ENVIRONMENT PLAN

Beehive-1 Exploration Drilling

WA-488-P

29 April 2022

Rev 0

eog resources

Prepared for:

EOG Resources Australia Block WA-488 Pty Ltd

ACN: 648 224 293

Suite 406, Level 4, 20 Bond 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

DOCUMENT CONTROL

Revision History

Document number	996161-2022-Beehive#1-Drilling-EP-Rev0				
Rev	Date	Purpose	Prepared	Reviewed	Approved
0	29/04/2022	Issued for public exhibition	Aventus Consulting	J. Chung, R. Doughty, N. Persad, J. Funk, L. Duthie, P. Harrick	P. Woods, N. Groves, B. Smith
B	02/03/2022	Draft for EOG review	Aventus Consulting	J. Chung, R. Doughty, N. Persad, L. Duthie	N/A
A	27/01/2021	Draft for internal review	Aventus Consulting	G. Pinzone	N/A

Project Team

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

Front cover image: The Noble Tom Prosser jack-up mobile offshore drilling unit, warm stacked in Port of Darwin (Photo credit: G. Pinzone, Aventus Consulting).

TABLE OF CONTENTS

List of Figures

List of Tables

Appendices

Appendix 1 – Commonwealth, State & Territory Legislation

Appendix 2 – Project Information Flyers

Appendix 3 – Stakeholder Communications

Appendix 4 – EPBC Act Protected Matters Search Tool (PMST) results

Appendix 5 – Existing Environment in the spill EMBA

Appendix 6 – Beehive-1 Well Blowout Oil Spill Trajectory Modelling report

Appendix 7 – Spill Response Strategic Net Environmental Benefit Analysis and ALARP Demonstration

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
AFANT	Amateur Fishermen's Association of the Northern Territory
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AGR	AGR Australia Pty Ltd
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
BAT	Best Available Techniques
BIA	Biologically Important Area
BOM	Bureau of Meteorology
BOP	Blowout Preventor
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
BWRS	Ballast Water Record System
CAMBA	People's Republic of China for the Protection of Migratory Birds and their Environment 1986
CASA	Civil Aviation Safety Authority (Cth)
CEFAS	Centres for Environment, Fisheries and Aquaculture Science (UK)
CFA	Commonwealth Fisheries Authority
CHARM	Chemical Hazard and Risk Management
CoEP	Code of Environmental Practice

Acronym	Definition
CPUE	Catch Per Unit Effort
CTD	Conductivity, Temperature and Depth
Cth	Commonwealth
DAFF	Department of Agriculture, Fisheries and Forestry (Cth)
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 (Cth)
DoD	Department of Defence
DoF	Department of Fisheries (WA)
DoT	Department of Transport (WA)
DP	Dynamic Positioning
DPIRD	Department of Primary Industries and Region Development (WA)
DPLH	Department of Planning, Lands and Heritage (WA)
DST	Drill Stem Test
EB	Environmental Benefit
EIA	Environmental Impact Assessment
EIAPP	Engine International Air Pollution Prevention
EMBA	Environment That May Be Affected
EOG	EOG Resources Australia Block WA-488-P Pty Ltd
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
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)
GHG	Greenhouse Gas
GMP	Garbage Management Plan
GNSS	Global Navigation Satellite System
HFC	High Frequency Cetacean
HFO	Heavy Fuel Oil

Acronym	Definition
HMCS	Harmonised Mandatory Control Scheme
HQ	Hazard Quotient
HSE	Health, Safety and Environment
HTB	High Temperature Blend
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
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
LCM	Lost Circulation Material
LFC	Low Frequency Cetacean
LoWC	Loss of Well Containment
LP	Low Pressure
LPG	Liquified Petroleum Gas
Ltd	Limited

Acronym	Definition
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
MWD	Measurement While Drilling
NatPlan	National Plan for Maritime Environmental Emergencies
NCVA	National Conservation Values Atlas
NDSMF	Northern Demersal Scalefish Managed Fishery
NEBA	Net Environmental Benefit Analysis
NIW	Nationally Important Wetland
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
NTSC	Northern Territory Seafood Council
NWMR	Northwest Marine Region
NWSA	North Wildcatch Seafood Australia
NZS	New Zealand Standard
OCNS	Offshore Chemical Notification Scheme
OCTG	Oil Country Tubular Goods
ODS	Ozone Depleting Substances
OIW	Oil-in-Water
OPEP	Oil Pollution Emergency Plan
OPGGS	Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Cth)
OPGGS(E)	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

Acronym	Definition
OPIC	Offshore Petroleum Incident Coordination
OSMP	Operational and Scientific Monitoring Program
OSPAR	Oslo-Paris Convention 1992
OSRL	Oil Spill Response Ltd
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response
OWS	Oily Water Separator
P&A	Plug and Abandon/Abandonment
P&ID	Piping and Instrumentation Diagrams
PAH	Polyaromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCPT	Piezo Cone Penetrometer Test
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
PSZ	Petroleum Safety Zone
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
RWP	Relief Well Plan
SBM	Synthetic-based Mud
SBP	Sub-bottom profiling
SBTF	Southern Bluefin Tuna Fishery
SCR	Safety Case Revision
SDS	Safety Data Sheet
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SIMOPS	Simultaneous Operations

Acronym	Definition
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
TD	Total Depth
TECS	Threatened Ecological Communities
TTS	Temporary Threshold Shift
TVDSS	Total Vertical Depth Subsea
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
VSP	Vertical Seismic Profile/Profiling
WA	Western Australia
WAF	Water-Accommodated Fraction
WAFIC	Western Australian Fishing Industry Council
WBM	Water-based Mud
WDP	Well Delivery Process
WEL	Woodside Energy Limited
WestPlan	Western Australian Oil Spill Contingency Plan 2015
WHP	Wellhead Platform
WOMP	Well Operations Management Plan
WSTF	Western Skipjack Tuna Fishery
WTBF	Western Tuna and Billfish Fishery
WWC	Wild Well Control

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 drill the Beehive-1 exploration well within Commonwealth marine waters approximately 80 kilometres (km) off the Western Australian (WA) coastline, located in the Joseph Bonaparte Gulf (JBG), WA (Figure 1.1). This is referred to as 'the activity' throughout this document.

1.2. Purpose

EOG proposes to undertake the activity using a jack-up mobile offshore drilling unit (MODU) with auxiliary activities including support vessels and helicopters. 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 activity 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.

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$65 billion (AUD$91 billion) as of 26th April 2022 and employs around 2,800 persons.

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 406, Level 4, 20 Bond Street,
Sydney, NSW, 2000, Australia

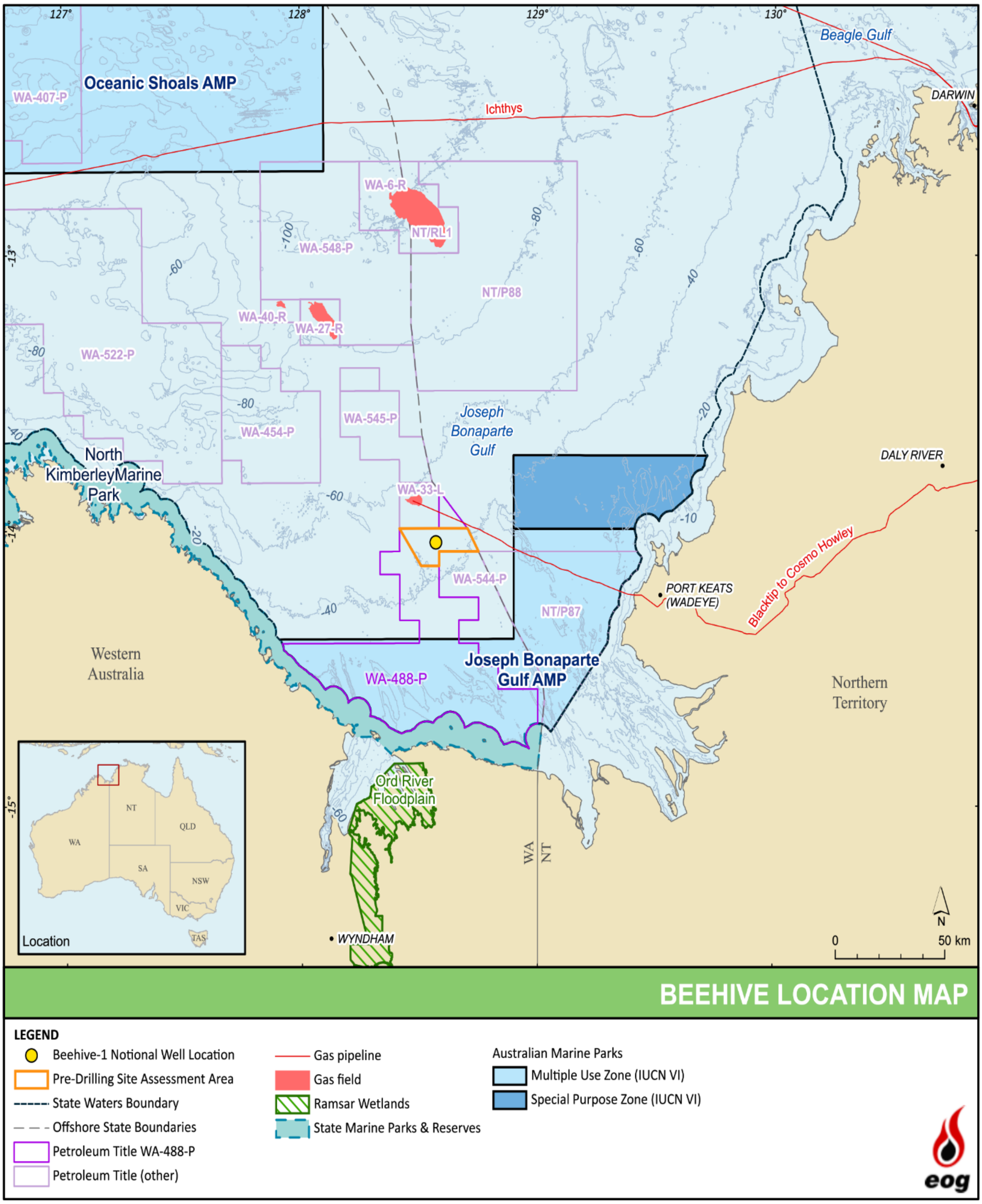


Figure 1.1. Location of Beehive-1 in WA-488-P

The nominated liaison person for this EP is outlined in Table 1.1.

Table 1.1. Titleholder nominated liaison details

Parameter	Details
Name	Jonathan Chung
Position	Director, Business Development International
Address	1111 Bagby Street, Sky Lobby 2, Houston, Texas 77007 USA
Telephone number	+1 713-651-7000
Email address	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 1.2.

Table 1.2. 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 process of drilling a well, from the time that the drill rig first jacks down its legs on site until the time it jacks up its legs and departs the operational area.*

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. Environment Plan Summary

Table 1.3 provides a summary of this EP as required by Regulation 11(4) of the OPGGS(E).

