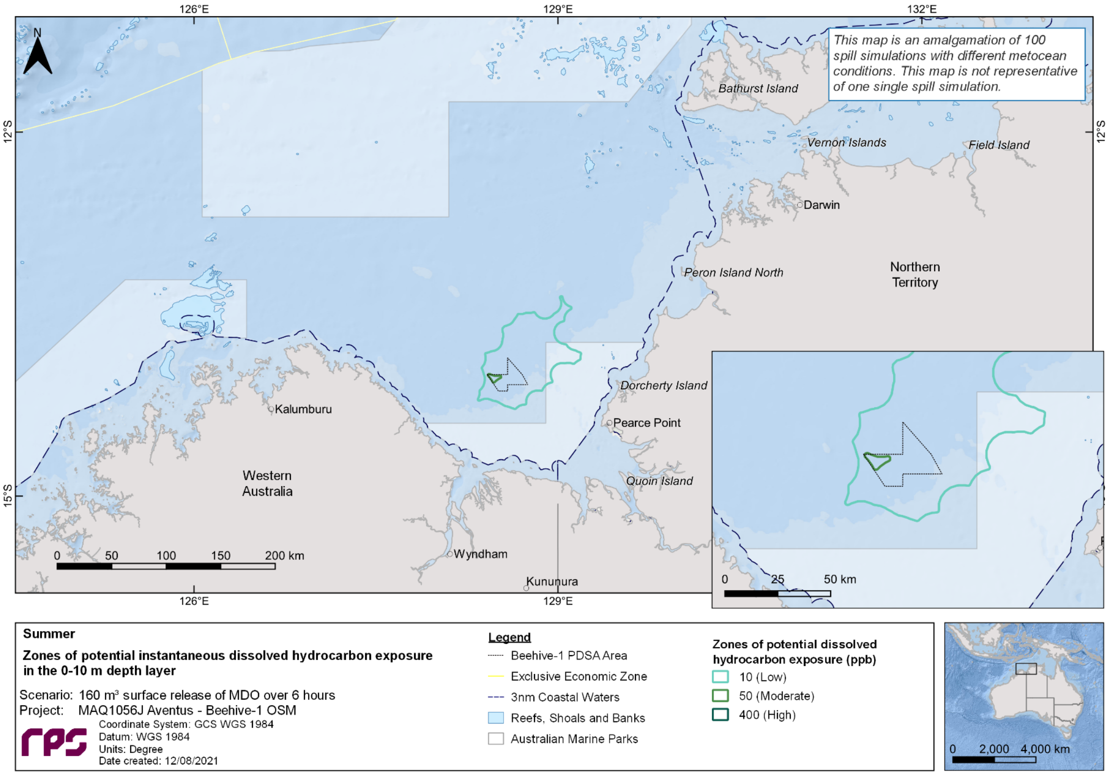


Figure 7.25. Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 160 m³ surface release of MDO over 6 hours, tracked for 28 days, during summer conditions

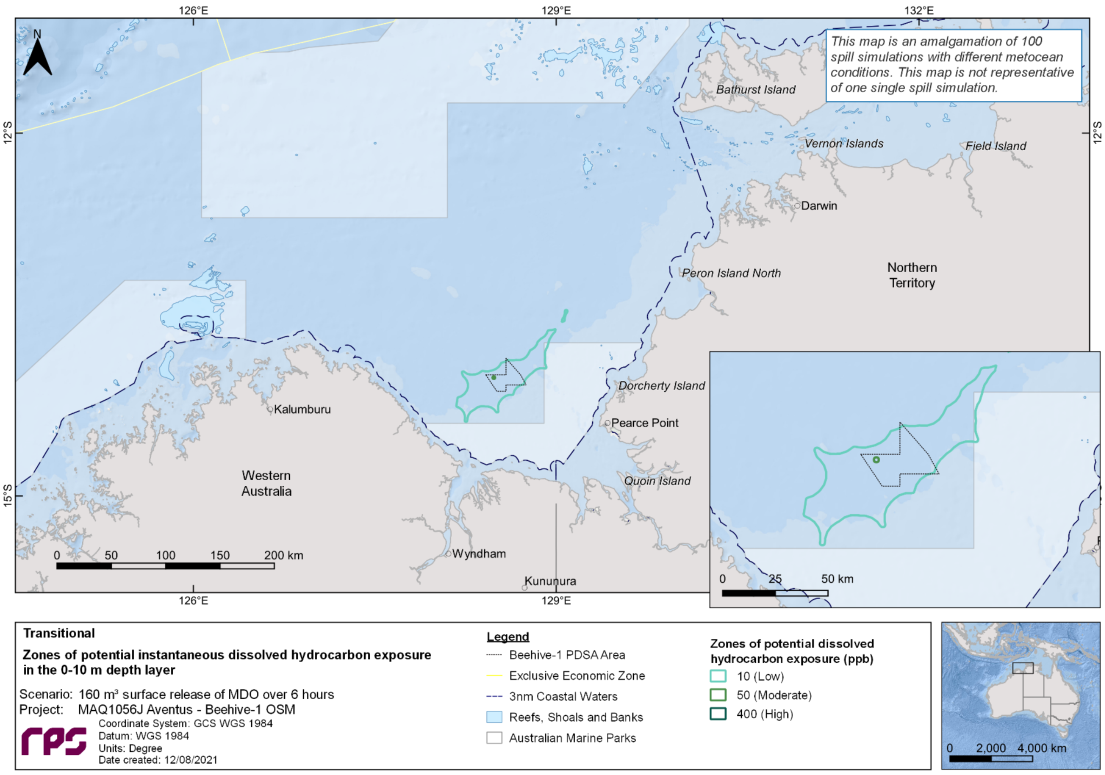


Figure 7.26. Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 160 m³ surface release of MDO over 6 hours, tracked for 28 days, during transitional conditions

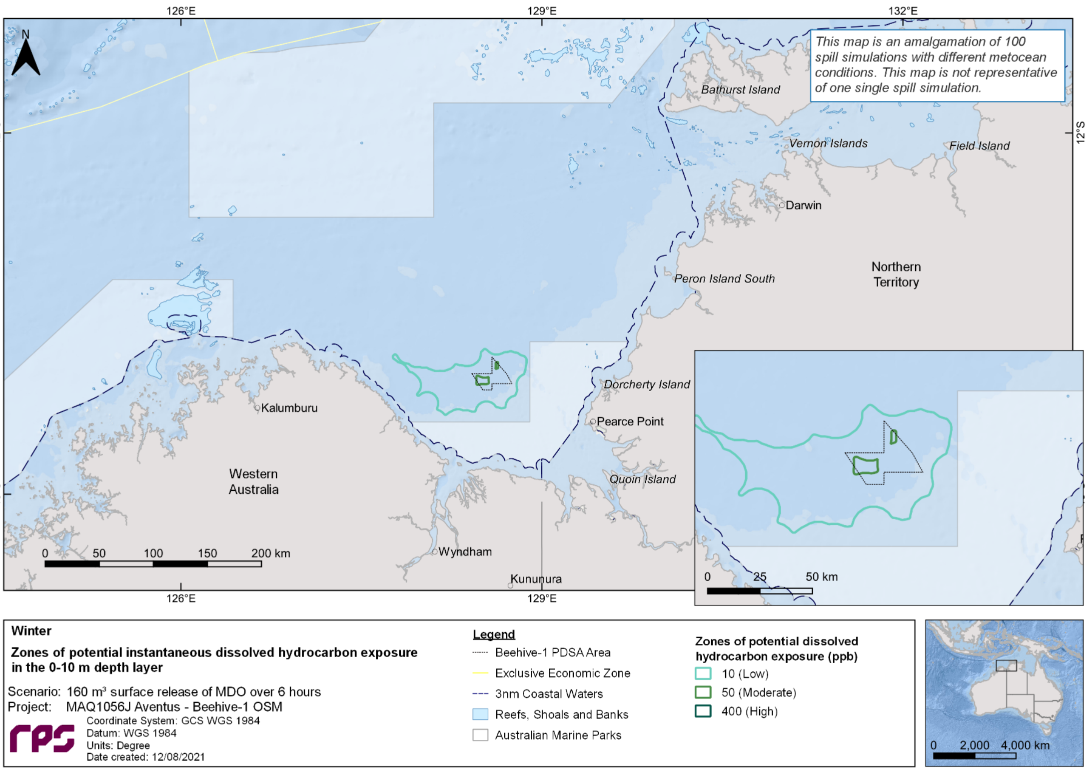


Figure 7.27. Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days, during winter conditions

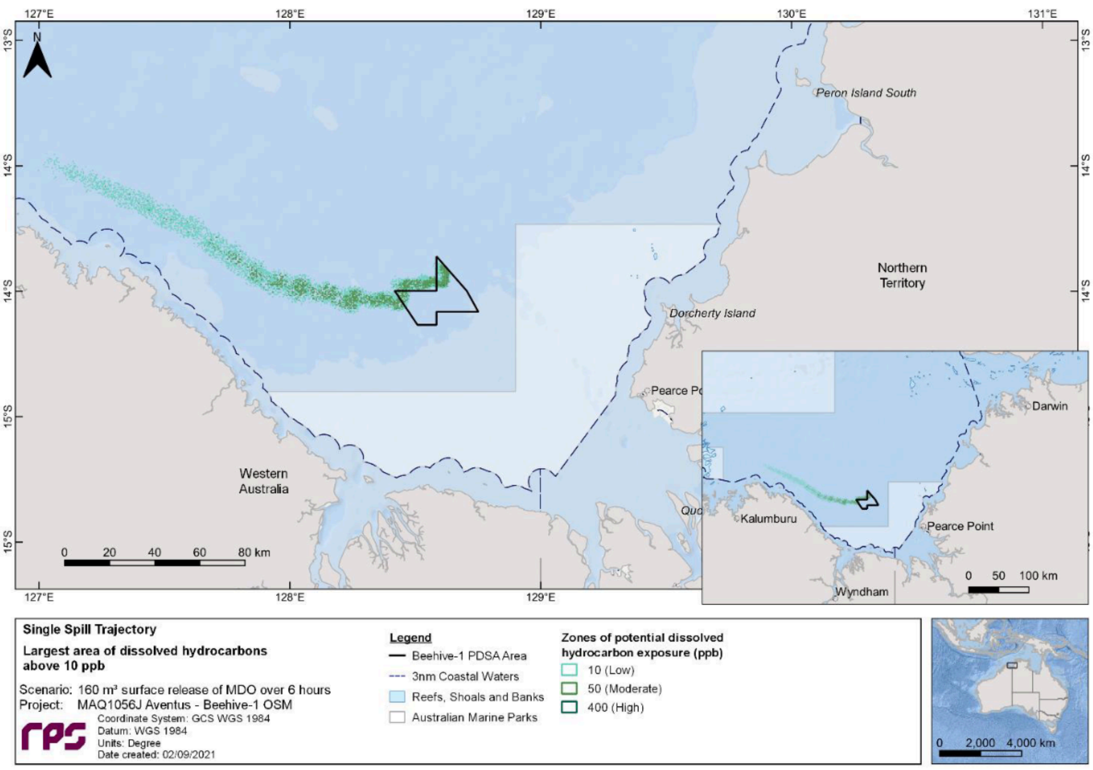


Figure 7.28. Zones of potential dissolved hydrocarbon exposure, for the trajectory with the largest area of dissolved hydrocarbons above 10 ppb, in the event of a 160 m^3 surface release of MDO over 6 hours, tracked for 28 days, during winter conditions

7.16.2. 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 exposed marine fauna and seabirds;
- Habitat damage where the spill reaches shorelines; and
- Changes to the functions, interests or activities of other users (e.g., commercial fisheries).

7.16.3. EMBA

The EMBA for a 160 m^3 spill of MDO (sea surface, shoreline, entrained and dissolved hydrocarbons) is illustrated in Figure 7.12 to Figure 7.28. Receptors most at risk within this EMBA, whether resident or migratory, are:

- Benthic assemblages;
- Macroalgal communities;
- Plankton;
- Fish (pelagic);
- Cetaceans;
- Marine reptiles (turtles);
- Avifauna (seabirds and shorebirds);
- Shoreline habitats (sandy beaches and rocky shores); and
- Commercial fisheries.

7.16.4. Evaluation of Environmental Risks

Vessel collisions are a low probability event in open ocean areas without restricted navigation, and shipping traffic around the activity area is low (see Figure 5.63). Higher commercial and recreational vessel traffic occurs in and around ports and harbours and around the Blacktip WHP, which is therefore where the greatest risk of collision occurs. While undertaking the activity, the vessel will be operating at low speed (and stationary when undertaking geotechnical investigations), reducing the risk of collision with third-party vessels.

The criteria for the sensitivity of receptors that may be affected by an MDO spill are presented in Table 7.53. The impacts of the MDO spill scenario on key environmental receptors in the spill EMBA are described in Table 7.54 to Table 7.63.

Table 7.53. 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. • Shorebirds. • Commercial fishing. • Protected areas.

Table 7.54. Potential risk of MDO release 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 5.3.1

<u>Surface hydrocarbons</u>

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.

<u>Water column/seabed hydrocarbons</u>

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 LC50 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 (Heyward *et al*., 2010), which 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. Recovery of benthic habitats exposed to entrained hydrocarbons would be expected to return to background water quality conditions within weeks to months of contact. Several studies have indicated that rapid recovery rates may occur even in cases of heavy oiling (Committee on Oil in the Sea, 2003).			
Potential consequences for this activity based on the OSTM results			
Sea surface	Water column – dissolved phase	Water column – entrained phase	Shoreline
Not applicable.	Contact at the low threshold was predicted 0-10 m below the surface. At the low threshold exposure to dissolved hydrocarbons, ecological impacts are unlikely. Where moderate exposure is predicted (i.e., in the central JBG in water depth of ~40 m), these areas do not contact the seabed and therefore will not impact benthic assemblages. There is no predicted exposure to moderate threshold dissolved hydrocarbons in	Contact at the low threshold was predicted 0-10 m below the surface. At the low threshold exposure to entrained hydrocarbons, ecological impacts are unlikely. Where high exposure is predicted (i.e., in the central JBG in water depth of ~40 m), these areas do not contact the seabed and therefore will not impact benthic assemblages.	The OSTM does not predict shoreline accumulations above the low threshold for hydrocarbons. Given that ecological impacts at the low exposure threshold are unlikely, the consequence of an MDO spill on benthic assemblages at the shoreline will be **negligible.**

	the nearshore (<10 m) benthic environment. Therefore, the consequence from an MDO spill on benthic assemblages is **negligible**.	There are no submerged reefs, shoals and banks (RSB) within the JBG that may be impacted at the high threshold for entrained hydrocarbons. All RSBs are outside the areas of high exposure to entrained hydrocarbons. Therefore, the consequence of a hydrocarbon spill on benthic assemblages is **negligible**.	

Table 7.55. Potential risk of MDO release from vessel on macroalgal communities

General sensitivity to oiling – macroalgal communities	
Sensitivity rating of macroalgal species and communities:	Low
A description of macroalgal species and communities in the EMBA is provided in:	Section 5.3.2

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 CO_2 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 oils 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.

Potential consequences for this activity based on the OSTM results			
Sea surface	Water column – dissolved phase	Water column – entrained phase	Shoreline
Exposure to low threshold sea surface hydrocarbons is predicted in the central JBG, which are unlikely to result in ecological impact at this threshold. There are no areas of moderate or high threshold sea surface hydrocarbons in the nearshore/intertidal environment where macroalgal communities (i.e., seagrass meadows) are more likely to occur. Therefore, the consequence of the MDO spill to macroalgal communities such as mangroves and seagrasses will be **negligible**.	Contact at the low threshold is predicted in the 0-10 m below the surface. At the low threshold exposure to dissolved hydrocarbons, ecological impacts are unlikely. There is only a limited extent of moderate threshold exposure to dissolved hydrocarbons in the water column in the PDSA area. This area does not contain habitat features that support macroalgal growth. As such, the consequence of a hydrocarbon spill on macroalgal communities is **negligible**.	Contact at the low threshold was predicted in the 0-10 m below the surface. At the low threshold exposure to entrained hydrocarbons, ecological impacts are unlikely. Where exposure to high thresholds are predicted (i.e., in central JBG in water depths of ~40 m), this area does not contain habitat features that support macroalgal growth. Therefore, the consequence of a hydrocarbon spill on macroalgal communities is **negligible.**	The OSTM does not predict shoreline accumulations above the low threshold for hydrocarbons. Given that ecological impacts at the low exposure threshold are unlikely, the consequence of an MDO spill on macroalgal communities at the shoreline will be **negligible.**

Table 7.56. Potential risk of MDO release on plankton

General sensitivity to oiling – plankton		
Sensitivity rating of plankton:	Low	
A description of plankton communities in the EMBA is provided in:	Section 5.3.3	
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 and would 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 consequences for this activity based on the OSTM results		
Sea Surface	Water column	Shoreline
Plankton found in open water of the EMBA is expected to be widely represented in the JBG as a result of being transported to and from the Gulf by the southerly movement of the Indonesian Throughflow and the southeast and northwest monsoonal wind-driven currents (Brewer		Not applicable.

et. al., 2007). Plankton in the upper water column are likely to be directly (e.g., through smothering and ingestion) and indirectly (e.g., toxicity from decrease in water quality and bioaccumulation) affected by moderate or high threshold surface, dissolved and entrained hydrocarbons. Once background water quality conditions are re-established following the natural weathering and dispersion of the hydrocarbons, plankton populations are expected to recover rapidly due to recruitment of plankton from surrounding waters. The consequence of an MDO spill on plankton populations is **negligible**.	