Table 1.3. EP Summary of material requirements

EP Summary requirement	EP section
The location of the activity	Section 2.1
A description of the receiving environment	Chapter 5 & Appendix 5
A description of the activity	Chapter 2
Details of the environmental impacts and risks	Chapters 7 & 8
The control measures for the activity	Chapters 7 & 8
The arrangements for ongoing monitoring of the titleholder's environmental performance	Chapter 9
Response arrangements in the oil pollution emergency plan (OPEP)	OPEP
Consultation already undertaken and plans for ongoing consultation	Chapter 4
Details of the titleholder's nominated liaison person for the activity	Section 1.3

2. Activity Description

This chapter provides a description of the proposed Beehive-1 exploration drilling program in accordance with Regulation 13(1) of the OPGGS(E).

2.1. Activity Location

The activity described in the EP is proposed to be conducted within Commonwealth petroleum exploration permit area WA-488-P, located in the Petrel Sub-basin (Bonaparte Basin) in the JBG, WA (see Figure 2.1).

Coordinates for the well location are provided in Table 2.1, noting that this may shift up to 1,500 m from this location based on continuous refinement during the well planning process. The operational area defines the spatial boundary of the proposed activity and for the purposes of this EP, the operational area is set as a 500 m radius around the final well location (which reflects the area of the Petroleum Safety Zone [PSZ] that will be gazetted around the MODU while it is on location).

Table 2.1. Coordinates for the proposed Beehive-1 well

Degrees, minutes, seconds		Eastings and northings	
Latitude	Longitude	Easting (m)	Northing (m)
14° 03' 16.41" S	128° 34' 14.54" E	453,651.86	8,446,199.05

GDA2020, UTM 52S.

The distances of key natural and socio-economic features from the Beehive-1 well are listed in Table 2.2.

Table 2.2. Distance to key features from Beehive-1

Feature	Distance and direction from Beehive-1
Natural features	
Closest mainland point	80 km south
Lacrosse Island (WA)	81 km south-southwest
Cape Domett (WA)	87 km south-southwest
Dorcherty Island (NT)	97 km east
Marine protected areas (nearest points)	
Joseph Bonaparte Gulf Australian Marine Park (AMP)	35 km east
North Kimberley Marine Park (WA)	68 km south
Oceanic Shoals AMP	158 km northwest
Petroleum infrastructure	
Blacktip gas export pipeline (nearest point)	12 km north-northeast
Blacktip unmanned wellhead platform	20 km northwest
Towns	
Port Keats (Wadeye), NT	103 km east-southeast

Feature	Distance and direction from Beehive-1
Wyndham (WA)	173 km south-southwest
Kununurra (WA)	190 km south
Darwin (NT)	300 km northeast

2.2. Timing

The activity is scheduled to commence in late Q1 (March)/early Q2 (April) 2023. However, due to the uncertainty of MODU availability, drilling may occur at any time during 2023.

Drilling activities are estimated to take approximately 55 days, or up to approximately 90 days (if re-spud or mitigating problems is required, or a Drill Stem Test [DST] is performed). The drilling duration may be subject to change based on geological conditions and potential for operational challenges. Operations will be conducted 24 hours per day, seven days per week.

2.3. Project Management

AGR Australia Pty Ltd (AGR) is the Drilling Management Contractor (DMC) appointed to this project by EOG. AGR is responsible for assisting EOG in project management and well delivery services for Beehive-1.

AGR's management system is accredited to ISO 9001:2015 (Quality Management Systems) and ISO 14001:2015 (Environmental Management Systems) and governs all of the group business as documented in the AGR Management System Manual.

The AGR Well Delivery Process (WDP) is a central component of the AGR Management System (see Section 9.3.2). This standardised management system process (approved by EOG) ensures that well activity is planned and managed efficiently and with due consideration to good oilfield practice, local and international standards as they relate to well design, operations planning, construction and then subsequent suspension or abandonment operations.

The AGR WDP is primarily split into five phases, namely:

- Phase 1; Project Scoping – describes the process from initial client contact through to the submission and approval of a formal proposal and the contract management responsibilities between AGR and the client or titleholder;
- Phase 2; Initial Planning – describes the initial engineering planning and design work in order to identify and select a preferred option;
- Phase 3; Detailed Well Planning – describes the detailed engineering planning and design work to take the preferred option through to the detailed operations guidelines;
- Phase 4; Operations – describes how AGR manages their daily operations on behalf of the titleholder; and
- Phase 5; Reporting and Review – describes how AGR analyse and report on the performance of the well and the planning.

The proposed activity is part of AGR's WDP Phase 4 (operations).

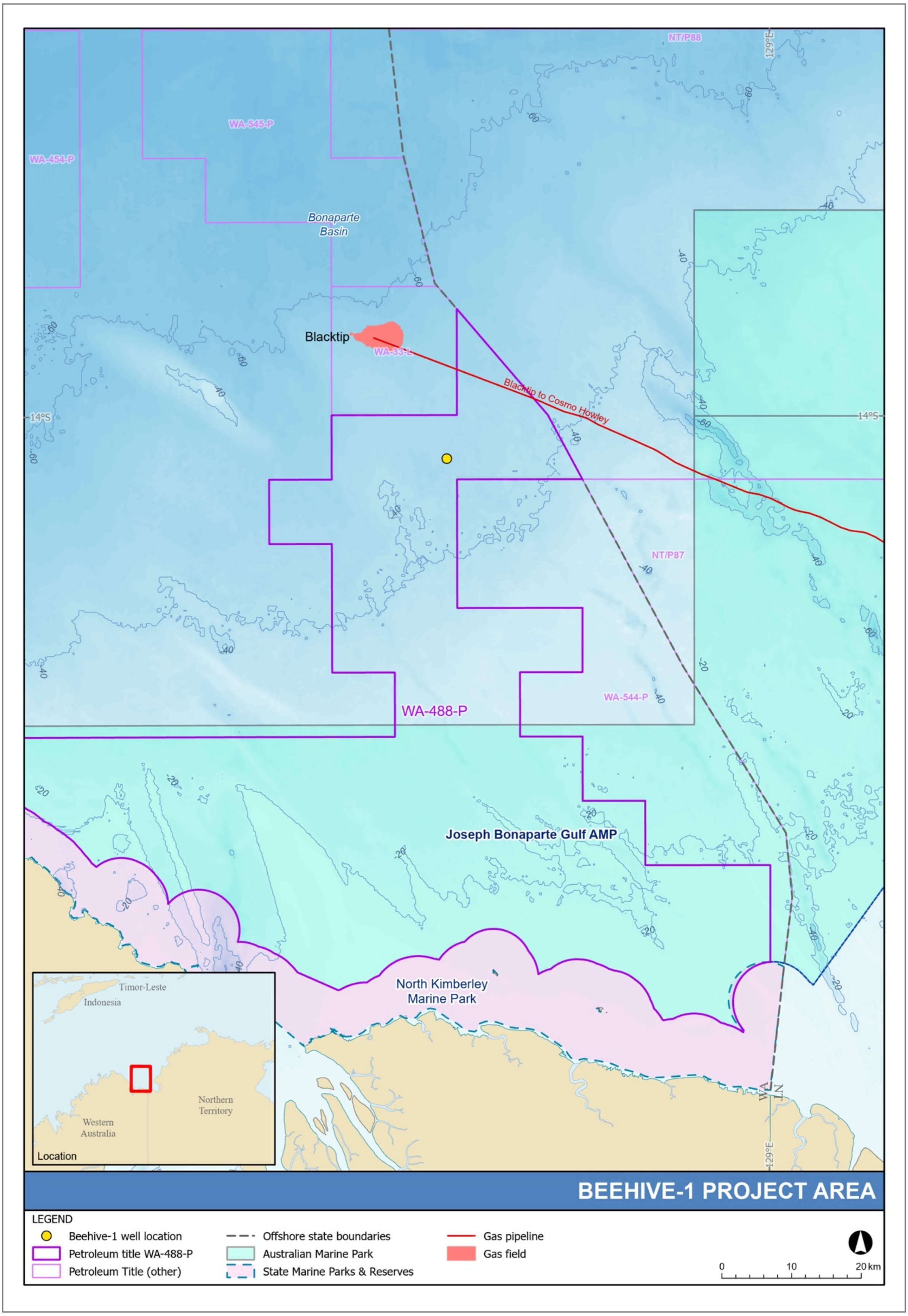


Figure 2.1. Location of the Beehive-1 well in the Joseph Bonaparte Gulf

2.4. Reservoir Characteristics

EOG is targeting the Sunbird (primary) and Tanmurra (secondary) formations. There are numerous large gas discoveries in the region close to Beehive. These are tied back to the Permian, gas-prone source rocks. Although the Lower Carboniferous oil-prone source rocks could be in the present-day gas window, filling the Beehive structure with gas, oil is the higher likelihood and therefore that is what EOG has selected as the basis for well blowout modelling.

EOG narrowed down oils in the region with a similar API to be Jabiru, Puffin, Mutineer-Exeter and Legendre crudes (all of which have APIs between 42° and 44°). Based on having an API closest to that expected at Beehive-1, together with being the most conservative in terms of the residual components, EOG has determined that Jabiru crude is the most analogous oil. Nearby oil samples from the Turtle and Barnett fields would have been idea since they area sourced from the same petroleum system, but no crude assay information is available from those discoveries as those oils were only tested, not produced.

Table 2.3 presents the properties of the oil based on the crude oil assay for Jabiru. Jabiru is from a different petroleum system but has comparable oil properties to what is expected at Beehive. EOG has determined that the API gravity most likely for the Beehive-1 oil target is 43° (light crude).

Table 2.3. Compositional analysis of Jabiru crude oil

Element	Unit of measurement	Measurement
API gravity	°API	42.3
Specific gravity	60°F	0.8143
Density @ 15°C	g/ml	0.8139
Total sulphur	wgt %	0.05
Flash point	°C	<15
Total nitrogen	ppm	170
Water content	Vol %	0.025
Pour point	°C	18
Wax content	wgt %	5.9
Wax melting point	°C	47
Viscosity @20°C	cST	3.694
Viscosity @40°C	cST	2.462
Asphaltenes	wgt %	0.45
Nickel	ppm	<0.5
Vanadium	ppm	<1.0
Mercury	ppm	<0.01

2.5. Drilling Operation

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

2.5.1. MODU

The well will be drilled using a jack-up MODU (drill rig) (such as that shown in Photo 2.1, the *Noble Tom Prosser*, which is currently working in Australia). Jack-up MODUs are typically used for drilling in water depths of less than 150 m. The characteristics of jack-up MODUs are generally similar, regardless of which rig is used, and the following points describe jack-up MODUs:

- Among the MODUs being considered are the two jack-up MODUs currently working in WA, being the *Noble Tom Prosser* and the *Valaris Rig 107*.
- The MODU will be towed into position by support vessels.
- Once in the desired location and with the MODU stationary, the legs are lowered to be in complete contact with the seabed, the rig hull is raised +/-3 m draft and then zero air gap when rig stabilisation activities are conducted (pre-loading).
- When pre-loading activities are completed, the MODU raises itself approximately 20 m above the sea surface. At this point, the drilling derrick is cantilevered over the edge of the MODU in readiness for drilling. Figure 2.2 provides a simplified overview of this process.

Photo 2.1. The *Noble Tom Prosser* jack-up MODU

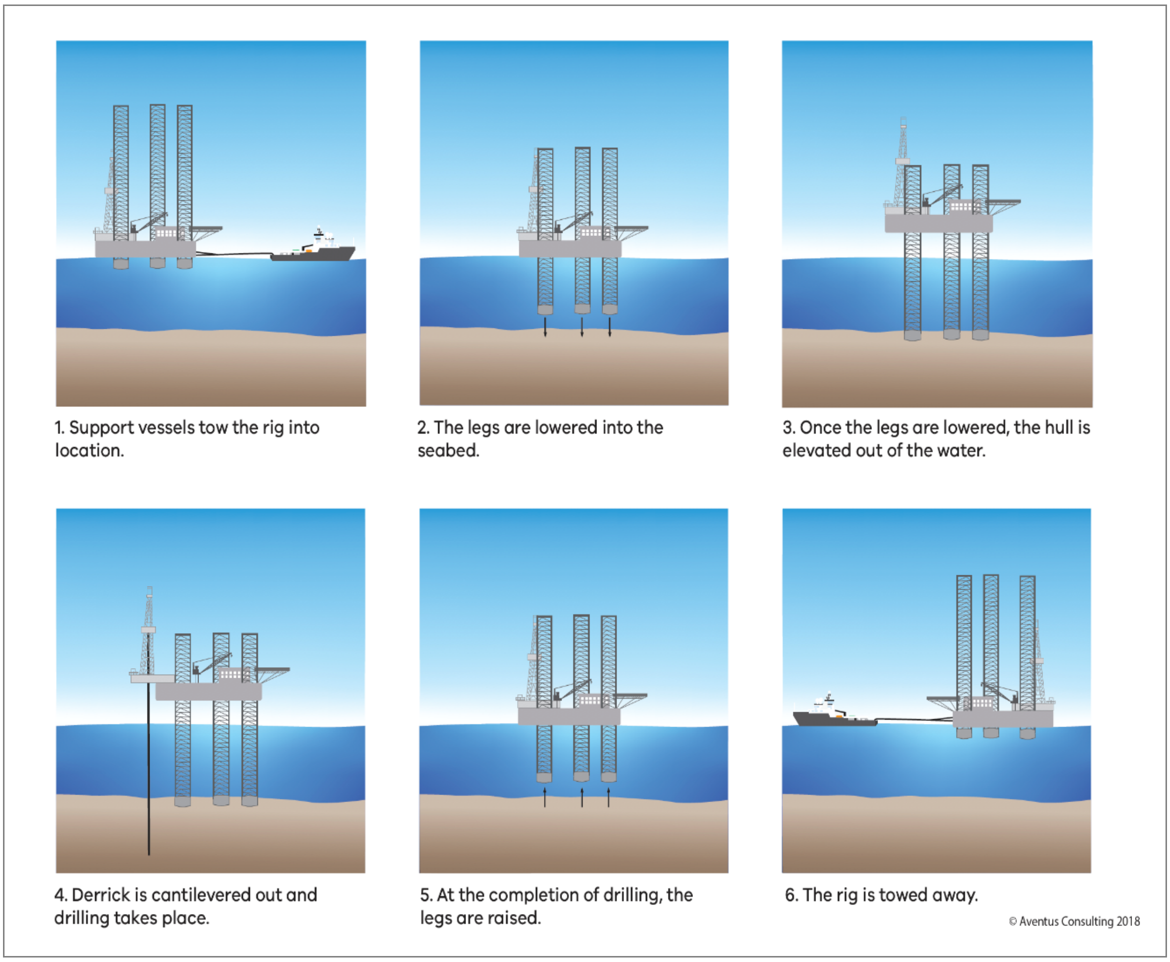


Figure 2.2. Simplified outline of the MODU positioning process

Environmental Credentials

EOG's screening of potential MODUs will involve ensuring that the MODU has, at a minimum, the following current and valid environmental credentials in place:

- International Oil Pollution Prevention (IOPP) certificate in accordance with MARPOL Annex I (enacted under AMSA Marine Orders Part 91, Marine Pollution Prevention – Oil);
- International Sewage Pollution Prevention (ISPP) certificate in accordance with MARPOL Annex IV (enacted under AMSA Marine Orders Part 96, Marine Pollution Prevention – Sewage);
- International Air Pollution Prevention (IAPP), Engine International Air Pollution Prevention (EIAPP) and International Energy Efficiency (IEE) certificates and Ship Energy Efficiency Management Plan (SEEMP) in accordance with MARPOL Annex VI (enacted under AMSA Marine Orders Part 97, Marine Pollution Prevention – Air Pollution);
- International Anti-fouling System certificate in accordance with the International Convention on the Control of Harmful Anti-fouling Systems on Ships 2008 (enacted under AMSA Marine Orders Part 98, Marine Pollution Prevention – Anti-fouling Systems);
- Shipboard Marine Pollution Emergency Plan (SMPEP) in accordance with MARPOL Annex I (enacted under AMSA Marine Orders Part 93, Marine Pollution Prevention – Noxious Liquid Substances); and
- Shipboard Garbage Management Plan in accordance with MARPOL Annex V (enacted under AMSA Marine Orders Part 95, Marine Pollution Prevention – Garbage).

EOG will arrange for an inspection of the MODU (e.g., condition survey, hazardous area and equipment survey, Blowout Preventer (BOP) and control system acceptance) by an independent MODU inspection contractor to ensure that the MODU is in good operating order. In addition, EOG will also conduct its own audit of the contractor's HSE management systems and pre-drilling inspection against the EP commitments to ensure that systems and processes meet legislative and activity requirements.

Regulatory Jurisdiction

The MODU is considered part of a 'petroleum activity' (as defined by Regulation 4 of the OPGGS(E)) while within the operational area and therefore subject to the OPGGS Act. While on location, hydrocarbon spills to sea from the MODU will be combatted in accordance with the MODU's SMPEP and the activity-specific OPEP (99616-2022-Beehive#1-OPEP-RevA).

An application for a temporary PSZ (an area encompassing a 500 m radius) around the MODU will be submitted to NOPSEMA to cover the duration of drilling. When the MODU is outside the gazetted PSZ (e.g., on tow to or from location) but within Australian waters, it comes under the regulatory jurisdiction of the *Navigation Act* 2012 (Cth), which is administered by AMSA. Accordingly, this EP does not cover MODU activities while outside the PSZ.

2.5.2. Support Vessels

Typically, two support vessels will be required to assist the MODU; however, this EP accounts for up to four (used for towing, equipment and material transfers, standby operations and emergency response). The support vessels are yet to be contracted but are usually offshore multiple purpose or anchor handling vessels.

Equipment and material transfers may include, but are not limited to, crew supplies, hydrocarbons (diesel, engine oil, hydraulic fluids, grease, etc.), bulk drilling products, MODU and drilling equipment and parts, and waste. MODU cranes will be used for transfers between the MODU and support vessels.

Bulk products will also be transferred via hose from the support vessels and the MODU. Such products include drilling fluids and solids, brine, drilling water, cement and fuel oil (diesel).

At least one support vessel will remain on standby within a short distance of the MODU. This is to ensure that the 500 m PSZ around the MODU is maintained, and to provide support in the event of an emergency or unplanned event (e.g., spills to the marine environment).

Support vessels will not anchor within 500 m of the MODU but may anchor in the permit area during the activity. No at-sea refuelling of support vessels will take place within the operational area.

Environmental Credentials

As part of the Invitation to Tender process, an initial screening of potential vessels will be conducted to ensure they have, at a minimum, current and valid environmental credentials that are the same as for the MODU described previously.

Regulatory Jurisdiction

The support vessels are considered part of the 'petroleum activity' while they are within a 500-m radius of the MODU (the PSZ). While a support vessel is located within this area, hydrocarbon spills to sea from the support vessels will be combatted in accordance with the vessel SMPEP and/or the activity-specific OPEP (depending on the size of the spill).

When the support vessels are outside the PSZ (e.g., steaming to or from location, or holding position outside the PSZ) and remain within Australian waters, they come under the regulatory jurisdiction of the *Navigation Act* 2012 (Cth), which is administered by AMSA. Accordingly, this EP does not cover activities performed by the support vessels while outside the PSZ.

The 500 m radius PSZ limit has been selected because within this zone, the support vessels must comply with the MODU operating procedures as detailed in the MODU's Facility Safety Case. Outside of this zone, the support vessels operate as trading ships as defined in Section 6(1) of the *Navigation Act* 2012 (Cth), and the combat of hydrocarbon spills is the responsibility of the vessel operator and AMSA in line with the NatPlan (AMSA, 2017).

2.5.3. Aviation Support

Helicopters will be used primarily for crew change and medevac, and occasionally equipment and material transfers. Helicopter flights will occur several times a week dependent on the progress of the drilling program and logistical constraints. Refuelling of helicopters may take place on the MODU.

Regulatory Jurisdiction

As with the support vessel, a helicopter is considered part of the 'petroleum activity' while it is within the 500m radius PSZ around the MODU. This EP does not cover activities performed by the helicopters while outside the PSZ.

At all times, helicopter operations come under the regulatory jurisdiction of the *Air Navigation Act* 1920 (Cth), Civil Aviation Safety Regulations 1998 (Cth) and the Federal Aviation Regulations, which are managed by the Civil Aviation Safety Authority (CASA).

2.6. Pre-drilling Geophysical Activities

As outlined in Chapter 2 of the NOPSEMA-accepted Beehive PDSA EP (996161-2022-Beehive#1-PDSA-EP-Rev2), there is the potential that some geophysical activities may need to be repeated immediately prior to MODU mobilisation. This would likely be limited to side-scan sonar and specifically excludes 2D shallow seismic surveying.

The purpose of this additional site clearance survey would be to reconfirm the absence of seabed hazards and meet the warranty requirements of the MODU owner. If this additional site clearance survey is required after the end of August 2022, it is included in the scope of this EP. Alternatively, a Remotely Operated Vehicle (ROV) may be deployed from the MODU prior to jacking up to undertake the site clearance survey to meet the MODU owner's warranty requirements.

In accordance with Regulation 31 of the OPGGS(E), EOG refers the reader to following sections of the PDSA EP (https://info.nopsema.gov.au/activities/468/show_public) to describe the possible investigations that may take place:

- Section 2.4 – description of geophysical investigations (excluding 2D shallow seismic); and
- Section 2.7 – description of typical vessels.

Any geophysical activities required immediately prior to the MODU mobilisation will occur within the same activity area as that outlined in Section 2.1 of the PDSA EP, which includes this activity's operational area.