Table 7.57. Potential risk of MDO release 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 5.3.4

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, fish are high 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 7.54 '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 LC50 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, 2001). In contrast, wave tank exposures reported much higher lethal concentrations (14-day LC50) 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, 2011; Law, 1997; Rawson *et al*., 2011).

During most of their lives, squid are widely distributed, however, when squid reach maturity at 1-2 years, they move inshore to spawn in large numbers and then die after spawning. Where large numbers of squid spawn in small areas, the population could be impacted by the reduction in successful spawn. As squid are generally abundant and reach sexual maturity rapidly, recovery is expected to be rapid (1-2 years) (Minerals Management Service, 1983).

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 consequences for this activity based on the OSTM results		
Sea Surface	Water column	Shoreline
There is a small area in which moderate (27.6 km) and high (20.7 km) threshold hydrocarbons are predicted to travel from the activity area on the sea surface. Fish species in the water column and syngnathid species associated with rafts of floating seaweed	Impacts to fish from exposure to hydrocarbons in the water column is likely to be spatially limited to the areas of moderate (for dissolved hydrocarbons) and high (for entrained hydrocarbons) threshold exposure and temporally limited due to the rapid weathering of MDO and open, well-mixed waters of the JBG. The OSTM predicts that exposure to high threshold entrained hydrocarbons (i.e., the concentration at which biological impact may occur) is predicted to occur up to a maximum	Not applicable.

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 small area of the sea surface in comparison to the wider JBG. As the majority of fish tend to remain in the mid-pelagic zone, they are not likely to come into contact with surface hydrocarbons, hence the consequence of an MDO spill will be **negligible**.	distance of 78 km north-northeast from the activity area. The high concentration represents the possibility of sub-lethal impacts to exposed fish species in the affected area. 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 oceanic whitetip 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. As highly mobile species, they are unlikely to remain in one area for a long period of time, minimising the risk that they would be exposed to toxic levels of hydrocarbons. Due to generally well-mixed waters in the JBG, and the high and rapid rate of MDO weathering, the consequence of an MDO spill on fish is likely to be restricted to the top 10 m of water and is **negligible** at a population level.	

Table 7.58. Potential risk of MDO release on cetaceans

General sensitivity to oiling – cetaceans	
Sensitivity rating of cetaceans:	High
A description of cetaceans in the EMBA is provided in:	Section 5.3.5

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 hydrocarbons, 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 whale 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 consequences for this activity based on the OSTM results		
Sea Surface	Water column	Shoreline
Exposure to low threshold sea surface hydrocarbons is predicted in the central JBG, which are unlikely to result in ecological impact at this threshold. There is a small area in which moderate exposure (27.6 km) and high exposure (20.7 km) hydrocarbon thresholds travel from the centre of the activity area on the sea surface. There are no cetacean BIAs within the ecological EMBA. If large quantities of zooplankton exposed to the spill were ingested by feeding cetaceans, chronic toxicity impacts to some individual cetaceans may occur. Biological consequences of physical contact with localised areas of high concentrations of hydrocarbons at the sea surface are unlikely to lead to any long-term population impacts.	Contact at the low threshold for dissolved and entrained hydrocarbons was predicted 0-10 m below the surface, with only a low likelihood of exposure to high entrained hydrocarbons (in the activity area, JBG AMP and Carbonate bank and terrace system of the Sahul Shelf). At the low threshold exposure to entrained and dissolved hydrocarbons, ecological impacts are unlikely. Impacts to cetaceans are likely to be limited to the areas of high exposure to entrained hydrocarbons. These areas do not overlap the resting, foraging, calving and breeding BIA for the Australian snubfin dolphin, Australian humpback dolphin or any other cetacean BIA.	Not applicable.

Evaporation of the hydrocarbons is expected to occur rapidly in this scenario with ~65.4 m^3 of the modelled 160 m^3 evaporating within 24 hours of the spill occurring, thus reducing the duration of the hydrocarbons persisting on the sea surface. Given 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 to cetacean populations from an MDO spill is **negligible.**	Given the low probability of exposure to hydrocarbons that may have ecological impacts and the absence of cetacean BIAs within the ecological EMBA, the consequence to cetacean populations from an MDO spill is **negligible**.	

This hydrocarbon spill scenario will not have a 'significant' impact on threatened cetacean species (see Section 5.3.5) 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 impact 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 survey 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 activity area and EMBA are unlikely to form a significant part 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 activity area and EMBA are not known to breed within these areas. 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	The water quality of the activity 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

habitat to the extent that the species is likely to decline.	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.	There are no known endangered cetaceans that may migrate through the activity area and EMBA. The activity area is considered within the 'likely' distribution of the species for blue whale; however no BIAs for this species are intersected by the spill EMBA or activity area. 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 negligible 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 cetacean species.

Table 7.59. Potential risk of MDO release on marine reptiles

General sensitivity to oiling – marine reptiles	
Sensitivity rating of marine reptiles:	Medium
A description of marine reptiles in the EMBA is provided in:	Section 5.3.6

Marine reptiles can be exposed to hydrocarbon 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 consequences for this activity based on the OSTM results		
Sea Surface	Water column	Shoreline
Exposure to low, moderate and high threshold sea surface hydrocarbons is predicted in the central JBG (see the surface exposure maps). Some individual marine reptiles may come into contact with hydrocarbons on the water surface as they come to the surface to breathe, feed or rest. The areas of moderate and high surface exposure overlap the olive ridley, green and flatback turtle foraging BIAs, as well as the internesting BIA for flatback turtles. As such there is the chance that turtles will encounter surface hydrocarbons that may result in the consequences described above, so the consequence of an MDO spill to individual turtles and populations is **minor.**	There is a limited area of moderate threshold exposure to dissolved hydrocarbons in the water column. The zone of entrained hydrocarbons at the high threshold extends to a larger area, and it is this area where sub-lethal or toxic effects to turtles may occur if they are exposed for long enough. However, given that turtles are mobile and their presence in the area exposed to moderate and high threshold hydrocarbons in the water column is likely to be transient, the consequence of an MDO spill to individual turtles and popularions is **minor**.	The activity area and EMBA intersects only the flatback turtle internesting BIA (Figure 5.26). The OSTM does predict shoreline hydrocarbon accumulations at the low threshold in isolated shoreline locations within this BIA. Given that ecological impacts at the low exposure threshold are unlikely, the consequence of an MDO spill to nesting turtle populations is **minor**.

Table 7.60. Potential risk of MDO release 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 5.3.7
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, 2011; 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 consequences for this activity based on the OSTM results		
Sea Surface	Water column	Shoreline
The threatened bird species likely to occur in the EMBA, such as the red knot, curlew sandpiper and eastern curlew, mainly occur within coastal areas and are unlikely to occur in the activity area due to their habitat preferences. There are no areas of moderate or high threshold sea surface hydrocarbons (considered detrimental to birds) in the nearshore/intertidal environment. Given the small area and temporary nature of the hydrocarbon release on the sea surface, the absence of seabird and shorebird BIAs in the activity area and ecological EMBA, and the extensive area of open ocean available for foraging, the consequence to avifauna from an MDO spill is **negligible.**	There is a limited area of moderate threshold exposure to dissolved hydrocarbons in the water column. The zone of entrained hydrocarbons at the high threshold extends to a larger area, and it is this area where sub-lethal or toxic effects to seabirds may occur if they are exposed for long enough. Due to this limited extent of dissolved hydrocarbons at the moderate threshold. Therefore, the consequence to seabirds and shorebirds from an MDO spill is **negligible.**	The OSTM does not predict shoreline accumulations above the low threshold for hydrocarbons. Given that ecological impacts at the low exposure threshold are unlikely, the consequence of an MDO spill on seabirds and shorebirds at the shoreline will be **negligible.**
This hydrocarbon spill scenario will not have a 'significant' impact on migratory shorebird species (see Section 5.3.7) 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, 2017b), 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 in very isolated areas, but given the behaviour of MDO and nature of the shorelines (mostly rocky in the areas of potential exposure), 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 EMBA, particularly the shoreline closest to the activity 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 seabird species (see Section 5.3.7) 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 activity area and EMBA are not critical to the survival or any seabirds.
• Disrupt the breeding cycle of a population.	Most of the seabird species known to occur in the activity area and EMBA (e.g., common noddy, streaked shearwater and frigatebirds) 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 activity area and EMBA (e.g., common noddy, streaked shearwater and frigatebirds) breed outside of Australia or well beyond the EMBA. This being the case, it is unlikely that adults would bring contaminated prey back to nests to feed chicks.

	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 no EPBC Act-listed endangered and critically endangered seabirds that occur in the activity area and/or ecological 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 evaporation and 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 activity 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.	
Formally managed shorebird species with oil spills listed as a threat include the red knot, curlew sandpiper, great knot, great sand plover, lesser sand plover, Nunivak bar-tailed godwit, bar-tailed godwit (Northern Siberian), eastern curlew, Australian painted snipe and painted snipe. There are no specific management actions in the conservation advice for each of these species regarding oil spills.	

Table 7.61. Potential risk of MDO release on sandy beaches

General sensitivity to oiling – sandy beaches	
Sensitivity rating of sandy beaches (environmental):	Low
Sensitivity rating of sandy beaches (socio-economic):	Medium
A description of sandy beaches in the EMBA is provided in:	Section 5.2.1
Sandy beaches are regularly exposed to wave action and have low sediment total organic carbon and therefore generally a low abundance of marine life (Hook *et al*., 2016). The low concentration of total organic carbon and large particle size of sand means that any MDO deposited on the beach would not be retained. However, sandy beaches are important socio-economically, so an MDO 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 (e.g., nematodes, annelids, arthropods, polychaetes, protists, fungi, algae and bacteria). 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 consequences for this activity based on the OSTM results
Shoreline
No shoreline accumulation above the moderate or high shoreline threshold is predicted in the OSTM. The shorelines predicted to be exposed to low MDO loading are isolated sandy beaches and mud flats (western shorelines of the JBG) with some short sections of rocky shores (eastern side of the JBG). Shorelines that may be exposed to low threshold loading are located at Thamarrurr, Victoria Daly and Whale Flat and the Wyndham - East Kimberley shoreline. Areas of low exposure to shoreline loading are not expected to exhibit environmental harm. Due to the exposed nature of the shorelines and the nature of MDO, long-term toxicity or smothering effects in areas of low MDO exposure are not expected and natural weathering should be sufficient to aid in recovering communities rapidly. The shorelines predicted to exposed to low threshold MDO are uninhabited, so socio-economic consequences are predicted to be **negligible.**

Table 7.62. Potential risk of MDO release on rocky shores

General sensitivity to oiling – rocky shores	
Sensitivity rating of rocky shores (environmental):	Low
Sensitivity rating of rocky shores (socio-economic):	Medium
A description of rocky shores in the EMBA is provided in:	Section 5.2.1
Cracks and crevices, rock pools, overhangs and other shaded areas provide habitat for soft bodied animals such as sea anemones, sponges and sea-squirts, and become places where hydrocarbons can become concentrated as it strands ashore. The same is true on stable boulder shores where the rich animal communities underneath the rocks are also the most vulnerable to hydrocarbon pollution. The vulnerability of a rocky shoreline to oiling is dependent on its topography and composition as well as its position. A vertical rock wall on a wave-exposed coast is likely to remain unoiled if an oil slick is held back by the action of the reflected waves. At the other extreme, a gradually sloping boulder shore in a calm backwater of a sheltered inlet can trap enormous amounts of hydrocarbons, which may penetrate deep down through the substratum. The complex patterns of water movement close to rocky coasts also tend to concentrate oil in certain areas. Some shores are well known to act as natural collection sites for litter and detached algae and oil is carried there in the same way. As on all types of shoreline, most of the oil is concentrated along the high tide mark while the lower parts are often untouched (IPIECA, 1995). It is not long before the waves and tides that carried the hydrocarbons onto the shore gradually remove it again, but the rate of such weathering is dependent on many factors. The wave exposure, weather conditions and the shore characteristics are most important. For example, a patch of oil on a rock exposed to heavy wave action is not going to remain there for long. However, it could take many years for the limited water movement in a sheltered bay to remove oil trapped under boulders or in gullies and crevices. Gradual leaching of this oil could result in constant low-level pollution of, for example, a rock pool. Microbial breakdown of the oil is slower in cold or temperature environments than sub-tropical or tropical environments. The presence of silt and clay particles can assist with oil removal by the process of flocculation. Grazing animals such as marine snails may also remove significant amounts of oil. As the oil is weathered it becomes more viscous and less toxic, often leaving little but a small residue of tar on upper shore rocks. This residue can remain as an unsightly stain for a long time but it is unlikely to cause any more ecological damage. Oil tends not to remain on wet rock or algae but is likely to stick firmly if the rock is dry (IPIECA, 1995).	
Potential consequences for this activity based on the OSTM results	
Shoreline	
The only predicted MDO exposure to rocky shorelines is at the low exposure threshold, which is unlikely to result in ecological impacts. Rocky shorelines occur predominantly in the western part of the JBG. Rapid weathering of stranded MDO through wave action against the rocks will aid in its rapid weathering. Therefore, the consequence of an MDO spill on rocky shores is **negligible.**	

Table 7.63. Potential risk of MDO spill on commercial fisheries

General sensitivity to oiling – commercial fishing	
Sensitivity rating of commercial fisheries:	High
A description of commercial fisheries operating in the EMBA is provided in:	Section 5.6.6
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, 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 Gulf of Mexico (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 a MDO spill, a temporary fisheries closure may be put in place by AFMA, the WA or NT fishery authorities (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 consequence from MDO release			
Fishery	Surface oiling	Water column	Shoreline
General	A short-term fishing exclusion zone may be implemented by AFMA, the WA or NT fishery authorities. Given the temporary nature of any surface slick and the low fishing intensity in the EMBA, there are unlikely to be any significant impact on fisheries in terms of lost catches (and associated income).	OSTM predicts areas may be exposed to entrained hydrocarbons at the high exposure threshold, and smaller areas at the moderate dissolved exposure thresholds. The high exposure threshold for dissolved hydrocarbons was not reached. A short-term fishing exclusion zone may be implemented by AFMA, the WA or NT fishery authorities. The areas of moderate dissolved and high entrained exposure thresholds represent small areas available to commercial fishing. The hydrocarbons are predicted to weather quickly and the area would return to pre-spill conditions rapidly. In the event of a spill, fisheries may be subject to a temporary closure (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons.	There are no fishing ports within the EMBA. Commercial fishing vessels use ports located well outside the EMBA, with the nearest being Darwin and Broome. As such, MDO will not make contact with moored fishing vessels, so staining or coating of vessel hulls will not occur.
Commonwealth-managed fisheries (those known to fish within the EMBA)			
NPF	No impacts due to their benthic habitat.	The area overlapped by the socioe-conomic EMBA represents 5.68% of the area available to the fishery. Given that the preferred activity window is scheduled to be early 2022 and that the NPF will enter a voluntary closure period from 1 December 2021 to 1 August 2022, a spill will not result in the temporary closure of the fishery. Therefore, the consequence of an MDO spill to the NPF is **negligible**.	As per 'general'.
WA-managed fisheries (those known to fish within the EMBA)			
MMF	No impacts due to their pelagic habitat.	The area overlapped by the socio-economic EMBA represents 2.18% of the area available to the fishery. Given that the preferred activity window is scheduled to be early 2022 and that the MMF fishing season is primarily from May to November, a spill will not result in the temporary closure of the fishery during its	As per 'general'.