2.7. Drilling Program

The Beehive-1 well will be drilled as a vertical well to target the Sunbird (primary) and Tanmurra (secondary) formations.

The well design includes drilling a conductor hole (and run conductor) and surface hole section (and run) to set the surface casing. The surface wellhead and BOP will be installed and tested before the well is drilled to total depth (TD). The planned TD is approximately 5,090 m total vertical depth subsea (TVDSS), however, the TD may be less or more depending on the geology and operational issues.

The following phases describe the planned drilling activity:

- Move the MODU to location, position MODU, pre-load and jack-up to operational elevation;
- Drill conductor hole and run conductor;
- Drill surface hole section;
- Run and cement surface casing;
- Install surface wellhead and BOP;
- Perform pressure test;
- Drill intermediate hole section(s);
- Run and cement intermediate strings;
- Drill remaining sections to well TD;
- Run well evaluation program (wireline logging, sidewall cores, formation testing, vertical seismic profiling [VSP], possibly a DST);
- P&A the well; and
- Demobilise the MODU.

The prognosed formation tops, depth uncertainties and lithological descriptions for Beehive-1 are illustrated in Figure 2.3. Note all depths are relative to mean sea level (MSL). This geological prognosis has been used to ensure the proposed well design achieves the evaluation objectives of the target formations and mitigates the potential formation-related drilling risks per the offset well experience.

Table 2.4 describes the notional Beehive-1 design.

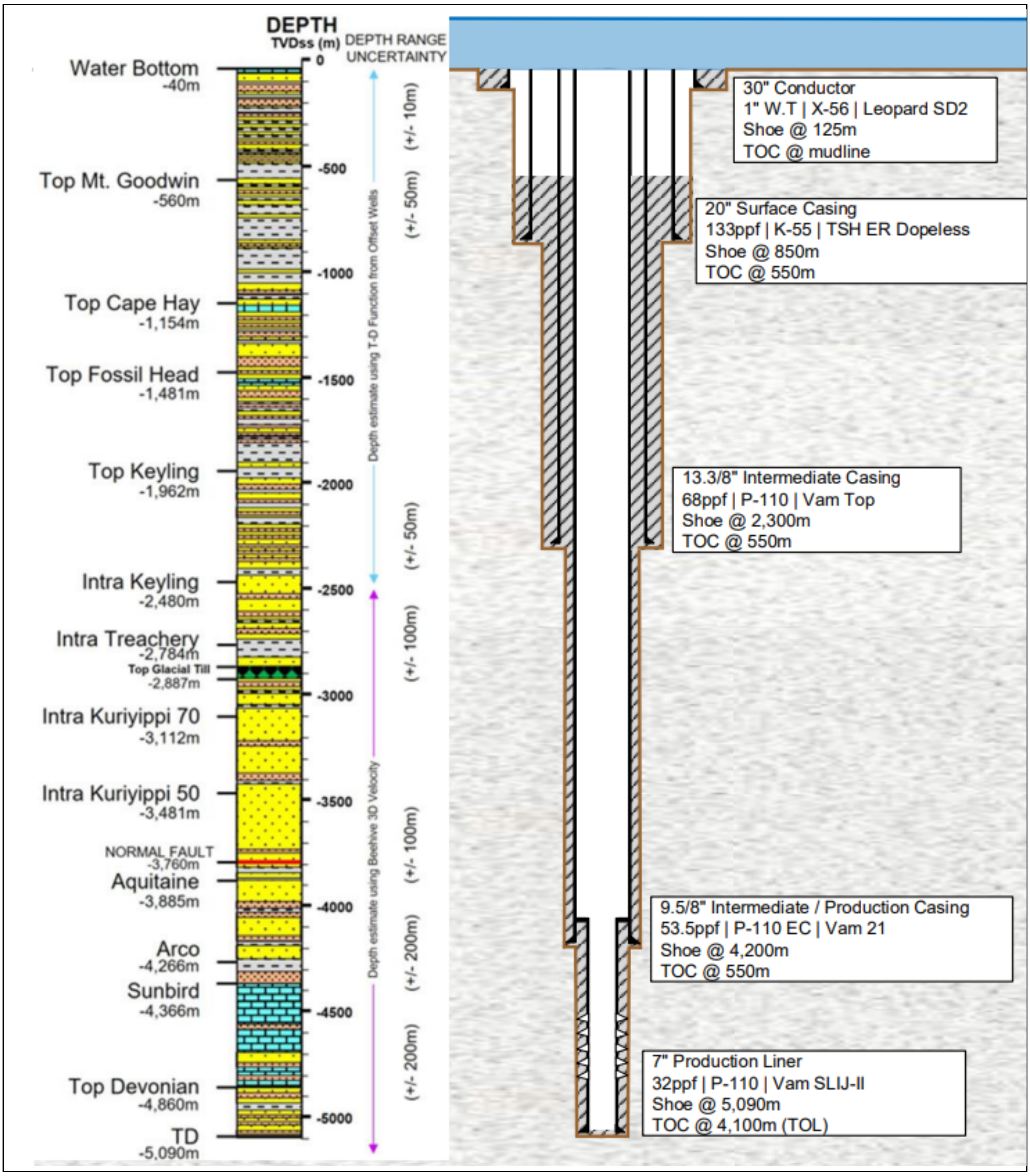


Figure 2.3. Beehive-1 planned well design

Table 2.4. Notional Beehive-1 design

Well section	Description
36” (914 mm) hole 30” (762 mm) conductor	A 36” hole will be drilled and 30” diameter, 1.0” wall thickness, X-56 conductor will be set ~85 m below the mudline in accordance with offset well design. It is planned to cement the 30” conductor to the seabed using an inner drill pipe string and tag in sub.
26” (660 mm) hole 20” (508 mm) surface casing	Section TD in the 26” hole section is planned to be in the Mt Goodwin shale at 855 m MSL. The shoe depth will also provide sufficient shoe strength for drilling to the next casing point. 20” casing will then be set ~5 m off bottom and cemented in place with the BOPs installed thereafter. Based on the shallow hazards analysis commissioned by EOG, encountering shallow gas to this shoe depth has been assessed as low risk.
17½” (444 mm) hole 13⅜” (340 mm) intermediate casing	The 13⅜” shoe is planned to be set within the Keyling formation at 2,300 m MSL. Section TD is based on pushing the 13⅜” shoe as deep as possible, maximising shoe strength to circulate out any overpressure kick in the 12¼” hole section with the next casing point planned to be within the anticipated overpressure.
12¼” (311 mm) hole 9⅝” (244 mm) intermediate/ production casing	The 12¼” hole section will be drilled from the 13⅜” casing shoe to the 9⅝” casing point towards the base of the Aquitaine formation.
8 ½” (216 mm) hole to TD 7” (178 mm) production liner	The 8½” hole section will be drilled from the 9⅝” casing shoe to planned well TD of 5,090 mRT (metres below rotary table) with a +/-200 m depth uncertainty. In a success case, a 7” production liner with a +/- 100 m liner lap is planned to facilitate DST operations.
Contingency: 6” (154 mm) hole 4½” (114 mm) production liner	In the event the 9⅝” casing is set early and the 7” liner is set as a drilling liner above the Sunbird Formation, the well will then be drilled to TD in 6” hole. In a success case, a 4½” production liner will be run to facilitate DST operations. A 6” contingency will also enable drilling to planned TD to evaluate the Tanmurra secondary target if it evidently becomes beneficial to set the 7” liner shallower.

2.7.1 Drilling Contingencies

Should drilling difficulties be experienced meaning the well cannot progress, a contingency option exists to cement up the existing hole above the trouble zone and side-track drill the well around the problem. Side-track drilling would only be exercised should drilling difficulties be experienced; this is not considered a new stage of the petroleum activity. A contingency liner is planned to mitigate some possible downhole problems should the need arise.

These activities may require an increase in the excavated rock volume (i.e., cuttings), drilling fluids and cement consumed.

2.7.2 Drilling Fluids and Cuttings

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

- Control of formation pressures (i.e., providing a hydrostatic head by managing mud density maintains well stability and prevent a blowout);
- Transport of drill cuttings out of the hole to the MODU;

- Maintenance of drill bit and assembly (i.e., lubrication, cooling and support); and
- Sealing of permeable formations to prevent formation invasion.

Drilling Fluid Program

Only water-based mud (WBM) will be used for the well.

The conductor hole section will be drilled using seawater and pre-hydrated gel (PHG) sweeps to clean the hole, and hole displaced to PHG to provide stability for running the conductor. This fluid will exit the well at the seabed while drilling the hole and installing the conductor casing. As with the drilling fluids, cuttings for the conductor hole section will exit the wellbore at the seabed.

Once the conductor casing is installed, and a closed circulating system is established, the remainder of the well will be drilled with WBM systems, as outlined in Table 2.5. WBM will be discharged from the MODU at the sea surface. As a contingency measure, if losses are noted when drilling the conductor, cuttings and muds may be discharged by opening a valve on the conductor above the seabed (rather than from surface).

Cuttings for the remaining hole sections to TD will be discharged at sea level after being removed from the WBM system through the solids control system. The solids control system comprises shale shakers, and if required to remove ultra-fine solids in the recovered drilling fluid, centrifuges.

Aqueous-based lost circulation material (LCM) will be available to pump should downhole losses occur.

Per AGR's Wells Standard (AP-WDP-S01), approved by EOG, a minimum 200 psi overbalance is required over prognosed pore pressures to maintain primary well control. Lower overbalances are acceptable in surface hole sections where an overbalance of 200 psi may not be possible.

The selection of drilling fluids to be used during the drilling program is undertaken through an evaluation of the technical, safety and environmental attributes. A well-specific Drilling Fluid Program will be prepared by the drilling fluids contractor (not yet appointed) and endorsed by AGR and EOG prior to spud.

The Drilling Fluid Program will contain details of the well data, drilling fluid-related risk assessment, load out list, logistics plan, execution plan and procedures. This Drilling Fluid Program will be implemented by the wellsite mud engineers (24 hr coverage).

The calculated volumes of drill cuttings to be generated and drilling and completion fluid solids discharged are outlined in Table 2.5.

Drill Fluid Additives

Seawater or drill water is the primary constituent of drilling fluids. Inert drilling fluid additives are added to the seawater or drill water to form a WBM. Details of the fluid additives will be available once a drilling fluid contractor has been selected. As such, the WBM additives (by name/brand and volume) likely to be used in the drilling program, and their toxicity ratings, are not available at this stage. However, the key additives used in WBM are xanthum gum (viscosifier), bentonite (viscosifier) and barite (weighting agent), which are all inert substances (they have no toxicity, see 'Drill Fluid Toxicity' section).

The contractor will be selected from the worldwide service providers who operate in Australia (e.g., Schlumberger, Halliburton, Baker Hughes).

Table 2.5. Estimated drilling cuttings and mud solids discharge volumes for Beehive-1

Bore diameter (inches)	Well interval	Cuttings	Mud solids		Discharge duration (days)
		Volume discharged (m^3)	Type	Volume discharged (m^3)	
36”	Conductor hole	80.4	Seawater & sweeps	19.5	0.2
26”	Surface hole	360.1	Gel/polymer WBM	75.0	1.2
17½”	Intermediate hole	322.9	Potassium chloride (KCl) WBM	81.3	2.4
12¼”	Production hole	172.3	High performance WBM	32.7	5.7
8½”	Production liner	29.7		8.8	3.1
	Mud solids discharged at sea surface at well completion			53.9	0.2
	Total	**965.4**		**271.2**	**12.8**

Drill Fluid Toxicity

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

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

Under the OSPAR Convention, organic-based compounds used in production, completion and workovers, drilling and cementing are subject to the CHARM model. The CHARM model calculates the ratio of the ‘Predicted Effect Concentration’ (PEC) against the ‘No Effect Concentration’ (NOEC) expressed as a Hazard Quotient (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/hazard-assessment-process/).

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.

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

<table>
<tr><th colspan="7">OCNS Hazard Groupings for CHARM and Non-CHARM Chemical Products</th></tr>
<tr><td>CHARM</td><td>Gold</td><td>Silver</td><td>White</td><td>Blue</td><td>Orange</td><td>Purple</td></tr>
<tr><td>Non-CHARM</td><td colspan="6">E | D | C | B | A</td></tr>
<tr><td></td><td colspan="6">Lowest Hazard → Highest Hazard</td></tr>
</table>

Source: NOPSEMA (2015)

Figure 2.4. Illustration of hazard ranking bands for chemical products classified under the OCNS

<u>Chemical Substitution</u>

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

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

<u>Chemical review process</u>

AGR and 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 a chemical doesn't meet the requirements regarding its hazard rating or has a substitution warning in place, AGR and EOG will review and assess the chemical proposed to ensure environmental risks are reduced to ALARP and acceptable levels. This will be managed using AGR's MoC process (described in Section 9.8).

Fluids Disposal

Where applicable, drilling fluids will be recycled between sections. Between the 17½" and the 12¼" hole sections, mud will be transferred from one section to the next.

At the end of the drilling program, any drilling fluid (mud and brine) remaining in the mud tanks will be discharged overboard. This volume will be minimised through careful mud management. Any dry, unopened sacks of chemicals left over at the end of drilling will be left on board for the next operator to use or returned to shore.

2.7.3 Cement Program

Cementing operations will be undertaken to provide zonal isolation between different formations as required, maintain well integrity, provide structural support of the casing and to set a temporary suspension plug or P&A plugs to abandon the well. Cement will provide the main barrier for isolation of the wellbore from reservoir conditions whether the well is P&A or temporarily suspended. The final cement plan will be confirmed once a cement service provider has been selected, though it is currently planned that the first three sections of the well will use Class G cement, while the lower two sections will use a high-temperature blend (HTB) cement. The notional cement program is outlined below:

- 30" conductor – the conductor will be cemented to the seabed with any returns discharged directly to the seabed. It is planned to pump 100-200% excess while cementing the conductor in place, however efforts will be made to reduce this by stopping the cement pumping operations once cement returns are observed at the seabed.
- 20" surface casing – the surface casing is planned to be at least 300 m above the casing shoe, with returns monitored at surface. It is planned that 50-100% excess cement will be pumped during this cement job to account for hole washout and losses that may occur during the cementation job.
- 13⅜" intermediate casing – the 13⅜" casing is planned to be cemented to ±550 m MSL, with returns monitored at surface. It is planned that 10-25% excess cement will be pumped during this cement job to account for hole washout and losses that may occur during the cementation job.
- 9⅝" intermediate/production casing – the 9⅝" casing is planned to be cemented back to ±550 m MSL, with returns monitored at surface. Top of cement for this casing string may change through the well design phase. It is planned that 10-25% excess cement will be pumped during this cement job to account for hole washout and losses that may occur during the cementation job.
- 7" production liner – if run, the production liner will be cemented to the top of the liner for zonal isolation for the DST. Although a caliper log will be run, it is planned that 10% or more excess cement will be pumped during this cement job to account for losses that may occur during the cementation job.

Abandonment cement plugs will be set as required to safely temporarily suspend or P&A the well. The final abandonment program will ensure moveable hydrocarbons (if identified while drilling) are isolated in line with a NOPSEMA-accepted Beehive-1 Well Operations Management Plan (WOMP).

During cementing operations, surface cementing equipment and lines will need to be flushed, washed and cleaned with water to prevent hard setting. The residual cement and wash water will be discharged to sea after each cement job (see Section 7.7).

Cement spacer in well returns and residual surface tank volumes will also be discharged to sea during cementing operations.

Cement Disposal

Cement will be discharged overboard as part of the cement program, with only required cement mixed to ensure minimal wastage. There will be some excess cement discharged directly at the seabed during the cementing of the conductor casing string. Although cementing details are yet to be finalised, planning 100-200% excess is common for the conductor casing cement job to account for losses and over-gauge hole conditions. Once quality cement returns are detected at the seabed, cement mixing will cease and displacement will commence, with a minimal quantity of cement being deposited at the seabed during the displacement. Table 2.6 presents the estimated discharge volumes associated with the cement program.

Table 2.6. Estimated cement discharge volumes

Cementing activity	bbl	m^3
Discharge of cement slurry during system testing.	50	8
Dry cement from the bulk tanks that may be blown overboard during windy conditions in preparation for the cement job.	30-60	5-10
Washing the cement unit and flushing cement hoses to prevent curing (for each of the five cementing operations). This is usually done with seawater or compressed air after every cementing operation (5 x casing strings, 3 x cement plugs).	20 for each cementing operation, total of 160	3 each (total of 24)
Cement overspill at the seabed during cementing of the top hole (30") cement job.	220	35
Total	**460-490**	**72-77**

At the end of the drilling program, and assuming the MODU moves directly to another operator, remaining dry cement will be retained on board for the next operator. Failing that, the cement will be discharged overboard as a slurry.

2.7.4 Well Evaluation

Well evaluation involves the collection of data on the well and surrounding formation. Downhole formation evaluation will be carried out via Logging While Drilling (LWD)/Measurement While Drilling (MWD) and wireline logging, which may include VSP. No conventional coring is planned. Formation evaluation involving DST operations will include flaring at surface.

Radioactive sources used in downhole tools for logging purposes will be managed in accordance with the MODU Safety Case so that occupational health and safety risks to people are managed to an acceptable and ALARP level.

Further details on these well evaluation activities are provided herein.

Measure/Logging While Drilling

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

The LWD tools will be utilised to gather key geological parameters while drilling to inform progress and anticipate upcoming intervals for logging operations.

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

- Direction survey;
- Pressure, temperature and vibration;
- Resistivity, gamma ray;
- Neutron and density; and
- Sonic response.

Wireline Logging

Conventional wireline logging operations will be conducted in both the 12¼" and 8½" holes if feasible. The objective of the wireline logging is to gather more detailed reservoir information than is available via LWD, carry out sampling of the Sunbird target, improve depth control of seismic and prove up rates of various lithologies for the potential drilling of a future Beehive-2 well. A well test program will be prepared.

Wireline logs may include:

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

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

Vertical Seismic Profiling

As a subset of the wireline logging operation, EOG intends to conduct zero offset VSP. The VSP will enable a high-resolution 2D image of the well and surrounding area to be obtained and improve tie-in to seismic survey data for the area. The sound source will be held over the side of the MODU by the crane. The notional VSP details are as outlined in Table 2.7.

Table 2.7. Notional VSP details

Parameter	Details
Number of airguns	4
Sound source volume	150 cubic inches (cui) (for a total of 600 cui)
Pressure	2,000 psi
Number of shots	150
Source effort	13.8 Bar-m
Duration	4 hours
Depth below sea level	4 m

DST Operations

In a success case, a well clean up flow and well production test(s) will be conducted after running the DST string. Each well test is expected to take approximately 3-5 days, with all flaring operations via high efficiency well effluent burner heads. Multiple zones may be tested, but the decision on which zones to test cannot be made until after logs are evaluated.

2.8. Plug and Abandonment

At the completion of drilling, the well will be P&A.

The possible final P&A condition of the well is as per the schematic in Figure 2.5 (in the case of a dry hole, where a production liner is not run).

The final abandonment plan will be confirmed once the well has been drilled and logged to ensure that the barriers are located at the necessary depths. The casing strings will be cut 1-3 m below the mudline and pulled back to surface and the depth of the cut will be measured.

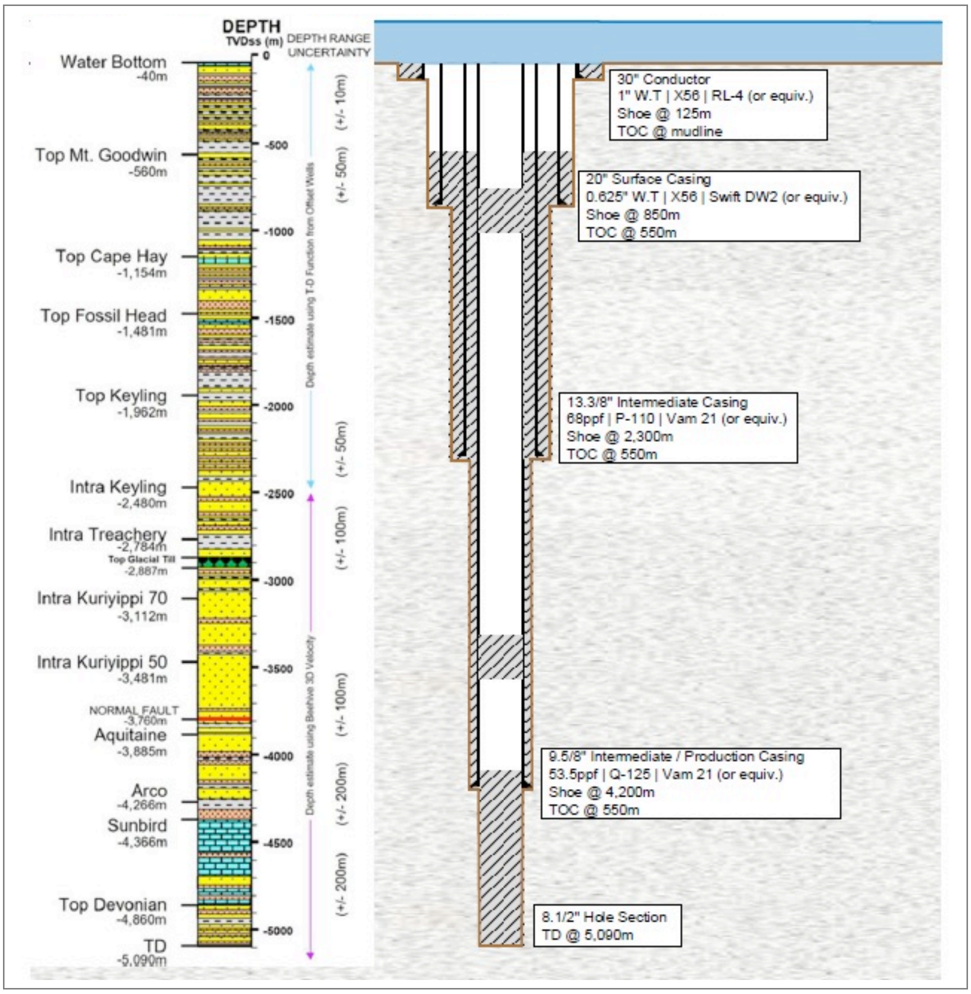


Figure 2.5. Conceptual P&A schematic (dry hole case)

2.9. Well Control

Well control is the process implemented to prevent a blowout from occurring. Primary well control is provided by the hydrostatic pressure of the drilling fluid having sufficient density to overcome any bottom hole pressure. Many steps are taken to ensure proper density of the drilling fluid is always maintained. Constant monitoring of the mud returns and pit levels help ensure that in the event the bottom hole pressure ever exceeds the hydrostatic pressure of the mud and the well tries to flow formation fluids (kick) into the wellbore, the drilling crew will shut in the BOPs (the secondary control). By shutting in the BOPs, the well flow stops and steps are taken to increase the mud density to overcome the bottom hole pressure.