		peak fishing season. Therefore, the consequence of an MDO spill to the MMF is **negligible**.	
NDSMF	No impacts due to their pelagic habitat.	The area overlapped by the socio-economic EMBA represents 7.9% of the area available to the fishery. Zone B of the NDSMF accounts for 90% of the fishery catch from 2019, of which only 1% of this area is overlapped by the socio-economic EMBA. This means the zone of potential hydrocarbon exposure (and potential location of a temporary fishery closure) is not highly fished. Therefore, the consequence of an MDO spill to the NDSMF is **negligible**.	As per 'general'.
Kimberley Crab Managed Fishery (North Coast Crab Fishery)	No impacts due to their benthic habitat.	The area overlapped by the socio-economic EMBA represents 2.6% of the area available to the fishery. Given this fishery operates from March to November, in the event of a spill, it may be subject to a temporary and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **negligible** consequence to the overall function of the fishery, its catch species and its future viability given the small overlap of the EMBA with the fishery.	As per 'general'.
Kimberley Prawn Managed Fishery	No impacts due to their benthic habitat.	The area overlapped by the socio-economic EMBA represents 5.5% of the area available to the fishery. Given this fishery operates from April to mid-June (likely to overlap with the activity), in the event of a spill, it may be subject to a temporary and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **negligible** consequence to the overall function of the fishery, its catch species and its future viability given the small overlap of the EMBA with the fishery.	As per 'general'.
Kimberley Gillnet and Barramundi Fishery	No impacts due to their pelagic habitat.	The area overlapped by the socio-economic EMBA represents 7.9% of the area available to the fishery. Given this fishery predominantly operates from April to September June (likely to overlap with the activity), in the event of a spill, it may be subject to a temporary and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be	As per 'general'.

		of **negligible** consequence to the overall function of the fishery, its catch species and its future viability given the small overlap of the EMBA with the fishery.	
NT-managed fisheries (those known to fish within the EMBA)			
Spanish Mackerel Fishery	No impacts due to their pelagic habitat.	The area overlapped by the socio-economic EMBA represents 4.4% of the area available to the fishery. This area is not expected to be a highly fished area for mackeral. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an impact on the overall function of the fishery, its catch species or its future viability given the small overlap of the EMBA with the fishery. Therefore, the consequence of the MDO spill is therefore **negligible**.	As per 'general'.
Offshore Net and Line Fishery	No impacts due to their pelagic habitat.	The area overlapped by the socio-economic EMBA represents 4.4% of the area available to the fishery. This area is not expected to be a highly fished area for the fishery. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an impact on the overall function of the fishery, its catch species or its future viability given the small overlap of the EMBA with the fishery. Therefore, the consequence of the MDO spill is therefore **negligible**.	As per 'general'.
Demersal Fishery	No impacts due to their pelagic habitat.	The area overlapped by the socio-economic EMBA represents 3.4% of the area available to the fishery. This area is not expected to be a highly fished area for the fishery. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an impact on the overall function of the fishery, its catch species or its future viability given the small overlap of the EMBA with the fishery. Therefore, the consequence of the MDO spill is therefore **negligible**.	As per 'general'.

7.16.5. Risk Assessment

Table 7.64 presents the risk assessment for an MDO spill.

Table 7.64. Risk assessment for an MDO spill

Summary		
Summary of risks	Localised and temporary reduction in water quality. Potential toxicity impacts to marine life. Temporary fisheries closures.	
Extent of risks	EMBA is defined in Figure 7.12 to Figure 7.28.	
Duration of risks	Short-term (several days, depending on level of contact, location and receptor).	
Level of certainty of risks	HIGH – the environmental impacts of spilled hydrocarbons are well understood.	
Risk decision framework context	Decision type	A - good industry practice required.
	Activity	Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.
	Risk & uncertainty	Risks are well understood, uncertainty is minimal.
	Stakeholder influence	No conflict with company values, no partner interest, no significant media interest.
Defined acceptable level	No unplanned discharge of MDO to sea.	

Risk Assessment (inherent)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Negligible	Rare	Negligible
Macroalgal communities	Negligible	Rare	Negligible
Plankton	Negligible	Rare	Negligible
Pelagic fish	Negligible	Rare	Negligible
Cetaceans	Negligible	Rare	Negligible
Marine reptiles	Minor	Rare	Negligible
Seabirds	Negligible	Rare	Negligible
Shorebirds	Negligible	Rare	Negligible
Sandy beaches	Negligible	Rare	Negligible
Rocky shores	Negligible	Rare	Negligible
Commercial fisheries	Negligible	Rare	Negligible

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Refuel in port only	Administrative	Yes	**EB**: Reduces the risk of an at-sea spill.

(RSK-05:EPS-01)			**C:** No additional cost. Vessel can undertake the activity without the need to refuel. **Ev**: Environmental benefits can be achieved without cost.
Navigation equipment and procedures **(RSK-05:EPS-02)**	Engineering	Yes	**EB:** Reduces the risk of collisions with other marine users. **C:** While the costs of navigation equipment are significant, it is standard on vessels and the costs of maintaining it are minimal. It is a requirement of maritime law. **Ev:** The safety benefits of having navigation equipment and procedures outweighs the cost.
Stakeholder notifications **(RSK-05:EPS-03)**	Administrative	Yes	**EB:** Ensures other marine users are aware of the vessel and thus reduces likelihood of collision and unplanned release. **C:** Minimal costs associated with EOG personnel preparing and issuing notifications and responding to stakeholders. **Ev:** Benefits outweigh the minimal cost.
SMPEP **(RSK-05:EPS-04, -05, -06, -07, -09)**	Administrative	Yes	**EB:** Ensures crew are well prepared to quickly respond to a spill, thereby minimising the volume spilled and the extent of sea affected. **C:** SMPEP should already be in place. Low costs to stock vessel with equipment and maintain it. This is standard maritime practice. **Ev:** Benefits outweighs the low costs.
OPEP **(RSK-05:EPS-08, -10, -11)**	Administrative	Yes	**EB:** Ensures EOG is well prepared to quickly respond to a spill, thereby minimising the extent of sea affected. **C:** Minimal cost to prepare OPEP and roll out training. This is standard industry practice. Significant costs for implementing response strategies and arranging call-off (standby) contracts for response resources. **Ev:** Environmental benefits outweigh the significant costs.
OSMP **(RSK-05:EPS-12)**	Administrative	Yes	**EB:** Ensures EOG is well prepared to quickly undertake operational and scientific studies, thereby supporting the future assessment of impacts resulting from the spill. **C:** High cost to prepare OSMP, detailed implementation plans and roll out training. This is standard industry practice. Low cost for putting call-off contracts in place and significant costs to implement the OSMP. **Ev:** Environmental benefits outweigh the significant costs.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Preventative controls as per 'interference with other marine users' and 'routine emissions – light.' Additional controls are provided here.		
Preparedness		
No MDO is spilled at sea.	**(RSK-05:EPS-01)** No vessel refuelling is undertaken at sea (this will be done in port).	Bunker log verifies that refuelling was undertaken in port.
	(RSK-05:EPS-02) In order to minimise the risk of vessel-to-vessel collisions, vessels contracted to EOG will: • Comply with the requirements of: o *Navigation Act* 2012 (Cth), Chapter 3, Part 3 (Seaworthiness of vessels). o Marine Order 21 (Safety and emergency arrangements). o Marine Order 30 (Prevention of Collisions). o Marine Order 91 (Marine pollution prevention - oil). • Operate navigational lights and communication systems. • Maintain navigational lights and communication systems in accordance with their PMS. • Have trained and competent crew maintaining 24-hour visual, radar and radio watch for other vessels.	Vessel audit/assurance reports (prepared or commissioned by EOG) verify that vessels contracted to EOG meet legislative safety requirements.
	(RSK-05:EPS-03) EOG notifies relevant persons ahead of the activity so that third-party marine users are aware of vessel location and timing.	Stakeholder correspondence verifies that EOG made contact with relevant stakeholders about the timing and location of the activity.
Vessel crews are prepared to respond to a spill.	**(RSK-05:EPS-04)** Vessels have approved SMPEPs (or equivalent appropriate to class) that is implemented in the event of a large MDO spill.	Current SMPEPs are available.
		Spill incident report verifies that the actions were taken in accordance with the SMPEP.
	(RSK-05:EPS-05) Vessel crews are trained in spill response techniques in accordance with their SMPEP.	Training records verify that crews are trained in spill response.
	(RSK-05:EPS-06) 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 hydrocarbon spills to deck record that the spill

		is cleaned up using SMPEP resources.
	(RSK-05:EPS-07) Prior to the activity commencing, a desktop oil spill response exercise is conducted to test the interfaces between the EOG OPEP, ERP and vessel contractor SMPEP.	Oil spill response exercise spreadsheet verifies that exercises have been undertaken.
Emergency response		
Vessel crews promptly respond to a spill.	**(RSK-05:EPS-08)** An OPEP and ERP are in place and tested annually in desktop exercises by those nominated in the plans to be part of the response strategies.	The OPEP and ERP are current.
		OPEP and 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.
		OPEP and ERP exercise reports verify that exercises have been undertaken.
	(RSK-05:EPS-09) The Vessel Master will authorise actions in accordance with the vessel-specific SMPEP (or equivalent according to class).	Daily operations reports verify that the SMPEP was implemented.
	(RSK-05:EPS-10) The Beehive-1 PDSA OPEP is implemented to limit the release of a Level 2 or 3 MDO spill.	Daily operations reports verify that the OPEP was implemented.
Recording & reporting		
EOG and regulatory authorities are promptly made of aware of near-misses and spills.	**(RSK-05:EPS-11)** EOG will report the spill to regulatory authorities within 2 hours of the spill or becoming aware of the spill.	Incident report verifies that contact with regulatory agencies was made within 2 hours.
Monitoring		
Characterise environmental impacts of a Level 2 or 3 spill.	**(RSK-05:EPS-12)** EOG will undertake operational and scientific monitoring in accordance with the OSMP.	Daily operations reports and overall study reports verify that the OSMP was implemented.

Risk Assessment (residual)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Negligible	Remote	Negligible
Macroalgal communities	Moderate	Remote	Negligible
Plankton	Moderate	Remote	Negligible
Pelagic fish	Moderate	Remote	Negligible

<table>
<tr><td>Cetaceans</td><td>Moderate</td><td colspan="2">Remote</td><td>Negligible</td></tr>
<tr><td>Marine reptiles</td><td>Moderate</td><td colspan="2">Remote</td><td>Negligible</td></tr>
<tr><td>Seabirds</td><td>Moderate</td><td colspan="2">Remote</td><td>Negligible</td></tr>
<tr><td>Shorebirds</td><td>Moderate</td><td colspan="2">Remote</td><td>Negligible</td></tr>
<tr><td>Sandy beaches</td><td>Moderate</td><td colspan="2">Remote</td><td>Negligible</td></tr>
<tr><td>Commercial fisheries</td><td>Moderate</td><td colspan="2">Remote</td><td>Negligible</td></tr>
<tr><td colspan="5">The risk of an unplanned MDO release is assessed as negligible for all receptors because:
• The control measures adopted are effective at reducing the likelihood of an unplanned MDO release to remote.</td></tr>
<tr><th colspan="5">Demonstration of ALARP</th></tr>
<tr><td colspan="5">A ‘negligible’ residual risk rating is considered to be ALARP and a ‘lower order’ impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.</td></tr>
<tr><th colspan="5">Demonstration of Acceptability</th></tr>
<tr><td>Policy compliance</td><td colspan="4">EOG’s Safety and Environmental Policy objectives are met.</td></tr>
<tr><td>EMS compliance</td><td colspan="4">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="4">The residual risk for each receptor is negligible, which is considered acceptable.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td colspan="3">No concerns have been raised with regards to MDO spills.</td></tr>
<tr><td>Stakeholders</td><td colspan="3">During the EP public exhibition process, stakeholders did not express project-specific concerns with regards to MDO spills.</td></tr>
<tr><td>Legislative context</td><td colspan="4">The EPS align with the requirements of:
• Navigation Act 2012 (Cth):
  ○ Chapter 4 (Prevention of Pollution).
• OPGGS Act 2006 (Cth):
  ○ Section 572A-F (Polluter pays for escape of petroleum).
• OPGGS(E):
  ○ Part 3 (Incidents, reports and records).
• Protection of the Sea (Prevention of Pollution by Ships) Act 1983 (Cth):
  ○ Section 11A (SOPEP).</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="4">The consideration and alignment of EPS with the mitigation measures in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented in this activity</td></tr>
<tr><td colspan="2">Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td colspan="2">The EPS developed for this activity are in line with the management measures listed for spills from vessels in Section 4.7.2 of the guidelines:
• Vessels having a SMPEP (RSK-05: EPS-04).</td></tr>
</table>

		• Vessels having radar fitted and maintaining appropriate lighting and navigation systems **(RSK-05: EPS-02)**. • Having safety exclusion zones around facilities **(RSK-05: EPS-01)**.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	No guidance is provided regarding preventing or managing an offshore MDO spill, other than having a spill contingency plan in place. An OPEP is in place for the Beehive-1 PDSA.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Section 75 (Spills): Conducting a spill risk assessment, implementing personnel training and field exercises, ensuring spill response equipment is available **(RSK-05: EPS-05, -06, -07)**. • Sections 76-79 (Spill response planning): A spill response plan should be prepared **(RSK-05: EPS-04, -08)**.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met with regard to: • Section 8.6 (Hazardous materials): Ensuring that vessels carry a SMPEP, that spills are reported to local authorities and that oil spill response drills are conducted at regular intervals **(RSK-05: EPS-04, -05, -07, -08)**. • Section 8.8 (Vessel operations): Vessels must have oil absorbent materials available to respond to spills, and oil spills must be reported to local authorities **(RSK-05: EPS-06, -11)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the risk of any unplanned release of material into the marine environment to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs	The MDO EMBA intersects the JBG AMP. The AMP has the following relevant conservation value: - Carbonate banks and shoals.

		As addressed in Table 7.54 to Table 7.63, the consequence of an MDO spill on these conservation values is negligible and unlikely to result in long-term ecological impacts.
	Ramsar wetlands	There are no Ramsar wetlands intersected by the spill EMBA.
	TECs	There are no TECs identified in the spill EMBA.
	Nationally threatened and migratory species	Some nationally threatened species and migratory species have the potential to be present in the MDO spill EMBA, however as evaluated in the previous tables in this section, the consequence to individuals or populations of threatened and migratory species are considered negligible.
	Other matters	
	KEFs	The MDO EMBA intersects the Carbonate bank and terrace system of the Sahul Shelf KEF. The conservation values of this KEF are related to its benthic environment (diverse corals, sponges and demersal fish), and as such are unlikely to be affected by MDO because MDO is unlikely to occur at anything other than low thresholds near the seabed.
	NIWs	There are no NIWs that are intersected by the activity area or the spill EMBA.
	State marine parks	The MDO EMBA intersects the North Kimberley MP, which has the following environmental values: • River estuaries; • Turtle nesting beaches; • Fringing reefs; • Seabird and shorebird breeding sites; • Marine mammal foraging habitat; • Presence of pelagic finfish; and • Mangrove and intertidal mudflats. Given that these values and sensitivities will not be exposed to hydrocarbon concentration that are likely to cause ecological impact, it is anticipated that the impact to these values will be negligible.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	Marine pollution is a threat identified for the Australian lesser noddy, Abbott's booby, red knot, curlew sandpiper, great knot, greater sand plover, lessor sand plover, Nunivak bar-tailed godwit, Northern Siberian bar-tailed godwit and eastern curlew. In general, population monitoring is the suggested action to deal with marine pollution. Table 7.60 outlines the potential risks of an MDO spill to these species.

		The conservation advice and management plans for blue, humpback, sei and fin whales identify hydrocarbon spill as threats, though there are no specific aims to address this. Table 7.58 outlines the potential risks of an MDO spill to these species.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the risk of an MDO release to be acceptable because: • It will adhere to the company's Safety & Environmental Policy; • The residual risk ratings are negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the design of the survey; • Relevant legislation and industry best practice will be complied with; • An MDO release will not have long-term or significant impacts on MNES; • The management of an MDO release is not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • The management of an MDO release is not inconsistent with the aims of relevant marine reserve management plans; and • The management of an MDO release is not inconsistent with ESD principles.	
Environmental Monitoring		
• As per the OPEP and OSMP.		
Record Keeping		
• Vessel assurance reports. • Notices to Mariners. • Stakeholder consultation records. • SMPEPs. • OPEP. • ERP.	• Crew training records. • Bunkering procedure. • Bunkering PTWs, JSAs, inspection checklists. • Oil spill response exercise records. • Inspection/audit reports. • Incident reports.	

7.17. RISK 7 – Hydrocarbon Spill Response Activities

This section assesses the environmental and socio-economic risks associated with the MDO spill response strategies. Not all oil spill response options are appropriate for every spill type – responses vary based on key factors such as hydrocarbon type (light oil, heavy oil, refined oil), volume, location, sea state and trajectory.