In addition to well control procedures implemented by the drilling crew, front end engineering design with input from EOG's geological team will design the well such that sufficient kick tolerance is managed from top to bottom of the hole while drilling. This is to ensure maximum anticipated surface pressure is known ahead of time and that properly designed surface equipment is used for the well construction.

2.9.1 Blowout Preventer

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

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

A BOP rated to a minimum of 10,000 psi working pressure will be installed and pressure tested prior to deployment and upon initial latch-up with the wellhead.

Response to the loss of well control

The following outlines the steps that would initially be taken in response to a well kick:

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

The BOP will only be removed once suitable barriers are in place and are tested. This will occur:

- After setting the cements plugs in the well, if the well is abandoned; and
- For any unplanned BOP maintenance or weather suspension reasons.

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

2.10. Response to a Loss of Well Control

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

- Containment; and
- Relief well drilling.

In the event of a blowout during drilling, reservoir modelling indicates that the worst-case discharge would be released through the 8½” (216 mm) open hole (no obstruction in the well) from a net pay zone of 330 m with zero mechanical skin factor for a period of 77 days (the time required to source a MODU, drill a relief well and kill the well). The oil and gas flow rates are provided in Table 2.8.

The global upstream petroleum industry has developed and continues to advance innovative technologies to respond to a well blowout.

Table 2.8. Predicted worst-case flow rates and volumes

Flow rates and release volumes	Release volume
Oil	
Initial oil flow rate (bbl/day)	72,572
77-day oil average oil flow rate (bbl/day)	64,270
77-day oil cumulative release volume (MMbbl)	4.9
Gas	
Initial gas flow rate (mmcf/day)	131
77-day average gas flow rate (mmcf/day)	116
77-day gas cumulative release volume (Bcf)	8.9
Water	
Initial water flow rate	N/A
77-day average water flow rate (bbl/day)	N/A

EOG has a contract in place with a well control service provider (Wild Well Control) that allows it to access personnel and equipment to respond to a well control response anywhere in the world. EOG has also a contract in place with Oil Spill Response Limited (OSRL) (which will include coverage for Australia) and will have in place a contract with the Australian Marine Oil Spill Centre (AMOSC) for hydrocarbon spill response resources that allows EOG to access personnel and equipment to respond to a hydrocarbon spill.

2.10.1 Capping and Containment

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

For this activity, a capping and containment approach is not feasible because these systems are designed for subsea wellhead applications and therefore not suitable for jack-up MODU surface stack systems (which will be used for Beehive-1).

2.10.2 Relief Well

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

Preliminary Relief Well Planning

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

The scope of activities involved with drilling a relief well is the same as drilling a standard well, though it would be a highly deviated well due to the need to drill from outside a safety zone. A Preliminary RWP (2021-006-03-29-01) has been prepared by AGR for Beehive-1. This plan:

- Describes industry guidelines relevant to relief well drilling;
- Describes the process in place to monitor for and rapidly source a suitable MODU; and
- Provides a relief well drilling program and schedule.

Further details on the Preliminary RWP are provided herein.

Rig Specification & Provision for Procurement

The selection of a suitable MODU to undertake relief well activities will be based on the closest available unit that meets the criteria listed in Table 2.9. Given the water depth in the vicinity of the Beehive-1 location (~40 m), it is assumed only jack-up MODUs would be capable of undertaking the activities. Two suitable jack-up MODUs have been identified as likely to be working within Australian waters during the planned drilling window for Beehive-1 and have an Australian Safety Case, which are the *Valaris 107* and *Noble Tom Prosser*. However, one of these MODUs will likely be contracted to drill the primary Beehive-1 well.

Table 2.9. Relief well rig specification

Parameter	Details
MODU type	Jack-up
Water depth	~40 m
Drilling depth rating	Minimum 6,000 m
Well control equipment rating	18¾” BOP, minimum 10,000 psi
Pumping capability	3 x 2,200 HP mud pumps, 7,500 psi circulating system
Regulatory requirements	Australian Safety Case in place

Any relief well schedule will be driven largely by the rig mobilisation period. It is assumed that the most likely location of the jack-up MODU not contracted to drill Beehive-1 would be from the North West Shelf area, which is approximately 10-14 days mobilisation time away from the Beehive-1 location. It is expected that any ongoing operations can be safely suspended and the relief well MODU can be mobilised to the Beehive-1 location within the timeframe for the Safety Case Revision to be developed and accepted by NOPSEMA, assumed to be 24 days. The availability of suitable MODUs will continue to be monitored and their status updated within the RWP on a monthly basis to ensure any assumptions on the timely execution of relief well remain valid.

Relief Well Construction and Long-lead Requirements

As per Beehive-1, a standard 18¾”, 10 ksi surface wellhead system configured for a 30” x 20” x 13⅜” x 9⅝” casing program and standard Oil Country Tubular Goods (OCTG) weights and grades (well loads expected to be very similar to Beehive-1) would be required for the purposes of executing a relief well. The relief well design is consistent with the original Beehive-1 well design setting 30” conductor, 20” surface casing and 13⅜” intermediate casing at the same TVDs. The final 9⅝” casing string will be set as deep as possible (~30 m above the intercept point) to provide the maximum formation fracture gradient for containing the dynamic kill whilst still also facilitating a positive alignment for penetrating into the target well.

The availability of standard long-lead equipment for the construction of the relief well has been identified as likely from local operator and/or vendor inventory and will be confirmed closer to the planned drilling window as planning for Beehive-1 progresses. Preliminary high-level specification and means of provision of long lead and drilling equipment for executing a relief well for Beehive-1 is outlined in the Preliminary RWP. Prior to spudding of Beehive-1, EOG will have in place access agreements to other operators' relief well contingency equipment (e.g., OCTG and wellheads) as required to ensure any assumptions on the timely execution of a relief well remain valid.

Relief Well Location and Trajectory

The preliminary relief well design assumes the surface location for a relief well would be approximately 1 km east/northeast from the primary Beehive-1 well location. No seabed hazards are expected proximal to the Beehive-1 well location. However, shallow hazards may be present westward to the Beehive-1 location. Therefore, the preferred relief well location is currently to be east of the Beehive-1 well location. This will be confirmed/adjusted based on the information that will be obtained from the geophysical survey planned for 2022.

For the most likely scenario of a well blowout (i.e., in the 8½" hole) for the worst case scenario (drill pipe above deepest casing shoe), the relief well is designed to set 9⅝" casing ~30 m prior to intersecting the Beehive-1 wellbore at the 9⅝" casing shoe at 4,250 m TVDRT. The relief well design is based on kicking off below the 13⅜" casing shoe at ~1,200 m TVDRT building at 2.0°/30 m to a maximum inclination of ~23°, allowing for wireline ranging tools to be run. Once the relief well is within ~50 m (centre to centre) from the target wellbore ~670 m (MD) above the planned interception point (start of locating phase), active ranging can begin to detect the target wellbore. After initial ranging, the tool will then be pulled out of the hole and directional drilling will continue until the next planned proximity ranging point, where again the ranging tool would measure the distance and direction to the original well. This process would continue with separation maintained so as to avoid intercepting the target well shallower than planned. The relief well trajectory during the tracking phase is designed to drop at 2.0°/30 m, bypassing the target wellbore ~490 m TVD above the planned interception point. The relief well will continue to be drilled alongside the target wellbore maintaining a separation of ~10 m with ranging performed as required and the relief well turned to align with the blowout well intercept point. Once the relief well and the target wellbores are aligned ~30 m above the desired intercept point at the Beehive-1 9⅝" casing shoe, 9⅝" casing would be set before the relief well intercepts the blowout well with a closure angle of ~4.6°. The preliminary relief well trajectory is shown in Figure 2.6.