Table 7.65 summarises the feasibility and effectiveness of the strategies available to respond to a Level 2 or 3 MDO spill, and whether they will be adopted. Only those that will be adopted are risk assessed in this section.

Table 7.65. Activity-specific MDO spill response options

Response option	Feasibility and effectiveness analysis	Adopt?
Source control	**Effectiveness** Implementing the vessel-specific SMPEP is the preferred manner in which to control an MDO release (e.g., transfer MDO from the ruptured tank to an intact tank, where possible). **Feasibility** This response strategy is effective based on the assumption that the vessel is not damaged to the point where electronic and hydraulic systems fail.	Yes
Monitor and Evaluate	**Effectiveness** MDO evaporates and disperses rapidly. MDO will be visible on the sea surface using satellite monitoring, vessel and aerial-based observations. **Feasibility** Monitoring is a fundamental part of any hydrocarbon spill response to gain situational awareness of the nature and scale of the spill and the direction of movement. Trained personnel at AMSA and within the oil and gas industry (via AMOSC) are readily available to undertake this monitoring.	Yes
Assisted Natural Dispersion	**Effectiveness** The use of vessels to break up slicks using propeller wash creates an inherent safety risk because of the presence of an ignition source (MDO is highly volatile). **Feasibility** Mechanical dispersion could be undertaken in slightly weathered MDO once the volatiles have flashed off to disperse the MDO into the water column to create smaller droplets and enhance biodegradation (only if monitoring indicates the slick is moving to sensitive shorelines).	Yes
Chemical Dispersants	**Effectiveness** Although the use of dispersants is 'conditional' for Group II oil such as MDO, the potential spill volume and the natural tendency of spreading into very thin films is evidence that dispersant application will be an ineffective response. Dispersant droplets will penetrate through the thin oil layer and cause 'herding' of the oil, which creates areas of clear water and could be mistaken for successful dispersion. **Feasibility** Dispersants push the MDO into the water column, creating longer lasting impacts in the water column than allowing the MDO to weather naturally from the sea surface. Dispersant use will have a net negative effect on the environment.	No
Offshore Containment and Recovery	**Effectiveness** The high volatility of MDO creates inherent safety risks when attempting to contain and recover it mechanically. This response technique is dependent on adequate MDO thickness (generally >10 g/m^2), calm seas and significant areas of unbroken surface slicks. Due to the low viscosity of MDO, the ability to contain and recover it is extremely limited. MDO evaporates faster than the collection rate of a thin	No

Response option	Feasibility and effectiveness analysis	Adopt?
	surface film present. It spreads in less time than is required to deploy this equipment. **Feasibility** There is recoverable MDO (>10 g/m^2) at the sea surface for this spill scenario, however it is unlikely to be effective because the areas of high MDO concentration would weather in less time than is required to deploy response equipment.	
Protection and Deflection	**Effectiveness** The high volatility of MDO creates inherent safety risks when attempting to use protection and deflection booms. Oceanic environments such as the offshore waters of the activity area often do not present suitable conditions for the use of booming material (i.e., swell and waves deem this strategy ineffective). **Feasibility** A shoreline protection and deflection response is not feasible for this activity because: • Rocky shorelines present a high safety risk for response personnel in terms of access. • MDO stranded on rocky substrate will weather rapidly due to the action of waves against the rocks. • Shoreline loading is predicted only at the low threshold, which will not result in toxicity impacts to fauna at the shoreline. • The remote locations where shoreline accumulations are predicted are very remote and suitable equipment may not be mobilised in time. • There are safety risks of working in shoreline areas known to be inhabited by crocodiles. Environmental impacts are likely to be higher when implementing this response technique compared to allowing for natural degradation.	No
Shoreline clean-up	**Effectiveness** MDO is highly volatile and will evaporate rapidly even after making shoreline contact. MDO also quickly infiltrates sand, where it is then remobilised by wave action (reworking) until it has naturally degraded. This quick infiltration through sediments makes it very difficult to recover without also recovering vast amounts of shoreline sediments. **Feasibility** A shoreline clean-up response is not feasible for this activity because: • Rocky shorelines present a high safety risk for response personnel in terms of access. • MDO stranded on rocky substrate will weather rapidly due to the action of waves against the rocks. • There is no length of shoreline predicted to be impacted by an actionable MDO exposure (>100 g/m^2) in the event of an MDO spill. Environmental impacts are likely to be higher when implementing this response technique compared to the natural degradation.	No
Oiled Wildlife Response (OWR)	**Effectiveness**	No

Response option	Feasibility and effectiveness analysis	Adopt?
	Because MDO evaporates and disperses rapidly, most fauna are unlikely to be exposed to sub-lethal or lethal hydrocarbon concentrations that warrant wildlife capture and treatment, especially at the sea surface or at shorelines. **Feasibility** The remoteness of the activity area and affected shorelines from wildlife rescue centres makes an OWR response infeasible. More wildlife harm could occur (during the handling and treatment process) using this response technique compared to allowing for natural cleaning. Hazing may be considered to disperse animals away from a slick (such as seabirds, shorebird, seals and dolphins) or any shoreline areas where MDO has not infiltrated beach sediments.	

Table 7.65 indicates that only the following responses may be used to respond to a hydrocarbon spill:

- Source control;
- Monitor and evaluate; and
- Assisted natural dispersion.

The risks associated with these response techniques is discussed in this section.

7.17.1. Scope of Activity

Source Control

In the event of a vessel-based MDO release, the key method of source control is outlined in the vessel-specific SMPEP (or equivalent based on class). The key response measures typically involve:

- Moving further out to sea (away from shoreline sensitivities) if the vessel is still able to navigate; and
- Transferring MDO from the affected tank/s to non-affected tanks.

Monitor and Evaluate

Ongoing monitoring and evaluation of a hydrocarbon spill is critical for maintaining situational awareness and to complement and support the other response activities. In some situations, monitoring may be the primary response strategy if natural dispersion and weathering processes are effective in reducing the volume of hydrocarbons reaching sensitive receptors (as is likely to be the case in this scenario).

Operational monitoring includes the following:

- Aerial observation (fixed-wing or helicopter);
- Vessel-based observation; and
- OSTM (computer-based and/or manual vector analysis).

Foot access along shorelines potentially at risk of contact (based on real-time OSTM) is not likely to be a feasible option given the remoteness of these shorelines, lack of vehicle access and amenities and presence of crocodiles.

Assisted Natural Dispersion

Assisted natural dispersion involves the use of motorised vessels to break up hydrocarbon slicks using propeller wash; essentially navigating a vessel in whatever pattern maximises travel through the slick to create smaller droplets and enhance biodegradation in the water column.

This activity is generally only necessary if monitoring indicates the slick is moving to sensitive shorelines.

Availability of Resources for Monitoring and Evaluation

EOG (through its membership with AMOSC) will have an operational monitoring capability as outlined in Table 7.66.

Table 7.66. Resources available for monitoring and evaluation

Resource required	AMSA resources	NT/WA resources	AMOSC resources
Availability to activity	Yes. Available to all non-petroleum vessels in Commonwealth waters.	Yes. Available to all non-petroleum vessels in state/NT waters.	Yes. EOG will be an AMOSC member at the time of the activity.
Aviation	AMSA has agreements in place to deploy fixed wing aerial dispersant capabilities, but not surveillance per se.	Access to aerial surveillance is available in the WA and NT Oil Spill Contingency Plans. Additionally, NatPlan resources can be activated.	Access to aerial surveillance is available from Batchelor, NT and can be mobilised within 4 hours.
Trained observers	Trained oil on water observers are available through the National Response Team (NRT).	Trained observers are available in the WA and NT Oil Spill Contingency Plans.	AMOSC's Core Group personnel (>120 oil and gas industry personnel nation-wide) are available 24/7 to respond to spills.
Vessel-based observations	Vessels of opportunity (VoO) based in the nearest ports (e.g., Darwin, Broome), would be engaged as required.		
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.	EOG will activate its contract with AMOSC to access 24/7 emergency OSTM. OSTM results can generally be provided within 4 hours of request.

7.17.2. Hazard

The hazards associated with each of these response options are:

- Additional vessel activity (over a greater area than the operational area), resulting in additional routine emissions (air, noise) and routine discharges (sewage, putrescible waste, cooling water, etc); and
- Sound generated by aircraft.

7.17.3. Potential environmental risks

The impacts and risks associated with these response options are:

- Routine and non-routine impacts and risks associated with vessel operations (as outlined throughout this chapter); and
- Noise disturbance to marine fauna and shoreline species by aircraft.

7.17.4. Evaluation of Environmental Risks

The impacts and risks associated with routine and non-routine vessel operations are assessed in Sections 7.1 to 7.16 and are not repeated here. In addition to these impacts and risks are those associated with the presence of aircraft. 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).

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.

7.17.5. Risk Assessment

Table 7.67 presents the risk assessment for hydrocarbon spill response activities.

Table 7.67. Risk assessment for hydrocarbon spill response activities

Summary	
Summary of risks	Disturbance to marine and shoreline fauna.
Extent of risk	Localised – area immediately around vessel or aircraft
Duration of risk	Short-term (days to a week).
Level of certainty of risk	HIGH – The impacts associated with vessel discharges and noise disturbance to fauna from vessels and helicopters are well understood, and controls are documented in legislation.

Risk decision framework context	Decision type	B – good industry practice required with engineering risk-based tools applied.
	Activity	New to the organisation or geographical area, infrequent or non-standard activity, good practice not well defined or met by more than one option.
	Risk & uncertainty	Amenable to assessment using well-established data and methods, some uncertainty.
	Stakeholder influence	No conflict with company values, some partner interest, some persons may object, may attract local media attention.
Defined acceptable level	The net environmental benefit of a spill response strategy must be greater than no response.	

Risk Assessment (inherent)			
Receptor	Likelihood	Consequence	Risk rating
Fauna disturbance	Occasional	Minor	Low
Fauna injury	Occasional	Minor	Low
Fauna death	Rare	Minor	Negligible

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
SMPEP **(RSK-06:EPS-01, -05)**	Administrative	Yes	**EB:** Ensures crew are well prepared to quickly respond to a spill, thereby minimising the volume spilled and the extent of sea affected. **C:** Minimal cost for vessel contractor to prepare document. Low costs to stock vessel with equipment and maintain it. This is standard maritime practice. **Ev:** Benefits outweighs the low costs.
OPEP **(RSK-06:EPS-04, -06, -07)**	Administrative	Yes	**EB:** Ensures EOG is well prepared to quickly respond to a spill, thereby minimising the extent of sea affected. **C:** Minimal cost to prepare OPEP and roll out training. This is standard industry practice. Significant costs for implementing response strategies and putting call-off contracts in place for response resources. **Ev:** Environmental benefits outweigh the significant costs.
Capable response equipment and personnel **(RSK-06:EPS-02, -03)**	Administrative	Yes	**EB:** Modern, functional and well-maintained equipment ensures efficient response. Trained personnel are more likely to deploy equipment correctly and minimise inadvertent impacts to fauna.

			C: Significant costs for AMOSC membership. Significant cost to maintain personnel capabilities through regular training. **Ev:** Environmental benefits outweigh the significant costs.
OSMP **(RSK-06:EPS-08)**	Administrative	Yes	**EB:** Ensures EOG is well prepared to quickly undertake operational and scientific studies, thereby supporting the future assessment of impacts resulting from the spill. **C:** High cost to prepare OSMP, detailed implementation plans and roll out training. This is standard industry practice. Low cost for putting call-off contracts in place and significant costs to implement the OSMP. **Ev:** Environmental benefits outweigh the significant costs.
Maintain distance from marine fauna during spill response activities **(RSK-06:EPS-09, -10, -11)**	Administrative	Yes	**EB:** Reduces potential for behavioural disturbance to cetaceans during spill response activities. **C:** No additional cost. **Ev:** Environment benefits can be achieved without cost.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Preparedness		
Source control EOG and its vessel contractors are operationally ready to respond to a spill.	**(RSK-06:EPS-01)** Vessels contracted to EOG have a current SMPEP (or as appropriate to class) in place.	Inspection/audit records verify current SMPEPs in place.
Monitor and evaluate EOG maintains capability to implement hydrocarbon spill monitoring and response in a Level 2 or 3 spill event.	**(RSK-06:EPS-02)** Access to operational response capabilities is maintained through the vessel paying the required shipping levy and EOG having membership with AMOSC.	Survey vessel pays required shipping levy. AMOSC membership is current.
	(RSK-06:EPS-03) AMSA undertakes regular testing of response arrangements and equipment to ensure it is always ready to respond rapidly.	AMSA response capabilities are maintained in a manner that permits them to respond to spills rapidly (noted in annual reports).
	(RSK-06:EPS-04) EOG undertakes a desktop drill prior to the survey commencing in order to test internal and external spill response communications.	Exercise drill report is available.
Response		
Source control The source of the release is stopped in	**(RSK-06:EPS-05)** MDO loss is managed through implementation of the vessel SMPEP (or equivalent according to class).	Incident logs verify that the SMPEP is implemented.

the shortest time possible in accordance with established procedures.		
Monitor and evaluate Undertake visual observations to monitor spill behaviour and determine whether it is likely to reach sensitive receptors.	**(RSK-06:EPS-06)** Visual observations from the support vessels are initiated immediately.	Incident report verifies that visual observations commenced immediately following a spill.
	(RSK-06:EPS-07) The NatPlan is activated so that AMSA can commence undertaking monitoring activities.	Incident communications log verifies that AMSA was contacted and asked to activate the NatPlan.
The trajectory of the spill is predicted based on the spill location in order to inform response strategies.	**(RSK-06:EPS-08)** OSTM is undertaken in accordance with NatPlan requirements.	Incident records verify OSTM was undertaken.
Activity controls		
Monitor and evaluate, protection and deflection Monitoring activities are undertaken in a manner that protects sensitive fauna and habitat.	**(RSK-06:EPS-09)** Helicopters will maintain a buffer distances of 500 m around cetaceans in accordance with EPBC Regulations 2000 (Part 8).	Flight instructions document these constraints.
	(RSK-06:EPS-10) Vessels will maintain buffer distances around whales and dolphins in accordance with The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) for those individuals not visibly affected by hydrocarbons (closer approaches may be necessary to determine impacts).	Incident reports note when cetaceans were sighted and what actions were undertaken.
	(RSK-06:EPS-11) Environmental briefings are conducted for shoreline monitoring crews to identify site-specific risks and suitable controls.	Briefing records are available.

Risk Assessment (residual)			
Receptor	Likelihood	Consequence	Risk rating
Fauna disturbance	Rare	Minor	Negligible
Fauna injury	Rare	Minor	Negligible
Fauna death	Remote	Minor	Negligible

The risk of spill response activities to the identified receptors is assessed as low because:

- The control measures adopted are effective in reducing the risk to ALARP

Demonstration of ALARP
A 'negligible' residual risk rating is considered to be ALARP and a 'lower order' impact. The adopted controls and associated EPS have lowered the risk to the point that any additional or alternative control measures either fail to lower the residual risk rating any further or are grossly disproportionate to the residual risk rating.

<table>
<tr><td colspan="3">Table 7.63 provides a guide as to the suitability of response techniques for an MDO spill, including in the context of the OSTM undertaken for the activity. This should be taken into account into this demonstration of ALARP.</td></tr>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td>Policy compliance</td><td colspan="2">EOG’s Safety and Environmental Policy objectives are met.</td></tr>
<tr><td>EMS compliance</td><td colspan="2">Chapter 8 outlines the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td rowspan="2">Engagement</td><td>Relevant persons</td><td>There have been no objections or claims received from relevant persons regarding spill response activities.</td></tr>
<tr><td>Stakeholders</td><td>During the EP public exhibition process, stakeholders did not express project-specific concerns regarding spill response activities.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS align with the requirements of:
• OPGGS Act 2006 (Cth) and OPGGS(E) (Cth):
  ○ Part 6.2 – directs the polluter to take actions in response to an incident and to clean up and monitor impacts.
  ○ Regulation 13(5) (Risk assessment undertaken to demonstrate ALARP).
• EPBC Regulations 2000 (Cth):
  ○ Part 8 (Interacting with cetaceans and whale watching).
• Pollution of Waters by Oil and Noxious Substances Act 1987 (WA)
• Pollution Control Act 1998 (NT)</td></tr>
<tr><td rowspan="5">Industry practice</td><td colspan="2">The consideration and alignment of EPS with the mitigation measures outlined in the below-listed codes of practice and guidelines demonstrates that BPEM will be implemented for this activity.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to:
• Emergency preparedness and response – spill preparedness and emergency response measures are in place (RSK-06: EPS-01).</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>No guidance is provided regarding oil spill response activities, other than having a spill contingency plan in place. An OPEP is in place for the activity.</td></tr>
<tr><td>Effective planning for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)</td><td>The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.</td></tr>
<tr><td>Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)</td><td>Guidelines met with regard to:
• Sections 76-79 (Spill response planning): A spill response plan should be prepared (RSK-06: EPS-01).</td></tr>
</table>

	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore development and production objectives: • To reduce the risk of any unplanned release of material into the marine environment to ALARP and to an acceptable level.
	Hydrocarbon spill-specific guidelines	
	NatPlan (AMSA, 2020).	AMSA will implement this plan in the event their resources are deployed. The EPS listed in this table complement the NatPlan.
	AMOSPlan (2017)	AMOSC (on behalf of EOG) will implement this plan in the event their resources are required. The EPS listed in this table complement AMOSPlan.
	WA Oil Spill Contingency Plan (2015)	DoT will implement this plan in the event their resources are deployed. The EPS listed in this table complement the WA Oil Spill Contingency Plan.
	NT Oil Spill Contingency Plan (2014).	DoT Marine Safety will implement this plan in the event their resources are deployed. The EPS listed in this table complement the NT Oil Spill Contingency Plan.
	Contingency planning for oil spills on water – Good practice guidelines for incident management and emergency response personnel (IPIECA/IOGP, 2015).	The EPS listed in this table are prepared cognisant of these guidelines, which discuss oil spill scenarios, various response techniques and the requirements for contingency plan preparation.
	Oil spill training - Good practice guidelines on the development of training programmes for incident management and emergency response personnel (IPIECA/IOGP, 2014).	The EPS listed in this table are prepared cognisant of these guidelines, in so far as training of EOG and contractor personnel in oil spill preparedness and response takes place and is overseen by an emergency response specialist.
	Aerial Observations of Marine Oil Spills (ITOPF, 2011b).	The EPS listed in this table related to monitoring were prepared cognisant of these guidelines, which describe monitoring techniques and outline the importance of monitoring in guiding on-water and shoreline response activities.
	Aerial Observations of Oil Spills at Sea (IPIECA/OGP, 2015).	
Environmental context	MNES	
	AMPs	Oil causing marine pollution are a threat identified in the North Marine Parks Network Management Plan 2018. Spill response will not be undertaken in AMPs given that actionable surface oiling is not predicted within the JBG AMP. Vessel or aircraft-

		based monitoring activities will have no significant impacts on the AMP.
	Ramsar wetlands	Spill response will not be undertaken in Ramsar wetlands given that surface oiling is not predicted. Vessel or aircraft-based monitoring activities will have no impacts on Ramsar wetlands.
	TECs	Spill response will not be undertaken in areas where TECs exist. Vessel or aircraft-based monitoring activities will have no impacts on TECs.
	Nationally threatened and migratory species	Some threatened and migratory species have the potential to be present in spill response areas but given that the key response strategy is centred on monitoring and surveillance because of the volatile nature of the hydrocarbons, vessel or aircraft-based monitoring activities will have no impacts on threatened and migratory species.
	Other matters	
	KEFs	Spill response will not be undertaken in KEFs given that an on-water clean-up is not required. Vessel or aircraft-based monitoring activities will have no impacts on KEFs.
	NIWs	Spill response will not be undertaken in NIWs given that surface oiling is not predicted. Vessel or aircraft-based monitoring activities will have no impacts on NIWs.
	State marine parks	Many of the Victorian marine and coastal reserve management plans list the protection of marine and terrestrial ecological communities and indigenous flora and fauna, particularly threatened species, as a management aim. Spill response may be undertaken in coastal marine parks given that shoreline loading is predicted to contact some parks. Land, vessel or aircraft-based monitoring activities will have no significant impacts on these marine parks or the management objectives of the parks' management plans.
	Species Conservation Advice / Recovery Plans / Threat Abatement Plans	Marine pollution is a threat identified in the Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017). The risks posed by response operations do not impact the relevant interim recovery objectives or management actions. The conservation advice and management plans for blue, humpback, sei and fin whales identify

		hydrocarbon spill as threats, though there are no specific aims to address this.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Statement of acceptability	EOG considers the risk of an MDO release to be acceptable because: • It will adhere to the company's Safety & Environment Policy; • The residual risk ratings are negligible; • An Implementation Strategy (described in Chapter 8) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons and stakeholders has been considered and incorporated into the design of the activity; • Relevant legislation and industry best practice will be complied with; • Spill response activities will not have long-term or significant impacts on MNES; • Spill response activities are not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • Spill response activities are not inconsistent with the aims of relevant marine reserve management plans; and • Spill response activities are not inconsistent with ESD principles.	
Environmental Monitoring		
• As per NatPlan requirements.		
Record Keeping		
• Contracts and agreements with third parties. • Equipment and service provider register. • Exercise drill reports. • Inspection/audit reports. • Incident and daily operations reports.	• Operational NEBA. • Briefing records. • Photos. • OSMP implementation records and reports. • IAP.	

8. Implementation Strategy

The OPGGS(E) Regulation 14 requires that an Implementation Strategy be included in an EP. EOG retains full and ultimate responsibility as the Titleholder of the activity and is responsible for ensuring that the EPO and EPS outlined throughout Chapter 7 are adequately implemented.

8.1. Activity Organisational Structure

Figure 8.1 provides an overview of the relationship between EOG, contractors and consultants for the activity.

As the project manager for the activity, EOG, with support from Aventus Consulting (Aventus) and AGR Australia (AGR), has overall responsibility for the management of the activity to ensure that:

- Design and execution of the activity is in accordance with industry accepted practice and legislated standards;
- All regulatory approvals are obtained prior to activity commencement;
- Contractors have been pre-qualified as having appropriate resources and equipment to undertake the activity and have appropriate systems in place to ensure that these activities are undertaken in accordance with all legislative requirements;
- The environmental impacts and risks of the activity are minimised and reduced to ALARP and environmental performance is monitored; and
- The day-to-day direction and oversight of work by contractors is undertaken in accordance with the accepted EP.

The vessel contractor/s will have the day-to-day control and management of the vessel/s through the Vessel Master. The Vessel Master has over-riding authority and responsibility to make decisions with respect to pollution prevention and to request assistance as may be necessary.

8.2. Roles and Responsibilities

The environmental roles and responsibilities of key project team members are summarised in Table 8.1.

Day-to-day implementation of the activity (and the EP) will occur on the vessel under the leadership of the Vessel Master, Party Chief and the EOG Onboard Representative. AGR will support the performance of the activity against the project plans as well as undertake reviews and audits as required.

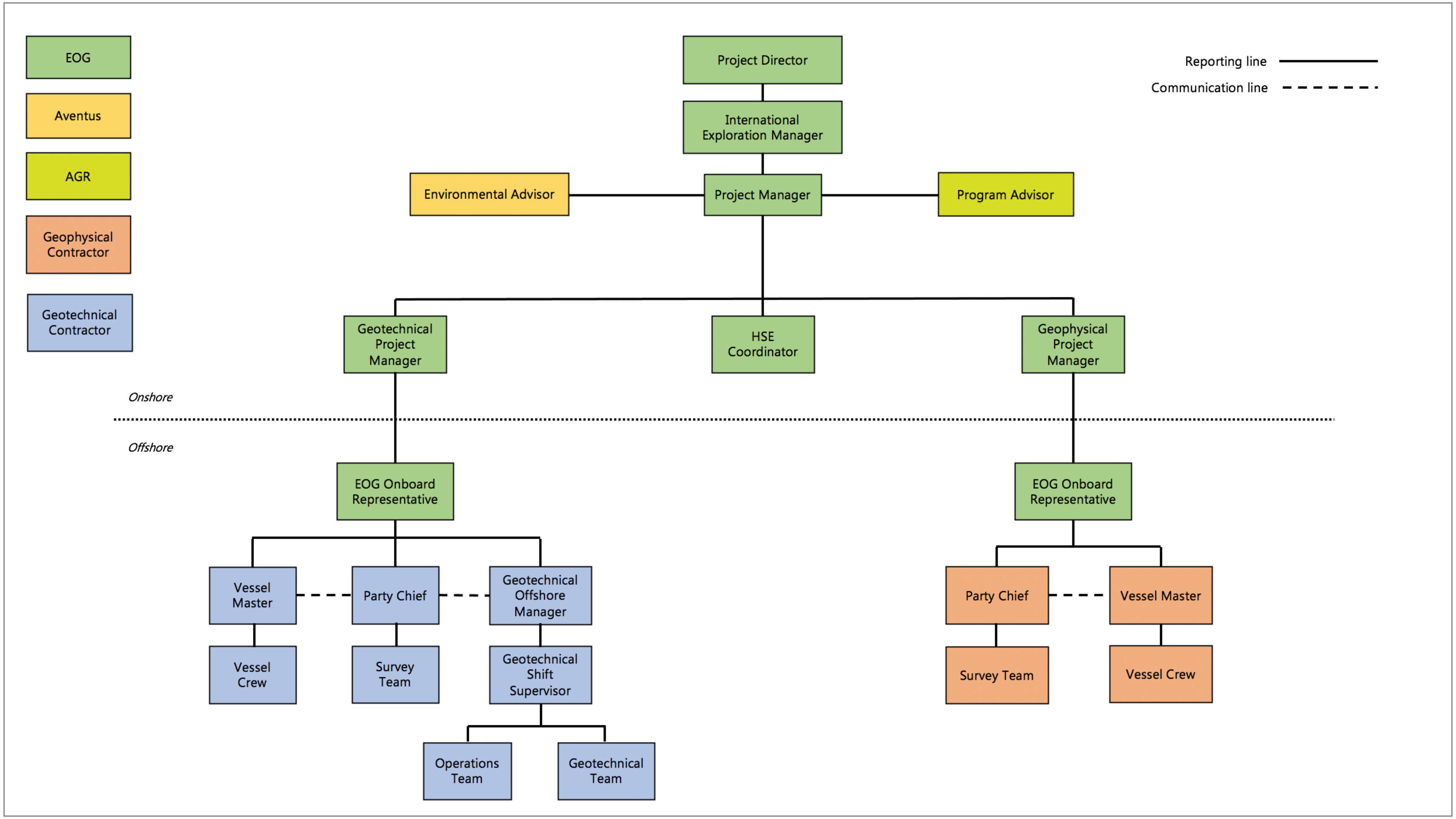


Figure 8.1. Activity organisation chart

Table 8.1. Environmental roles and responsibilities for the activity

Role	Environmental responsibilities
Onshore	
EOG	
Project Director	• Ensures EOG is adequately resourced to undertake the PDSA. • Ensures AGR and Aventus are adequately resourced to support the PDSA. • Provides direction on stakeholder consultation. • Approves this EP for submission to NOPSEMA. • Approves incident reports for submission to NOPSEMA. • Approves the Environmental Performance Report for submission to NOPSEMA. • Approves the end-of-activity notification for submission to NOPSEMA.
Vice President (Safety & Environment)	• Ensures EOG's Safety and Environmental Policy is applied to the activity.
Manager, Exploration, International New Ventures	• Provides guidance on operational procedures. • Reviews major changes to operations. • Attends stakeholder consultation, as required. • Reviews this EP. • Reviews incident investigation reports. • Reviews the Environmental Performance Report for submission to NOPSEMA. • Reviews the end-of-activity notification for submission to NOPSEMA.
Project Manager	• Overall project manager for the PDSA. • Works with the EOG team, as well as all contractors, to execute a safe and successful PDSA. • Liaises with AGR and Aventus for guidance • Attends operations meetings during the activity. • Reviews technical proposals to ensure compliance with industry best practice and EOG's Safety and Environmental Policy. • Confirms all required plans, audits and reviews are undertaken in accordance with the requirements of the EP. • Liaises with and submits incident reports for submission to NOPSEMA. • Reviews this EP. • Reviews incident reports and submits them to regulators, as required. • Ensures all notifications are prepared and submitted in a timely fashion. • Submits the Environmental Performance Report to NOPSEMA. • Submits the end-of-activity notification for submission to NOPSEMA.
Senior HSE Coordinator	• Manages the preparation of HSE regulatory approvals documents. • Reviews this EP. • Arranges for review of vessel contractor's HSE management system and other HSE documentation upon contract award. • Reviews emergency response plans. • Records and reports incidents to EOG. • Reviews incident reports and notifications. • Leads HSE incident investigation and reporting. • Provides HSE support during operations. • Ensures management systems processes and procedures are applied to the activity.
Geophysical/ Geotechnical Project Manager	• Reports to and maintains open and frequent communication with the EOG Project Manager. • Undertakes a technical review of the activity.

Role	Environmental responsibilities
	• Ensures compliance with data acquisition technical requirements. • Ensures inductions, auditing and reporting requirements are met. • Prepares Scope of Work. • Liaises with EOG project team regarding operations. • Provides technical and operational advice. • Monitors offshore performance on a daily basis. • Attends daily operational meetings. • Makes technical decisions regarding operations.
SPECIALISTS	
AGR (Program Advisor)	• Supports EOG with vessel inspections to ensure compliance with scope of activity and EP. • Provides emergency response support and facilities. • Provides logistical and operational support before, during and after the activity.
Aventus (Environmental Advisor)	• Prepares the EP. • Provides technical input to stakeholder consultation. • Maintains the stakeholder consultation register. • Plans for the implementation of the EP. • Prepares the environmental induction. • Conducts inspections/audits of compliance with the EP. • Monitors environmental performance against the EPS in this EP. • Assists with review, investigation and reporting of environmental incidents. • Provides incident support. • Reviews major changes to operations. • Alerts EOG ahead of any required notifications. • Prepares monthly recordable incident reports for submission to NOPSEMA. • Prepares the end-of-activity notification for submission to NOPSEMA. • Prepares the end-of-activity environmental performance report for submission to NOPSEMA.
Offshore	
Vessel Master	• Ensures full compliance with all applicable navigational safety standards and regulations. • Conducts emergency drills. • Supervises vessel crew to ensure they are fit for duty and undertaking work only within their area of qualification and training. • Monitors, reports and takes appropriate action to remedy any vessel or equipment defects that may impact on safety and environmental performance of the vessel. • Maintains logs of emissions and discharges in accordance with MARPOL regulations. • Ensures that all crew are appropriately qualified, trained and equipped for their roles on the vessel. • Reports all incidents and near-misses to the Vessel Manager and EOG Onboard Representative, recording the details and taking initial actions with the Vessel Master to render the situation safe. • Ensures the EPBC Act Policy Statement 2.1 - Part A (Standard Management Procedures) is implemented during geophysical investigations and that megafauna sightings and interactions are recorded. • Ensures megafauna observations are distributed to EOG at the completion of the activity.

Role	Environmental responsibilities
EOG Onboard Representative	• Facilitates clear communications between EOG and the vessel contractor. • Attends incident investigations. • Conducts induction for all project personnel. • Ensures compliance with Scope of Work and EP. • Checks all data meets specifications and notes any deviations. • Provides daily feedback on operations progress to EOG Project Manager. • Reports all incidents to the EOG Project Manager. • Ensures the EP and EOG HSE Plan are followed throughout the work. • Confirms survey equipment supplied is fit for purpose. • Monitors work and confirms it is being completed to appropriate standards. • Attends and contributes to project meetings and any HAZIDs. • Supervises all aspects of the work. • Keep a project log for the duration of the work. • Tracks progress, issues, status and schedule. • Highlights any project risks to EOG Project Manager. • Submits daily reports and calls to EOG Project Manager. • Continually monitors and compares newly acquired data against EOG data and reports any deviations to EOG Project Manager. • Promotes a proactive approach to safety awareness and acts to prevent incidents, as required. • Reviews contractor documents for EOG. • Reports incidents and near-misses to the EOG Project Manager. • Analyses, makes recommendations and reports on contractor's HSE performance.
Party Chief	• Implements the Scope of Work, HSE Plan, EP (and ERP, if required). • Ensuring the procedures and work instructions required for operations are known, understood and followed by all vessel personnel. • Ensures toolbox meetings are carried out. • Ensures new employees receive inductions and training relevant to their role and are appropriately supervised. • Ensures HSE inspections and audits are undertaken. • Ensures that preventative maintenance is carried out on equipment and installations onboard. • Ensures that all working codes and practices are implemented for the activity in accordance with industry standards. • Promotes safe operations. • Maintains open and clear communication with the EOG Onboard Representative. • Attends project calls and meetings as required.
Vessel crew	• Apply operating procedures in letter and in spirit. • Follow good housekeeping procedures and work practices. • Attend all necessary toolbox talks and HSE inductions. • Encourage improvement in environmental performance wherever possible. • Immediately report environmental incidents or near-misses to their Supervisor.