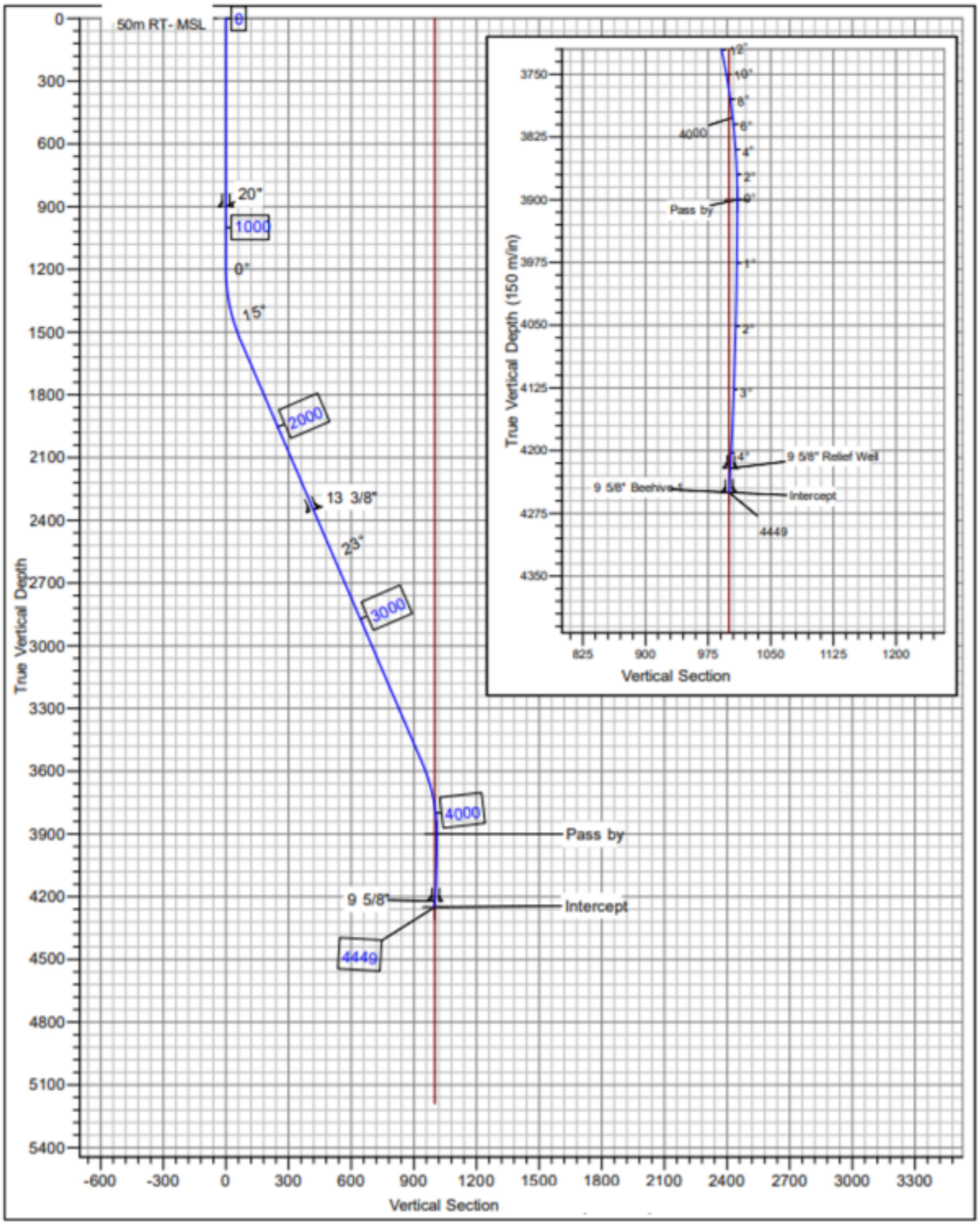


Figure 2.6. Preliminary relief well trajectory

Relief Well Project Schedule

The Preliminary RWP indicates it would take 77 days (11 weeks) to perform the well kill (including MODU mobilisation), as detailed in Table 2.10. The preliminary time estimate for drilling the relief well and well kill is 53 days.

APPEA Mutual Assistance Agreement

APPEA developed the Memorandum of Understanding for Mutual Assistance (known as the Mutual Assistance Agreement, MAA) that facilitates the transfer of a MODU between operations in the event of a drilling emergency that requires a relief well to be drilled.

EOG will sign up to the MAA prior to the commencement of drilling to ensure it will be in place during the Beehive-1 drilling program.

Table 2.10. Preliminary relief well schedule

Activity	Duration (days)	Comments
Planning (prior to Beehive-1 drilling)		
Initial relief well planning	>3 months prior to spud	Relief well complexity assessment. Relief well location identification and initial design. MODU and long-lead equipment specification and identification. Signatory to APPEA MoU and Operators equipment access agreements in place as required. Prepare RWP. Regional rig status update (monthly).
Execution (post-blowout)		
Suitable MODU identified	0-1	Provision for relief well aid is confirmed. Detailed relief well design is initiated.
Develop SCR	1-2	Meet NOPSEMA to discuss imminent SCR.
SCR submitted to NOPSEMA	2-16	
SCR review process	16-23	Dialogue with NOPSEMA to optimise assessment process.
MODU mobilised	20-23	Spud equipment loaded onto MODU. Specialised equipment mobilised.
SCR accepted by NOPSEMA	24	
Relief well drilling	24-77	Blowout is killed.
Total	**77**	

2.11. Drilling Summary

The key drilling activity parameters are summarised in Table 2.11.

Table 2.11. Key drilling parameters

Parameter	Details
Location and timing	
Exploration permit	WA-488-P
Operational area	500 m radius PSZ around the MODU
Water depth	40 m
Start date (earliest)	Late Q1/early Q2 2023
Duration of activity	Approximately 55-90 days
MODU and support services	
MODU	Jack-up, yet to be contracted
Support vessels	Two, yet to be contracted
Marine base	Yet to be decided, most likely from Darwin
Aviation support	Yet to be contracted
Drilling details	
Well depth	5,090 (+/- 200 m) MD/TVD-MSL
Drill cuttings volume (est)	965 m^3
Drilling fluid	WBM
Muds discharge volume (est)	271 m^3
Cement discharge volume (est)	To be confirmed
Well evaluation	LWD, mud logging, electric line logging (including VSP), potential well test

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.

Rev. May 2021

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 Chapter 9 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:

<u>EPs</u>

- 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 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, June 2020).

<u>Oil Pollution Emergency Plans (OPEPs)</u>

- 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 (WA Department of Transport, Version 5.0, July 2020).
- WA Oil Spill Contingency Plan (Department of Transport, Version 1.0, January 2015).
- NT 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).

<u>Operational and Scientific Monitoring Programs (OSMPs)</u>

- 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 Chapters 7 & 8.

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 more than 170 countries.

In 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 (with WA and NT legislation also included in the event of ingress into State or Territory waters being required in an emergency situation).

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.

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: • The packing, marking, labelling and stowage of packaged harmful substances complies with Regulations 2 to 5 of MARPOL Annex III;

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 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; • 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.

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
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.

3.5.3. 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 (2015)

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. Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (2015)

The International Association of Drilling Contractors (IADC) developed the Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (2015) for drilling contractors to provide, among other things, a demonstration to external stakeholders that their management system's risk reducing measures meet agreed stakeholder expectations.

These guidelines present broad environmental (along with health and safety) considerations for achieving BPEM. The guidelines are recommended for use as a demonstration of good industry practice for drilling contractors.

3.5.6. 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 March 2022, IPIECA's members comprise 74 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.

3.5.7. ITOPF Oil Spill Response Technical Information Papers

The International Tanker Owners Pollution Federation Limited (ITOPF) was established in 1968 to promote effective response to marine spills of oil, chemicals and other hazardous substances by providing five core services (spill response, claims analysis and damage assessment, information services, contingency planning and advice and training and education). Membership of ITOPF comprises owners or demise charterers of tankers, defined as any ship (whether or not self-propelled) designed, constructed or adapted for the carriage by water in bulk of crude petroleum, hydrocarbon products or other liquid substances. While this definition excludes MODU and MODU operators becoming members of ITOPF, owners of support vessels servicing MODUs may become members.

More broadly, ITOPF's series of 17 Technical Information Papers relate to marine pollution, including the effects of oil pollution, contingency planning for marine oil spills and responding to oil spills assist the upstream petroleum industry in preparing for and responding to oil spills.

In this EP (and associated OPEP), these ITOPF guidelines have been referenced to support the oil spill response strategies.

3.6. Australian Industry Codes of Practice and Guidelines

There are few Australian industry codes of practice or guidelines regarding environmental management for offshore petroleum exploration. Those that do apply to this activity are briefly discussed in this section in chronological order.

None of these codes of practice or guidelines have legislative force in Australia (other than the EPBC Act Policy Statement 2.1) but are considered to represent BPEM. Aspects of each code or guideline relevant to the impacts and risks presented by the activity are described in the 'demonstration of acceptability' throughout Chapters 7 and 8 of this EP.

3.6.1. Australian Ballast Water Management Requirements (2020)

The Australian Ballast Water Management Requirements (DAWR, 2020, 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 (2009)

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 (2008)

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 EIA and ERA in 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 Chapter 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 9 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 drilling activity, 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, online heritage and native title searches 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 exploration drilling

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)	10. Department of Foreign Affairs (DFAT)

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	
11. Department of Primary Industries and Region Development (DPIRD) - Fisheries	12. Department of Biodiversity, Conservation and Attractions (DBCA)
13. Department of Transport (DoT) – oil spill response coordination	14. Department of Fisheries (DoF) – under DPIRD
15. Department of Planning, Lands and Heritage (DPLH)	16. Pilbara Ports Authority
Northern Territory	
17. Department of Industry, Tourism and Trade (DITT)	18. Department of Environment, Parks and Water Security (DEPWS)
19. DITT – Fisheries Division	20. Department of Transport (DoT) – marine safety branch.
21. Environmental Protection Agency (EPA)	
Category 3 – The Department of the responsible State Minister	
Western Australian	
22. WA Department of Mines, Industry Regulation and Safety (DMIRS)	
Northern Territory	
NT DITT (number 17 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)	
23. Northern Prawn Fishery (NPF) (Cth)	24. Southern Bluefin Tuna Fishery (SBTF)
25. Western Skipjack Tuna Fishery (WSTF)	26. Western Tuna and Billfish Fishery (WTBF)
27. Northern Prawn Fishing Industry Pty Ltd (NPFI)	28. Northern Demersal Scalefish Managed Fishery (NDSMF) (WA)
29. Mackerel Managed Fishery (MMF) – Area 2 (WA)	30. Kimberley Prawn Managed Fishery
31. Kimberley Crab Fishery (WA)	32. Kimberley Gillnet and Barramundi Fishery (WA)
33. A Raptis & Sons Pty Ltd	34. Northern Wildcatch Seafood Australia (NWSA)
35. Demersal Fishery (NT)	36. Offshore Net & Line Fishery (NT)
37. Spanish Mackerel Fishery (NT)	38. Coastal Line Fishery (NT)
Fisheries Associations	
39. Commonwealth Fisheries Authority (CFA)	40. Australian Southern Bluefin Tuna Industry Association (ASBTIA)

41. Western Australian Fishing Industry Council (WAFIC)	42. Pearl Producers Association (PPA)
43. Recfish West	44. Northern Territory Seafood Council (NTSC)
45. Amateur Fishermen's Association of the Northern Territory (AFANT)	
Cultural Heritage	
46. Kimberley Land Council (KLC)	47. Miriuwong and Gajerrong Aboriginal Corporation
48. Balanggarra Aboriginal Corporation	49. Northern Land Council (NLC)
Tourism	
50. Marine Tourism Western Australia (MTWA)	
Other	
51. Darwin Port Corporation	52. NT Regional Harbourmaster
53. WA Cambridge Gulf Limited (CGLTD) - Wyndham Port	54. Seafarms Group Limited
Petroleum	
55. Eni Australia B.V.	56. Woodside Energy Ltd (WEL)
57. Melbana Energy Limited	58. Neptune Energy Bonaparte Pty Ltd
59. Santos Ltd	60. BP Developments Australia Pty Ltd
61. Chevron Australia Pty Ltd	62. Kuwait Foreign Petroleum Exploration Company (Kufpec)
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 9.2 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 LoWC (see Section 8.8).

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 –
  - 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 the public exhibition of the EP), and provided information on the location and timing of the activity (see the PDSA EP (996161-2022-Beehive#1_PDSA-EP-Rev2, available at https://info.nopsema.gov.au/activities/468/show_public). 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.
  - 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.

  - Third information sheet – was issued on 28th February 2022, 14th March 2022, 15th March 2022, 25th March 2022 and 4th April 2022 to inform relevant persons and additional stakeholders (as they became known) on the drilling activity (**Appendix 2**).