8.3. HSE Management

EOG will have overall responsibility for the management, review and audit of HSE issues during implementation of the activity, ensuring the activity is conducted safely and in accordance with corporate policies and procedures, as well as relevant Australian legislation and international standards.

EOG will have in place a project-specific HSE Plan that is aligned with ISO 14001:2016 (*Environmental Management Systems – requirements with guidance for use*), ISO 31000:2009 (*Risk management*), ISO 45001:2018 (*Occupational health and safety management systems*) and ISO 9001:2016 (*Quality management systems–requirements*) to guide the management of the activity. The HSE Plan will include (but not be limited to) the following:

- Leadership and commitment –HSE objectives and performance monitoring, stop work authority;
- Organisation – roles and responsibilities, reporting;
- HSE legislation and standards – occupational, health and safety legislation, international G&G standards;
- Risk management – risk management procedures and matrix;
- HSE competence and training – training and induction requirements;
- Subcontractors – pre-qualification process, management;
- Communications – meetings, record keeping and reporting, HSE awareness programs;
- Work instructions – permit to work system;
- Management of change;
- Incident management – recording and reporting procedures, investigation procedure, communicating lessons learned;
- Safety critical equipment and activities – safety critical equipment, working at heights, confined space, PPE requirements, hot work;
- Emergency response;
- Occupation health – medical facilities, infectious disease management (e.g., COVID-19), hygiene, smoking, fatigue management, drugs and alcohol, heat stress, mental health;
- Security – International Ship and Port Facility Security (ISPS) compliance, security alert levels, port security, third-party interference;
- Environmental management – EP compliance, waste management, spill prevention, preparedness and response, biosecurity, monitoring; and
- Audit and review – inspection and audit program.

The vessel contractor/s used to conduct the activity will be required to have an HSE management system or plan that meets the requirements of the EOG Safety and Environmental Policy.

8.4. Training and Awareness

8.4.1. Recruitment and Training

During its contractor selection process, EOG will conduct an HSE qualification to ensure that the vessel contractor/s has procedures in place to ensure the correct selection, placement, training and ongoing assessment of employees.

Procedures should also be in place to identify the training needs of an individual to competently perform their role, and evidence of corporate and/or vessel inductions will also be required.

8.4.2. Environmental Induction

An activity-specific HSE induction for all personnel working on the activity will be undertaken. The environmental component of the induction will include information on the following environmental issues:

- Description of the environmental sensitivities, conservation and heritage values of the activity area and spill EMBA;
- The 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 aboard the vessel.

Aventus will prepare the induction and the Onboard EOG Representative is responsible for ensuring personnel receive this induction prior to the commencement of the activity. All personnel will be required to sign an attendance sheet to confirm their participation in and understanding of the induction.

The vessel contractor/s will conduct their own company and vessel-specific inductions independently of the activity-specific HSE induction.

8.4.3. Oil Spill Response Training

Quarterly training of vessel crews in SMPEP procedures is a MARPOL requirement for vessels over 400 GRT (Annex 1, Regulation 37).

During its contractor audit process, AGR will assess the vessel contractor's implementation of their SMPEPs (or equivalent, relevant to class).

An office-based desktop spill response exercise of the activity-specific OPEP will be conducted by AGR, involving EOG (if representatives are in-country), AGR and key personnel from the vessel contractor/s prior to the activity commencing.

8.4.4. Megafauna Observers

The Vessel Master will nominate crew to undertaken observations for megafauna during the geophysical investigations.

The EOG Onboard Representative will provide an information session, prepared by Aventus, to the geophysical vessel crew at the start of the geophysical investigations on the requirements for implementing EPBC Act Policy Statement 2.1 to ensure their duties are undertaken efficiently.

8.4.5. Toolbox Talks and HSE Meetings

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

Environmental issues will also be addressed in daily operations meetings and weekly HSE meetings, where department leads will participate with the EOG Onboard Representative and Vessel Master in discussing HSE matters that have arisen during the week, and issues to consider for the following week.

Records associated with environmental training, inductions and attendance at toolbox meetings will be recorded and maintained onboard the vessel.

8.4.6. Communications

The Vessel Master, Vessel HSE Lead, Party Chief and EOG Onboard Representative are responsible for keeping personnel informed about HSE issues, acting as a focal point for personnel to raise issues and concerns, and consulting and involving all personnel in the following:

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

Table 8.2 outlines the key meetings proposed to take place onshore and offshore during the activity.

Table 8.2. Activity communication meetings

Meeting	Frequency	Attendees
Onshore		
EOG Project Management	Daily	Vessel Manager (if necessary), EOG Project Manager, EOG Onboard Representative, Party Chief.
Vessel		
Operations (including HSE)	Daily	Vessel Master, EOG Onboard Representative, Party Chief, vessel HSE Lead, Lead Processor, Medic, Heads of Departments
Pre-start safety meeting	Daily, prior to each shift	All personnel on shift
Toolbox	Before each task	All personnel involved in the task, including the Party Chief, EOG Onboard Representative and Medic (if necessary)

8.5. Environmental Emergencies and Preparedness

In the event of an emergency of any type, the Vessel Master will assume overall onsite command and act as the Emergency Response Coordinator (ERC). All personnel aboard the vessel will be required to act under the ERC's directions.

At the EOG corporate level, the EOG Onboard Representative will maintain communications with the EOG Project Manager, who will become the overall Incident Management Team (IMT) Leader and will coordinate EOG's IMT (if required), with support from AGR as required.

In the event of an emergency involving a hydrocarbon spill, the Vessel Manager will implement the vessel SMPEP, while AGR can provide several personnel with current IMO spill response training as well as other support, if the event requires it. Oil spill emergency response for this activity is outlined in Chapter 9.

8.5.1. Adverse Weather Protocols

It is Vessel Master's responsibility to be the focal point for all actions and communications with regards to adverse weather or sea state, to safeguard the vessel, all personnel onboard and the environment. During adverse weather, the Vessel Master is responsible for implementing the vessel's Severe Weather Plan (or equivalent), which includes:

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

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

In addition to using Very High Frequency (VHF) Marine Radio Weather Services, the vessel contractor will obtain daily weather forecasting from the Bureau of Meteorology (BoM) and/or other suitable weather monitoring services to monitor weather within the activity area in the lead up to and for the duration of the activity.

8.5.2. Vessel Emergencies and Oil Spills

Activity-specific emergency response procedures will be included in the HSE Plan, SMPEP and vessel contractors' ERP. The ERP will contain instructions for vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification and emergency contact information.

Vessel-specific SMPEP and ERPs 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.

The SMPEP includes information about initial response, reporting requirements and arrangements for the involvement of third-parties having the appropriate skills and facilities necessary to respond effectively to oil spill issues. The SMPEP will be the principal working document for the vessel and crew in the event of a marine oil spill incident. This document will include specific emergency procedures including steps to control discharges for bunkering spills, hull damage, grounding and stranding, fire and explosion, collisions, vessel list, tank failure, sinking, and vapour releases. The SMPEP also includes requirements for regular drills of the plan and revision following drills or incidents.

The activity-specific OPEP (Chapter 9) will be implemented (and supplements the vessel-specific SMPEP) in the event of a Level 2 or Level 3 hydrocarbon spill that requires response resources beyond those immediately available to the vessels. The Vessel Master will ensure that all crew on board are fully aware of the vessel-specific requirements and that exercises for vessel-related incidents are conducted.

8.5.3. Emergency Response Training

The readiness and competency of EOG and the vessel contractor/s to respond to incidents and emergencies will be tested by conducting a desktop emergency response exercise no earlier than four (4) weeks prior to the activity commencing. If different contractors are hired for each of the geophysical and geotechnical campaigns, this exercise applies to both campaigns.

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). This way several plans (i.e., the ERP and OPEP) can be tested simultaneously.

This exercise has the objectives of:

- Developing and testing the response arrangements as outlined in the emergency response procedures;
- Ensuring the skills and teamwork of the Emergency Response and Command Teams to respond to major emergency events are up-to-date. In particular, ensuring individual roles, responsibilities and reporting requirements are understood;
- Testing interfaces between all key parties involved in emergency response (EOG, AGR and vessel contractor); and
- Ensuring the correct communications are known and used and that contact details (e.g., phone numbers) are correct.

This exercise will be facilitated by an experienced facilitator. At the completion of the exercise, 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 testing exercise will be addressed and incorporated into the relevant emergency response plans and procedures to ensure they remain effective.

8.6. 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.

The activity area is located 1.4 km from the Blacktip gas pipeline, operated by Eni Australia. EOG will remain in contact with Eni so that SIMOPs issues can be addressed if and as required.

Santos is planning to acquire the Petrel Sub-Basin South-West 3D MSS between 1st December 2021 and 31 March 2022. This does not overlap with the timing of the Beehive PDSA. EOG will remain in contact with Santos to ensure that if both activities occur simultaneously, they can do so safely.

8.7. Incident Management

8.7.1. Recordable Incident Management

Regulation 4 of the OPGGS(E) regulations defines a 'recordable' incident as:

> *A breach of an EPO or EPS in the EP that applies to the activity that is not a reportable incident.*

Routine monthly recordable incident reports, including 'nil' incident reports, will be prepared by the EOG Environment Advisor and submitted to NOPSEMA by the 15th of each month. These are reported using the NOPSEMA template *Monthly environmental incident reports* (N-03000-FM0928). Table 8.3 summarises the recordable incident reporting requirements.

Table 8.3. Recordable incident reporting details

Timing	Reporting requirements	Contact
By the 15th of each month	• All recordable incidents that occurred during the previous calendar month. • The date of the incident. • All material facts and circumstances concerning the incidents that the operator knows or is able to reasonably find out. • The EPO and/or EPS breached. • Actions taken to avoid or mitigate any adverse environmental impacts of the incident. • Corrective actions taken, or proposed to be taken, to stop, control or remedy the incident. • Actions taken, or proposed to be taken, to prevent a similar incident occurring in the future. • Actions taken, or proposed, to prevent a similar incident occurring in the future.	NOPSEMA – submissions@nopsema.gov.au

8.7.2. Reportable Incident Management

Regulation 4 of the OPGGS(E) defines a 'reportable' incident as:

> *An incident that has caused, or has the potential to cause, moderate to significant environmental damage.*

In the context of the EOG Environmental Risk Matrix, EOG interprets 'moderate to significant' environmental damage to be those hazards identified through the EIA and ERA process (see Chapter 7) as having an inherent or residual impact consequence of 'moderate' or greater. Impacts and risks with these ratings (as outlined throughout Chapter 7) are:

- Damage to third-party subsea infrastructure; and
- MDO spill.

Table 8.4 presents the reportable incident reporting requirements.

Table 8.4. Reportable incident reporting requirements

Timing	Requirements	Contact
Verbal notification		
Within 2 hours of becoming aware of incident	• The verbal incident report must include: • All material facts and circumstances concerning the incident that the titleholder knows, or is able, by reasonable search or enquiry, to find out; • Any actions taken to avoid or mitigate any adverse environmental impacts of the reportable incident; and • The corrective action that have been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	• NOPSEMA – 1300 674 472

Timing	Requirements	Contact
	For a Level 1, 2 or 3 hydrocarbon spill, as above.	As above, plus: • AMSA – 1800 641 792 (24 hrs) • WA – (08) 9480 9924 • NT – 1800 064 567
	Oiled wildlife	• WA – (08) 9219 9108 • NT – 1800 064 567
	Suspected or confirmed IMS introduction	• WA Fisheries – 1800 815 507 • DAWE - 1800 803 772 (general enquiries)
	Injury or death of EPBC Act-listed or FFG Act-listed fauna (e.g., vessel collision or entanglement with streamers)	• WA – 9474 9055 • DAWE – 1800 803 772
Within 24 hours of discovery	Notify DAWE if previously unrecorded underwater cultural heritage (e.g., shipwreck) is found	Submit report at the following address: http://www.environment.gov.au/shipwreck/public/forms/notification.do;jsessionid=7DF6B6DBCFD9E9E1071EB71DC201B84C?mode=add.
Written notification		
Not later than 3 days after the first occurrence of the incident	A written incident report must include: • All material facts and circumstances concerning the incident that the titleholder knows, or is able, by reasonable search or enquiry, to find out; • Any actions taken to avoid or mitigate any adverse environmental impacts of the reportable incident; • The corrective action that have been taken, or is proposed to be taken, to stop, control or remedy the reportable incident; and • The action that has been taken, or is proposed to be taken, to prevent similar recordable incidents occurring in the future.	• NOPSEMA – submissions@nopsema.gov.au
Within 72 hours of the incident	As above, with regard to details of a vessel strike incident with a cetacean	• Upload information to DAWE online National Ship Strike Database (https://data.marinemammals.gov.au/report/shipstrike)
Within 7 days of the incident	As above, with regard to impacts to MNES, specifically injury to or death of EPBC Act-listed species	• EPBC.Permits@environment.gov.au
Within 7 days of providing written report to NOPSEMA	As above	• NOPTA – reporting@nopta.gov.au

8.7.3. Incident Investigation

Any non-compliance with the EPS outlined in this EP will be investigated and follow-up action will be assigned as appropriate.

The findings and recommendations of inspections, audits and investigations will be documented and distributed to relevant vessel and project personnel for review. Tracking the recommendations and close-out actions arising from incident investigations will be managed via EOG's incident management system.

Investigation outcomes will be communicated to the project team via daily operations meetings and to the vessel crew during daily toolbox meetings and at weekly HSE meetings.

8.7.4. Routine Recording and Reporting

Routine recording and reporting of activity HSE matters will encompass the following:

- Daily teleconferences – held between the EOG Onboard Representative and EOG personnel each morning for an update on progress from the previous day and the forward plan, including any HSE matters that have arisen. AGR and the onshore vessel manager may participate if necessary.
- Daily operations reports – the Party Chief and EOG Onboard Representative will prepare a daily operations report, including data on activities conducted for the day and any HSE issues arising and distributed to the extended project team.
- HSE reporting – the Party Chief, vessel HSE Lead and the EOG Onboard Representative will collate key HSE performance statistics on a daily and/or weekly basis and communicate those to the wider project team during daily teleconferences and through reports.

8.8. Management of Change

EOG's HSE Plan will outline the Management of Change (MoC) procedure for the activity. The MoC procedure will be used to determine whether any changes to the design of the activity (or other factors) trigger revisions to the EP that require re-submission to NOPSEMA (as outlined in Section 1.6.1). AGR and Aventus will assist in implementing the MoC procedure.

Permanent or temporary changes to organisation, equipment, plant, standards or procedures that have potential HSE and/or integrity impacts are subject to formal review and approval by the relevant EOG role with responsibility for the change prior to initiating the change to ensure risks remain acceptable and are reduced to ALARP. The level of management approval for each change is commensurate with the risk.

An MoC form must be completed. This is then reviewed by relevant specialists that have technical and project-specific knowledge and understanding to determine the impact (if any) and significance of the change. The relevant role with responsibility for the change shall look at any additional safety requirements needed to ensure the safety of personnel, the effect on schedule and cost, the effect on equipment and third-party assets and then decide whether to approve or reject the change. The results of the review shall then be documented in the MoC form and the relevant role will communicate the change to all those who may be affected by it. The MoC form will then be stored by EOG.

The vessel contractor MoC process will be applied to any vessel-related changes in accordance with its standard operating procedures. Routine optimisation of vessel operating parameters will be carried out using the vessel contractor procedures and is not subject to the formal change management control as described previously.

8.8.1. Record Keeping

In accordance with Regulations 27 and 28 of the OPGGS(E), documents and records relevant to the implementation of this EP are stored and maintained by EOG for a minimum of five years. These records will be made available to NOPSEMA in electronic or printed form upon request.

8.9. Assurance, Reporting and Review

8.9.1. Field Environmental Monitoring

EOG will maintain a quantitative record of emissions and discharges, and other environmental matters generated on location during the activity, as required under Regulation 14(7) of the OPGGS(E).

The vessel contractor is responsible for collecting this data and reporting it to the EOG Onboard Representative. This is facilitated by completing a daily environmental monitoring register that will be provided by EOG to the contractor, which captures the commitments made in Table 8.5 below.

Table 8.5. Summary of environmental monitoring requirements

Aspect	Monitoring parameter	Frequency	Record
Impacts			
Underwater sound	Megafauna observations	During geophysical investigations	Megafauna observation register
Atmospheric emissions	Fuel consumption	Tallied at end of activity from daily reports and/or bunker receipts	Emissions register
Displacement of other marine users	Ongoing patrol for, and communications with, third-party vessels	Continuous during activity	Bridge communications book
Bilge water	Volume of bilge water discharged during the activity	Each discharge (infrequent)	Oil record book
Risks			
Waste disposal	Weight/volume of wastes sent ashore (including oil sludge, solid/hazardous wastes)	Tallied at end of activity	Waste manifest
Displacement or interference with other marine users	Ongoing patrol for, and communications with, third-party vessels	Continuous during activity	Bridge communications book
Introduction of IMS to activity area	Volume and location of ballast water discharges noted	Each discharge	Ballast water log
Vessel strike or entanglement with megafauna	Megafauna observations	Continuous during geophysical operations	Incident report
MDO spill	Operational monitoring in line with the OPEP and scientific monitoring in	As required	Incident reports

Aspect	Monitoring parameter	Frequency	Record
	line with the OSMP (depending on spill volume)		

8.9.2. Routine Reporting and Notifications

Regulation 11A of the OPGGS(E) specify that consultation with relevant authorities, persons and organisations must take place. This consultation includes an implicit obligation to report on the progress of the activity. Table 8.6 outlines the routine reporting obligations that EOG will undertake with external organisations.

Table 8.6. External routine reporting obligations

Requirement	Timing	Contact details	OPGGS(E) regulation
Pre-activity			
Notify the DoD of the activity commencement date.	Five weeks prior to activity starting.	Offshore.Petroleum@defence.gov.au.	11A
Notify the AHO of the activity commencement date and duration to enable Notices to Mariners to be issued.	Three weeks prior to activity starting.	datacentre@hydro.gov.au	11A
Notify all other stakeholders in the stakeholder register with the activity commencement date.	Two weeks prior to activity starting.	Via email addresses in the stakeholder consultation register	11A
Notify NOPSEMA with the activity commencement date.	At least 10 days prior to activity starting.	submissions@nopsema.gov.au	29
Notify AMSA in order to issue daily AusCoast warnings.	Within 24 hours of activity starting.	rccaus@amsa.gov.au	11A
Activity completion			
Notify AMSA in order to cease daily AusCoast warnings.	Within 24 hours of activity completion.	rccaus@amsa.gov.au	11A
Notify all stakeholders in the stakeholder register.	Within 2 days of activity completion.	Via email addresses managed by the Environment Advisor	11A
Notify the AHO in order to cease the issuing of Notices to Mariners.	Within 2 days of activity completion.	datacentre@hydro.gov.au	11A
Notify NOPSEMA of the activity end date.	Within 10 days of activity completion.	submissions@nopsema.gov.au	29
Notify NOPSEMA of the end of the operation of the EP.	After acceptance of the end-of-activity EP performance report.	submissions@nopsema.gov.au	25A

Requirement	Timing	Contact details	OPGGS(E) regulation
Performance reporting			
Submit an end-of-activity EP Performance Report.	Within 3 months of activity completion.	submissions@nopsema.gov.au	26C
Provide marine fauna observation data to the DAWE.	Within 3 months of activity completion.	Upload via the online Cetacean Sightings Application at: https://data.marinemammals.gov.au/nmmdb	N/A – EPBC Act

8.9.3. Environment Plan Review

The EOG Environmental Consultant may determine that an internal review of the EP is necessary based on any one or all of the following factors:

- Changes to hazards and/or controls identified in the review of the EP, which in itself is supported by:
    - Reviewing changes to AMP management arrangements (through subscription to the AMP email update service at https://parksaustralia.gov.au/marine/about/).
    - Environment and industry legislative updates (through subscriptions to NOPSEMA, APPEA and legal firms).
    - Running a new EPBC Act PMST for the EMBA to determine whether there are newly-listed threatened species or ecological communities in the EMBA.
    - Remaining up to date with new scientific research that may impact on the EIA/ERA in the EP (for example, through professional networking and APPEA membership).
    - Remaining in regular contact with relevant persons.
- Implementation of corrective actions to address internal or external inspection or audit findings;
- An environmental incident and subsequent investigation identifies issues in the EP that require review and/or updating;
- A modification of the activity is proposed that is not significant but needs to be documented in the EP;
- Changes identified through the MoC process, such as hazards or controls, organisational changes affecting personnel in safety critical roles; and
- Changes to any of the relevant legislation.

Aventus will provide advice to the EOG Project Manager on the material impact of the items listed above and whether or not a review of the EP should be undertaken. The scope of a review is determined by the factors that trigger the review and an appropriate team will be assembled by Aventus to conduct the review.

If a review of the EP relates to a topic that had previously been raised by a relevant person or stakeholder, an updated response will be prepared and provided to affected stakeholders in a process managed by Aventus for EOG.

Revisions Triggering EP Re-submission

EOG will revise and re-submit the EP for assessment as required by the OPGGS(E) regulations listed in Table 8.7.

Table 8.7. EP revision submission requirements

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

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

- **New** impact or risk – one that has not been assessed in Chapter 7.
- **Increased** impact or risk – one with greater extent, severity, duration or uncertainty than is detailed in Chapter 7.
- **Significant** change –
    - The change to the activity design deviates from the EP to the degree that it results in new activities that are not intrinsic to the existing Activity Description in Chapter 2.
    - The change affects the ability to achieve ALARP or acceptability for the existing impacts and risks described in Chapter 7.
    - The change affects the ability to achieve the EPO and EPS contained in Chapter 7.

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

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

While an EP revision is being assessed by NOPSEMA, any activities addressed under the existing accepted EP are authorised to continue. Additional guidance is provided in NOPSEMA Guideline *When to submit a proposed revision of an EP* (N04750-GL1705, September 2020).

Minor EP Revisions

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

- Minor administrative changes are identified that do not impact on the environment (e.g., document references, contact details, etc.).
- A review of the activity and the environmental risks and impacts of the activity do not trigger a requirement for a revision, as outlined in Table 8.7.

Minor revisions to the EP will not be submitted to NOPSEMA for assessment.

8.9.4. Inspections and Audits

Various inspections and audits will be undertaken for the activity using competent personnel, as outlined in Table 8.8.

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

A summary of the EP commitments for the activity will be distributed aboard the vessel and implementation of the EPS will be continuously monitored by Aventus through review of the completed weekly checklists and attendance at relevant meetings.

Non-compliances and/or opportunities for improvement will be communicated to the EOG Project Manager in writing and at appropriate meetings.

Table 8.8. Summary of environmental inspections and audits

Type	When	Frequency	Method	Details
HSE due diligence inspection	Post-award, pre-activity	Once	Desktop or in port/during mobilisation	Focused on ensuring HSE Plan and EPS in this EP can be met through review of relevant records and databases.
EP compliance audit	Post-award, pre-activity	Once (supplemented by compliance management during the activity)	In person on board	A suitably experienced auditor will assess compliance against each EPS through interviews, observations and review of databases and records.
Ongoing informal inspections	During activity	Weekly	In person on board	Checklists provided by EOG to be completed by the Party Chief and/or the EOG Onboard Representative.

8.9.5. Regulatory Inspections

Under Part 5 of the OPGGS Act, NOPSEMA inspectors have the authority to enter EOG premises, including the vessel, to undertake monitoring or investigation against this EP.

EOG will cooperate fully with the regulator during such investigations.

8.9.6. End of Activity Performance Report

In accordance with the OPGGS(E) Regulation 14(2), EOG will submit an end-of-activity EP performance report to NOPSEMA within three months of completion of the activity. Performance will be measured against the EPO and EPS outlined in Chapter 7. The information in the report will be based on the information collected during routine communications, inspections and audits, as outlined in this chapter.

8.9.7. Monitoring and Review

The vessel contractor will have specific contractual compliance obligations associated with implementing the EP, OPEP and other applicable plans. EOG will monitor the contractor against these obligations both in terms of deliverables and quality.

EOG will establish, maintain and review an EP commitments register to assist in monitoring against these EP. Learnings from this monitoring will inform continued operations and the development of EPs for future phases of the Beehive project.

8.10. Summary of Implementation Strategy Commitments

Table 8.9 summarises the commitments provided throughout the Implementation Strategy by assigning EPO, EPS and measurement criteria to each commitment.

Table 8.9. Summary of EP implementation strategy commitments

Section	EPO	EPS	Measurement criteria
8.4.1	Project personnel are trained and competent to fulfil their duties.	The project HSE Plan records and tracks core and critical HSE and technical compliance training.	Training records are readily accessible through.
		Due diligence is undertaken on contractors to ensure they are competent to work on the activity.	Contractor due diligence reports are readily available and verify their suitability to work on the activity.
8.4.2	Project personnel are familiar with their HSE responsibilities.	All personnel working on the vessel are inducted into the activity HSE requirements.	Vessel crews and visitor lists, along with induction familiarisation checklists are readily available, verifying that all personnel working on and visiting the vessel are inducted.
8.4.2, 8.4.3 & 8.4.6	Project personnel are familiar with operations HSE issues.	Regular HSE communications take place between vessel- and office-based personnel.	HSE meeting records are available and verify regularity of communications.
8.5.2	Emergency response responsibilities are clearly defined.	The project HSE Plan, vessel SMPEP and ERP outline emergency responsibilities for project personnel.	The project HSE Plan, vessel SMPEP and ERP emergency responsibilities are communicated to project personnel prior to the activity commencing.
8.5.2	Vessel- and office-based personnel are familiar with their	All relevant vessel- and office-based personnel participate in emergency response (e.g., ERP	Training records verify that emergency response exercises were undertaken.

Section	EPO	EPS	Measurement criteria
	emergency response responsibilities.	and OPEP) training, drills and exercises.	
8.7.1 & 8.7.2	Incident reports are issued to the regulators as required.	Recordable incidents reports are issued monthly to NOPSEMA as per Table 8.4.	Recordable and reportable incident reports and associated email correspondence is available to verify their issue to NOPSEMA (and other agencies, as required).
		Reportable incidents are reported to NOPSEMA in accordance with the timing requirements provided in Table 8.5.	
8.7.3	Incidents are investigated.	Incident investigations are undertaken by suitably qualified and experienced personnel in a timely manner.	Incident investigation reports are available and align with incidents recorded in the incident management system.
8.8	Changes to approved plans (including this EP), equipment, plant, standards or procedures are assessed through the MoC process.	Changes are documented in accordance with the MoC Directive.	MoC records are available in the Stature database.
8.8.1	All records relevant to implementation of the EP are available for five years.	All records relevant to implementation of the EP are retained by EOG.	EP documents are readily accessible.
8.9.1	Emissions and discharges from the vessels are recorded.	Emissions and discharges from the vessels, in line with Table 8.6, are recorded.	Monitoring records are available and align with the requirements in Table 8.6.
8.9.2	Regulatory agencies and stakeholders are aware of activity start and end.	Pre- and post-activity notifications to regulatory agencies and stakeholders are issued as per Table 8.7.	Notification records verify issue.
8.9.3	The EP is reviewed for currency in light of any changes to the activity, controls, legislation or relevant scientific research.	EOG updates the EP as required.	The revision history of this EP is updated to record document changes.
8.9.3	This EP is reviewed and updated on an as-required basis.	This EP is reviewed and updated based on the triggers presented in Section 8.9.3 on an as-required basis.	A record of EP reviews and updates is available.
			The review and/or update details are recorded in the document control page of this EP.
		If the review identifies that significant changes to the EP	A record of EP revision is included in the document control page of this EP.

Section	EPO	EPS	Measurement criteria
		are required, the EP is updated and re-issued to the regulators.	Correspondence is available to verify the re-issue of the EP to NOPSEMA.
8.9.4	EP compliance inspections and audits are undertaken for the activity.	EP compliance is assessed pre-activity and during the activity by competent personnel.	Environmental inspection reports, completed checklists and audit report are available and verify compliance with this EP.
8.9.6	An end-of-activity EP performance report is submitted to NOPSEMA.	The end-of-activity EP performance report is issued to NOPSEMA within three months of completion of the activity.	The end-of-activity EP performance report and associated email correspondence is available to verify its issue to NOPSEMA.

9. Oil Pollution Emergency Plan

This OPEP provides an overview of EOG's arrangements for responding in a timely manner to an MDO spill during the activity.

The activity vessel is not classified as a 'facility' in Section 15 and Schedule 3 of the OPGGS Act 2006 because it:

- Does not rest on the seabed;
- Is not fixed or connected to the seabed; and
- Is not attached or tethered to a facility, structure or installation.

Because the activity vessel is not a 'facility', for oil spill response purposes, it is treated as any other vessel under legislation such as the *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth), *Australian Maritime Safety Authority Act* 1990 (Cth) and the *Navigation Act* 2012 (Cth). It is therefore suitable to describe the spill response arrangements provided at the Commonwealth and state levels for responding to hydrocarbon spills (described in Section 9.1).

In the event of an MDO spill, the Vessel Master will assume onsite command, will make the initial regulatory notifications to AMSA as defined in Section 9.4 and will act as onsite coordinator directed by AMSA. All persons aboard the vessel will be required to act under the direction of the Vessel Master.

The activity vessel will have equipment on board for responding to emergencies, including but not limited to medical equipment, firefighting equipment and oil spill response equipment as defined in the vessel SMPEP.

The Vessel Master will notify the EOG Onboard Representative (who will in turn report to the EOG Project Manager) of the emergency, with this EOG role acting as onshore liaison. EOG has insurance policies in place that will cover the costs of any clean-up or remediation activities following a spill, no matter the jurisdiction.

9.1. Oil Spill Response Arrangements

In order to encompass the nature and scale of the activity and respond to the identified worst case credible spill scenario, modelling of a loss of 160 m^3 of MDO has been undertaken and the risks assessed (see Section 7.16). This OPEP has been developed based on the results of this modelling and encompasses multiple levels of planning and response capability. The spill scenario is considered to be very conservative because vessel tanks are never filled 100% full, fuel will have already been combusted to reach the activity area, there are no emergent features to collide into and vessel-to-vessel collision (resulting in a spill) is extremely rare, especially in and around the activity because it has a low level of commercial shipping (see Section 5.6.6).

The overall OPEP for the activity comprises the following emergency plans:

- Vessel SMPEP – for spills contained on the vessel or spills overboard that can be managed by the vessel;
- Vessel contractor Emergency Response Plan (ERP);
- The National Plan for Maritime Environmental Emergencies ('NatPlan') (AMSA, 2020) – AMSA is the jurisdictional authority and control agency for spills from vessels originating in or affecting Commonwealth waters;
- The Western Australian Oil Spill Contingency Plan 2015 ('WestPlan') (DoT, 2015) with the WA Department of Transport (WA DoT) being the Control Agency for spills that affect WA state waters; and
- The Northern Territory Oil Spill Contingency Plan 2014 ('NT Plan') (DoT, 2014) with the NT Department of Transport (NT DoT) being the Control Agency for spills that affect NT waters.

9.1.1. National Plan Summary

The NatPlan is an integrated government and industry framework that seeks to enable effective response to marine pollution incidents and maritime casualties. In accordance with the polluter pays principles of the OPRC 1990, the framework provides for industry as the Control Agency for all spills that originate from offshore petroleum facilities (e.g., platforms, drill rigs). NOPSEMA collaborates closely with AMSA, as the manager of NatPlan, to ensure that arrangements under NatPlan, the OPGGS Act and associated regulations are aligned and understood.

As stated in Section 4.4 of the NatPlan (AMSA, 2020), for all marine pollution incidents that do not originate from a petroleum facility, AMSA is the Control Agency for spills that cannot be managed locally (i.e., Level 2 or 3 spills). Guidance for spill classification, as noted in Part 5 of the NatPlan (AMSA, 2020) is provided in Table 9.1.

Table 9.1. Guidance for spill incident classification

Characteristic	Level 1	Level 2	Level 3
Jurisdiction	Single (e.g., Commonwealth only)	Multiple (e.g., Commonwealth and WA)	Multiple, including international
Agencies	First response (e.g., vessel only)	Multiple	Agencies across government and industry
Resources	From within one area (e.g., vessel)	Intrastate	National or international resources
Type of response	First-strike	Escalated	Campaign
Duration	Single shift	Multiple shifts (days to weeks)	Extended (weeks to months)
Environment at risk	Isolated impacts, natural recovery within weeks	Significant impacts, recovery may take months, remediation required	Significant area of impacts, recovery may take months, remediation required

As stated in Section 2.5 of the NatPlan, maritime environmental emergencies have the potential to impact upon the interests of two or more Australian jurisdictions, where each jurisdiction has legitimate administrative and regulatory interests in the incident (for this activity, this includes WA and/or NT). The Australian Government established the Offshore Petroleum Incident Coordination (OPIC) framework for coordinating a whole-of-government response to a significant petroleum incident in Commonwealth waters. The framework interfaces with other emergency incident response/coordination arrangements, including the NatPlan, titleholder OPEPs and State/Territory marine pollution contingency plans as appropriate. In the case of this activity, AMSA would liaise with the WA DoT and the NT DoT to determine which agency is best placed to take the lead.

In Commonwealth waters, initial spill response actions will be undertaken by the vessel with subsequent actions determined in consultation with regulatory authorities under the NatPlan. AMSA is the responsible Combat Agency for hydrocarbon spills from vessels in Commonwealth waters; upon notification of a Level 2 or 3 spill, AMSA will assume control of the incident.

9.1.2. Western Australian Arrangements

In the event that the MDO spill crosses into WA state waters, WA DoT will assume incident control over the impacted area in State waters while AMSA will remain responsible for managing the spill outside of WA state waters.

If an incident affecting wildlife occurs in Commonwealth waters close to WA State waters, AMSA will request support from the Department of Biodiversity, Conservation and Attractions (DBCA) Parks and Wildlife Service (PWS) to assess and lead a wildlife response if required.

As noted in the WA Oiled Wildlife Response Plan (DEW, 2014, Rev 1.1), WA PWS will be the Control Agency for a wildlife response, using arrangements included in the Oiled Wildlife Response Plan (DEW, 2014, Rev 1.1).

9.1.3. Northern Territory Arrangements

In the event that the MDO spill crosses into NT waters, the NT DoT will assume incident control over the impacted area in State waters while AMSA will remain responsible for managing the spill outside of NT waters.

If an incident affecting wildlife occurs in Commonwealth waters close to NT waters, AMSA will request support from the Parks and Wildlife Commission (PWC) to assess and lead a wildlife response in accordance with the NT Oiled Wildlife Response Plan, if required.

9.1.4. Vessel SMPEP

MARPOL Annex I requires a SMPEP to be carried on all vessels greater than 400 gross tonnes. In general, a SMPEP describes the steps to be taken:

- In the event that a hydrocarbon spill has occurred;
- If a vessel is at risk of a hydrocarbon spill occurring; and
- For notification procedures in the event of a hydrocarbon spill occurring and provides all important contact details.

The Vessel Master is in charge of implementing the SMPEP and ensuring that all crew comply with the plan.

Vessel SMPEPs include vessel-specific procedures for managing a fuel spill. The SMPEP includes information about initial response, reporting requirements and arrangements for the involvement of third parties having the appropriate skills and facilities to effectively respond to oil spill issues. The SMPEP will be the principal working document for the vessel and crew in the event of an MDO spill. The SMPEP describes specific emergency procedures including steps to control discharges for bunkering spills, hull damage, grounding and stranding, fire and explosion, collisions, vessel list, tank failure, sinking and vapour releases. The SMPEP also includes requirements for regular emergency response drills of the plan and revisions following drills or incidents.

Priority actions in the event of an MDO spill are to:

1. Make the area safe;
2. Stop the leak (source control); and
3. Ensure that further spillage is avoided.

All deck spills will be cleaned-up immediately, using appropriate equipment from the onboard spill response kits to minimise any likelihood of discharge of hydrocarbons or chemicals to the sea.

The Vessel Master is responsible for activating and implementing the vessel SMPEP, the shipboard emergency response team (ERT) is responsible for both prevention and response activities with detailed instructions for the team being listed in the vessel SMPEP.

Specifically, the SMPEP provides the following:

- A description of all actions to be taken by onboard personnel to reduce or control the discharge following an MDO spill;
- A detailed description of all spill response equipment held onboard the vessel, including what equipment is available and where it is stored;
- Detailed diagrams of the vessel, including locations of drainage systems, location of spill response equipment and general layout of the vessel;
- An outline of the roles and responsibilities of all onboard personnel with regard to MDO spills;
- A description of the procedures and contacts required for the coordination of MDO spill response activities with the relevant Commonwealth and state agencies; and
- Requirements for testing of the SOPEP and associated drills.

EOG will conduct a desktop SMPEP exercise prior to the activity commencing (see Section 9.4).

9.2. Spill Response Options Assessed

Spill response mitigation measures will be implemented as appropriate to reduce the likelihood of impacts to key marine environmental receptors (see Section 9.2.1 for the spill response strategy). The objectives of spill response include the protection of human health, environmental values and the protection of assets.

The selection of spill response techniques in any situation will include an operational net environmental benefit analysis (NEBA) to confirm the suitability of the strategic spill response NEBA (see Section 7.17). The operational NEBA would be jointly conducted between AMSA and EOG and will take into account priorities for protection and sensitivity of the receptors at risk, as well as operational limitations including the amount and availability of equipment, access to competent personnel, logistical support, access, maintaining equipment deployments, waste management and weather conditions.

9.2.1. Preferred Spill Response

A number of response options have been assessed specific to the survey location, fuel type and spill modelling results, which are outlined in Section 7.17. These are:

- Source control – locating the source of the leakage and isolating the tanks and transferring fuel to slack or empty tanks (where safe to do so);
- Monitor and evaluate the trajectory and extent of the spill; and
- Assisted natural dispersion using propeller wash, if advised by the Control Agency that it is safe to do so.

Initial actions for source control are outlined in the vessel SMPEP and would be undertaken in consultation with the relevant Combat Agency (initially AMSA, given the activity's location in Commonwealth waters).

These spill response activities are not expected to introduce additional hazards to the marine environment or to result in significant additional potential impacts. The response options of source control, monitor and evaluate and assisted natural dispersion will use the existing activity vessel, and the potential impacts associated with the use vessels is evaluated throughout Chapter 7.

9.3. Spill Notifications

The Vessel Master has the responsibility for reporting overboard spills to the AMSA Response Coordination Centre (RCC) (via POLREP Form contained in the vessel's SMPEP).

Once this initial report has been undertaken, further reports (SITREP forms) will be issued from the vessel at regular intervals to keep relevant parties (such as AMSA, NOPSEMA, etc.) informed. The EOG Onboard Representative is responsible for advising the EOG Project Manager of the spill incident, who will in turn inform the EOG Project Director. The EOG Project Manager is responsible for notifying NOPSEMA.

Regulatory notification arrangements are provided in Table 9.2. In addition to this, EOG will advise potentially affected relevant persons of the spill.

Table 9.2. MDO spill regulatory notifications for a Level 2 or Level 3 spill

Notification timing	Report to	Report from	Contact Number	Details
Level 1				
ASAP	EOG Onboard Represent-ative	Vessel Master	TBA	Vessel to notify EOG immediately to ensure further notifications can be undertaken.
Within 2 hours	AMSA	Vessel Master	1800 641 792	Verbally notify AMSA RCC of spill. Follow up with written POLREP ASAP. http://www.amsa.gov.au/forms-and-publications/AMSA1522.pdf https://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/Contingency/Oil/documents/Appendix7.pdf
Within 2 hours	NOPSEMA	EOG Project Manager	1300 674 472	EOG to verbally notify NOPSEMA of spill >80L http://www.nopsema.gov.au/assets/Guidance-notes/N-03000-GN0926-Notification-

Notification timing	Report to	Report from	Contact Number	Details
				and-Reporting-of-Environmental-Incidents-Rev-4-February-2014.pdf
Level 2 or 3 (in addition to Level 1 notifications)				
ASAP - if spill affects WA or NT waters	WA DoT	AMSA/ EOG Project Manager	(08) 9480 9924 (24 hours)	Verbally notify WA DoT and follow up with POLREP ASAP and SITREP (if required)
	NT DoT	AMSA/ EOG Project Manager	1800 064 567	Verbally notify NT DoT and follow up with POLREP ASAP and SITREP (if required)
	WA DMIRS	EOG Project Manager	0419 960 621	Email notification to petroleum.environment@dmirs.wa.gov.au
Within 2 hours	Type II Monitoring Service Provider (AMOSC)	EOG Project Manager	0438 379 328 (24 hours)	Verbally notify service provider to initiate scientific monitoring if triggered (as outlined in Section 9.6.2).
Within 1 day	NOPTA	EOG Project Manager	08 6424 5317	Provide a verbal or written incident summary.
Within 3 days	NOPSEMA	EOG Project Manager	08 6461 7090	Provide a written incident report form.
If MDO is travelling towards one or more AMPs				
ASAP	Director of National Parks	EOG Project Manager	0419 293 465	Spill with potential to impact AMPs, including potential for oiled wildlife. Provide: • Titleholder details; • Time and location of the incident (including name of AMP likely to be affected); • Proposed response arrangements as per the OPEP; • Confirmation of provision of monitoring and evaluation reports when available; and • Contact details for the response coordinator.

9.4. Spill Response Testing Arrangements

The vessel SMPEP includes provision for testing emergency drills (in accordance with Regulation 14(8A)(8C) of the OPGGS(E)). Furthermore, a test of the oil spill emergency response arrangements referred to in this EP will be conducted:

- When they are introduced;
- When they are significantly amended;
- Not later than 12 months after the most recent test; and
- If and when a new vessel is engaged for the activity.

Prior to commencing the activity, spill response arrangements applicable to the vessel will be tested. The outcomes of the test will be documented to assess the effectiveness of the exercise against its objectives and to record any lessons and actions. Any actions arising from the test will be recorded and tracked to completion prior to the start of the activity.

The test will audit the onboard spill response capability against the SMPEP to verify spill preparedness and ensure vessel personnel are familiar with required actions.

9.4.1. OPEP Review

In accordance with OPGGS(E) Regulation 14(8), the OPEP must be kept up to date. A review of the OPEP occurs on an annual basis and is revised as required. Any of the following factors may trigger a revision of the OPEP:

- Changes to hazards and/or controls identified in the EP;
- Changes to response and/or monitoring capability;
- Outcomes from annual testing of the response arrangements;
- Revision of emergency management procedures;
- When major changes that may affect the oil spill response coordination or capabilities have occurred;
- After an actual emergency if gaps are identified within the plan;
- Change in state or Commonwealth oil spill response arrangements and resources; and
- Before installing and commissioning new plant and equipment (if risk profile changes).

9.5. Cost Recovery

In the event of a hydrocarbon spill, Part 6.1A of the OPGGS Act states that titleholders are required to eliminate or control the spill, clean up the spill and remediate any environmental damage and undertake environmental monitoring of the impact of the spill. The Act also states that any costs incurred by NOPSEMA and Commonwealth and state/Territory government agencies must be reimbursed by the titleholder.

Part 1B of the OPGGS(E) specifies that titleholders are required to maintain sufficient financial assurance to meet the costs, expenses and liabilities that may result from a worst-case event associated with its offshore activities. In the case of this activity, this most credible such event would be a large scale MDO spill. Financial assurance must be demonstrated to NOPSEMA before the EP can be accepted.

EOG has insurance policies in place that will cover the costs of spill response and operational and scientific monitoring (see the following section).

9.6. Hydrocarbon Spill Monitoring

The Operational and Scientific Monitoring Plan (OSMP) for this activity is contained in this chapter and is designed to rapidly provide key information to inform response planning and implementation during an incident. In the event of a Level 2 or 3 spills, and if requested by AMSA, EOG will provide support on the surveillance and tracking of the hydrocarbon slick. Scientific monitoring studies may be activated, if requested by AMSA and/or in consultation with AMSA, by EOG to quantify the impacts and the subsequent recovery from the spilled MDO and response activities.

Monitoring appropriate to the nature and scale of the spill will be determined based on the size and nature of the release (e.g., slow continuous release or instantaneous short duration release), weathering characteristics (dispersion and dilution rates), the exact location of the release and the modelled trajectory of the spill. There are two types of monitoring considered, discussed in detail below.

9.6.1. Type 1 Operational Monitoring

As the Control Agency, AMSA is responsible for initiating an appropriate level of Type I Operational Monitoring using NatPlan resources to monitor the spill and any response effort, if required.

Operational monitoring includes spill surveillance and tracking to validate the OSTM. EOG will, at the direction of the Control Agency, support Type I monitoring with on-water surveillance to:

- Determine the location and extent of a spill;
- Track the movement and trajectory of the spill;
- Identify receptors at risk; and
- Determine sea conditions and potential constraints to spill response activities.

This monitoring will also enable the Vessel Master to provide information to the Combat Agency (AMSA), via a POLREP/SITREP form, to allow for determination and planning of appropriate response actions under the NatPlan (if required).

Operational monitoring and surveillance in the event of a spill will inform an adaptive spill response and will support the identification of appropriate scientific monitoring of relevant key sensitive receptors.

Specific monitoring/data requirements for Type 1 monitoring includes:

- Estimation of sea state;
- Estimation of wind direction and speed;
- Locating and characterising any surface slicks;
- GPS tracking;
- Manual or computer predictions of oil trajectory and weathering; and
- GIS mapping.

Determining the location and characterisation of surface slicks will likely be restricted to daylight hours only, when surface slicks will be visible from the vessel. Evaluations of sea state and weather conditions from the vessel will continue until this function is taken over by the Combat Agency. The information gathered from this initial monitoring will be passed on to the Combat Agency, via the POLREP form, but also via ongoing SITREP reports following the initial spill notification to AMSA RCC.

EOG will implement, assist with, or contribute to (including funding if required) any other Type I monitoring (e.g., computer OSTM) as directed by the Combat Agency.

9.6.2. Type II Scientific Monitoring

EOG will work with AMSA and relevant stakeholders to develop and implement appropriate Type II scientific monitoring, if required, aligned with APPEA's Joint Industry OSMP Framework.

The aim of the scientific monitoring is to understand the environmental impacts of the spill and response activities on the marine environment, with a focus on relevant environmental and social values and sensitive receptors. The scientific monitoring program outlined in the OSMP has been developed to ensure that it is sufficient to inform any remediation activities and is consistent with monitoring guidelines and methodologies such as CSIRO (2016).

The scientific monitoring may comprise some or all of the monitoring studies described in Table 9.3. As described previously, EOG will engage with AMSA to coordinate and review operational monitoring data. Operational monitoring provides valuable surveillance and modelling data to confirm the predicted extent and degree of MDO exposure and impacts. This data will then be used to determine if scientific monitoring of relevant key sensitive receptors may be of value in the longer term to evaluate environmental impacts and recovery of affected receptors. The requirement for, and design of scientific monitoring studies will be based on desktop/technical studies and/or field investigations, in order to ensure they are feasible and will obtain relevant information based on available monitoring data, the nature of the receiving environment and results of the consultation process.

Table 9.3. Scientific monitoring program summary

Scientific Monitoring Study	Objectives	Initiation triggers
SM01 Water quality impact assessment	Determine the impact to, and recovery of; offshore and intertidal water quality from oil exposure and/or any impacts to associated with response activities.	A Level 2 or Level 3 MDO spill has occurred and data from the OPEP 'Monitor and Evaluate' response strategy has confirmed exposure to offshore and/or intertidal waters.
SM02 Sediment quality impact assessment	Determine the impact to, and recovery of, offshore, intertidal and shoreline sediment quality from oil exposure and/or any impacts associated with response activities.	A Level 2 or Level 3 MDO spill has occurred and data from the OPEP 'Monitor and Evaluate' response strategy has confirmed exposure to shoreline sediments.
SM03 Subtidal habitats impact assessment	Determine the impact to, and recovery of, subtidal habitats from oil exposure and/or any impacts associated with response activities.	A Level 2 or Level 3 MDO spill has occurred and data from the OPEP 'Monitor and Evaluate' response strategy indicates potential and/or actual exposure to near-bottom waters or sediments
SM04 Intertidal and coastal habitats impact assessment	Determine the impact to, and recovery of, intertidal and coastal habitats from oil exposure and/or any impacts associated with response activities.	A Level 2 or Level 3 MDO spill has occurred and data from the OPEP 'Monitor and Evaluate' response strategy indicates potential and/or actual exposure to near-bottom waters or sediments.

Scientific Monitoring Study	Objectives	Initiation triggers
SM05 Marine fauna impact assessment	Determine the impact to, and recovery of, marine fauna from oil exposure and/or any impacts associated with response activities.	A Level 2 or Level 3 MDO spill has occurred and data from the OPEP 'Monitor and Evaluate' response strategy confirms exposure to marine fauna.
SM06 Fisheries impact assessment	Determine the presence of, and recovery from, oil taint in commercially or recreationally important fish species and/or any impacts associated with response activities.	A Level 2 or Level 3 MDO spill has occurred and there is confirmed presence of fish tainting.
SM07 Heritage and socio-economic impact assessment	Determine the impact to, and recovery of, heritage and socio-economic features from MDO exposure and/or any impacts associated with response activities.	A Level 2 or Level 3 MDO spill has occurred and data from the OPEP 'Monitor and Evaluate' response strategy indicates potential and/or actual exposure to known areas of heritage or socio-economic features.

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