- 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/australia) 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 62 relevant persons listed in Table 4.1, 57 were issued with the drilling information flyer (some relevant persons are consulted via other relevant persons). There were 11 relevant persons in the list that had either requested not to be issued additional project information after the PDSA flyer was issued in September 2021 or who EOG had determined were no longer relevant given the lack of interest in the original PDSA program.

Of the 57 relevant persons issued the drilling flyer, only six (10%) responded. The only substantive issues raised were:

- WA DoT – if there is a risk of a hydrocarbon spill entering WA state waters, they must be consulted in accordance with their marine oil pollution consultation arrangements.
- WAFIC – if an oil spill occurred, they want assurance that baseline scientific data on the marine environment will be collected, that a desktop emergency training exercise includes commercial fishing interests, that there is support to the commercial fishing industry with regards to traceability of fish products to manage tainting risks, there is an OSMP in place and there is a commitment to financial adjustment to the commercial fishing industry.
- Project Sea Dragon - concern for water quality (and impacts on an aquaculture water intake) along the NT coastline in the event of a large hydrocarbon spill.

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. This is current as of 29th April 2022.

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 drilling activity. 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 9.

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 9.9.2 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
		28/02/2022 (AHO-06 & 07) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	AHO acknowledged EOG's email and EOG's email and stated that the data was registered, assessed, prioritised and validated in preparation of updating navigational chart products which adhere to international and Australian charting specifications and standards.	
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 9.9.2 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	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
			obtained and mapped AIS traffic data for the project area for inclusion in the EPs.		
		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.	
		28/02/2022 (AMSA-05) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
		01/03/22 (AMSA-06) Email	AMSA thanked EOG for the information sheet and stated that their initial advice on the project will continue to apply and advised EOG and to continue to provide AMSA with updates as the project progresses.	No concerns raised.	
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.	

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 (ACMA-03) Email	EOG emailed ACMA noting there was no need to continue consultation with ACMA for this project given the project area is not located within or near a submarine cable protection zone.	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 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).	

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 (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.	
		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.	

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 (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.	
		28/02/2022 (DoD-10) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	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.	
		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.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
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 the EP. Biosecurity notification requirements are provided in Section 9.9.2 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.	
		28/02/2022 (DAWE-04) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
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.
		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	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
			received and advised EOG to resend to an alternative address. EOG re-issued the email.		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.
		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.	
		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	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
		(DNP-06) Email	is available for public exhibition on the NOPSEMA website.		
		28/02/2022 (DNP-07) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	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.	
		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.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
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 (MBC-05, 06 & 07) Email	EOG re-issued the email and requested a receipt of email and any 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.	No concerns raised.	
		02/12/2021	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
		(MBC-08) Email	is available for public exhibition on the NOPSEMA website.		
		28/02/2022 (MBC-09) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
10. DFAT	Responsible if the activity poses oil spill risk that could impact international jurisdictions.	14/03/2022 (DFAT-01) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	No assessment of merit required. Further consultation will be undertaken if required.
Category 2. Each Department or agency of a State to which the activities to be carried out under the EP may be relevant					
11. 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.	
		28/02/2022 (DPIRD-08) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
12. 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.
		18/09/2021 (DBCA-02) Email	DBCA automated acknowledgment of email received.	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
		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.	No further consultation is required with this relevant person in line with their advice.
		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.	
		28/02/2022 (DBCA-05 & 06) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	DBCA replied noting they did not have any comments in relation to its responsibilities under the *CALM Act* 1984 & *Biodiversity Conservation Act* 2016.	
13. 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. Consultation is ongoing with the WA DoT in relation to the development of the drilling OPEP.
		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.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		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. EOG advised they will provide more information going forward.	No concerns raised.	
		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,	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
			did not require additional information.		
		28/02/2022 (DoT-07) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
		09/03/2022 (DoT-08) Email	WA DoT replied to EOG stating if there is a risk of a spill impacting WA State waters from the proposed drilling activities, EOG must ensure that the WA DoT is consulted as outlined in the DoT Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020).	No concerns raised.	
		17/03/2022 (DoT-09) Phone call & Email	EOG resent WA DoT the Information Flyer #3 in response to phone call discussion regarding the OPEP.	No concerns raised.	
		30/03/2022 (DoT-10) Meeting & Email	EOG had a meeting with WA DoT to discuss resourcing, logistics and state implications in relation to oil spill response. EOG emailed a summary of the meeting discussion to WA DoT.	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
		08/04/2022 (DoT-11) Email	WA DoT confirmed the summary of meeting discussion and thanked EOG for the advance consultation.	No concerns raised.	
14. WA DoF	Refer to WA DPIRD (see entry #10).				
15. WA DPLH	Responsible for protecting Aboriginal heritage, assisting with compliance of the *Aboriginal Heritage Act* 1972 and providing access to heritage information.	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 received for the PDSA consultation period.
		06/10/2021 Phone call	EOG followed up with a phone call to DPLH who stated they had not received the project information sheet. DPLH advised to resend the email.	No concerns raised.	
		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.	
		28/02/2022 (DPLH-05) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling	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
			program and invited return comment.		
16. Pilbara Ports Authority	Responsible for management of Dampier Port under the *Port Authorities Act* 1999 (WA).	14/03/2022 (PPA-01) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	No assessment of merit required.
17. 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 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
		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 (DITT-03,04,05 & 06) Email	EOG responded to administration support at DITT to confirm receipt of test message and requested that the email containing the information flyer be sent to the appropriate individuals at DITT.	No concerns raised.	
		13/10/2021	Program Leader, Research and Field Operations at DITT emailed EOG confirming the permit area is	DITT's key concerns were: • The impact	

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	contained wholly within WA waters and no NT commercial fisheries operate within the PDSA area.	• 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.	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 content prior to formal submission to NOPSEMA.
		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.	
		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.	
		02/12/2021 (DITT-08)	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.		
		28/02/2022 (DITT-09) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
18. 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.	
		17/03/2022 (DEPWS-03) Phone call & Email	EOG called and emailed the Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	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
		22/03/2022 (DEPWS-04) Email	DEPWS thanked EOG and notified that the assigned DEWPS contact person would be in contact.	No concerns raised.	
		25/03/2022 (DEPWS-05) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
19. 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.	
20. NT DoT	Responsible for oil pollution	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.

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
	response in NT waters.	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.	Further consultation will be undertaken if required.
		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.	
		28/02/2022 (NT DoT-03) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
21. NT EPA	Independent authority established under the *NT Environment Protection Authority Act* 2012.	25/03/2022 (EPA-01 & 02) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment. An automated acknowledgement email of receipt was received.	No concerns raised.	No assessment of merit required. Further consultation will be undertaken if required.
Category 3 – The Department of the responsible State Minister					
22. WA DMIRS	Responsible for the management of offshore	18/09/2021 (DMIRS-01) Email	EOG emailed the project information sheet and invited return comment.	No concerns raised.	No assessment of merit required.

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
	petroleum in the adjacent State waters.	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.	Notification requirements are included in Section 9.9.2 and spill notifications are provided in Section 9.3 of the EP. Further consultation will be undertaken if required.
		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 comments through via reply email at their earliest convenience.	DMIRS replied and stated they had no specific comments given the project location is in Commonwealth waters and NOPSEMA may refer the EP to 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.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		28/02/2022 (DMIRS-06) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
NT DITT	As per entry #17.				
Category 4 – A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP					
23. NPF (Cth)	Peak body representing the Northern Prawn Fishery.	Consultation with this fishery is undertaken via the NPFI. See NPFI entry (#27).			
24. 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 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	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 that SBTF would contact EOG directly if they had any issues. No feedback received to date.		
25. 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.	
		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 the NPF, EOG stated they	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
			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.		
26. WTBF (Cth)	Peak body representing the WTBF.	Consultation results as per WSTF (see entry #22).			
27. 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 avoid disruption to the fishery. This will also negate the need for compensation. • Impacts to threatened species, such as turtles, sawfish and sea snakes,
		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 CEO to review on 11 October and provided EOG with the CEO's contact details.	No concerns raised.	
		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	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
			review and provide EOG with a response in the following week.		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.
		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 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	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
				fishing season of 1st August to 1st December each year. • Impacts to threatened species, such as turtles, sawfish and sea snakes, 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 EOG is there are any impacts to it from disruption, displacement or loss of fishery productivity.	
		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.	

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 (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.	
		28/02/2022 (NPFI-12) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
28.NDSMF (WA)	Peak body representing the Northern Demersal Scalefish Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#41).			
29. MMF (WA)	Peak body representing the Mackerel Managed Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#41).			
30. Kimberley Prawn Managed Fishery (WA)	Peak body representing the Kimberley Prawn Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#41).			

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
31. Kimberley Crab Fishery (WA)	Peak body representing the Kimberley Crab Fishery.	Consultation with this fishery is undertaken via WAFIC. See WAFIC entry (#41).			
32. 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 (#11).			
33. 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.	
		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.	
		28/02/2022 (ARAPTIS-03)	EOG emailed Information Flyer #3 to notify the stakeholder of 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
		Email	Beehive-1 exploration well drilling program and invited return comment.		
34. NWSA	NWSA 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.	
		28/02/2022 (NWSA-04) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
35. Demersal Fishery (NT)	Peak body representing	18/09/2021 (Demersal-01)	EOG emailed the project information sheet and invited return comment.	No concerns raised.	EOG has addressed this relevant person's concerns

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
	Demersal fishing allowed from 15 nm from the low water mark to the outer boundary of the Australian fishing zone, excluding the area of the Timor Reef Fishery.	Email			regarding the impact and risk assessment methodology (see Chapters 6) and issues regarding impacts to fish spawning (Sections 7.5, 8.7 and 8.8).
		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.	
		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
		28/02/2022 (Demersal-10) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
36. 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).			
37. 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).			
38. 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).			
39. CFA	Peak body representing the collective rights, responsibilities and interests of a diverse group of	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.
		07/10/2021	EOG contacted CFA to confirm receipt of project information. CFA	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
	commercial fishers in Commonwealth-regulated fisheries	Phone call	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 further consultation required.
40. 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	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
			confirmed they did not need to be kept updated on the project going forward.		
41. WAFIC	Peak industry body representing the interests of the WA commercial fishing, pearling and aquaculture sectors.	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: • Agreed to no fishing from activity vessels (see PDSA EP). • Control measures in relation to temporary displacement of commercial fishers and interference with commercial fishing vessels is addressed in in the EPs. • Baseline publicly available data on the existing environment is included in Chapter 5 of the EPs. • The OPEP includes the communication strategy between EOG and fisheries. • The OSMP framework includes testing for fish tainting. Baseline data on water quality and sediment quality would be obtained from control sites in the
		06/10/2021 Phone call	EOG left a voice message for WAFIC to confirm receipt of project information.	No concerns raised.	
		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)	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	

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 and Email		do not interfere with commercial fishing vessels. WAFIC requested further information regarding EOG's plans for responding to an unplanned diesel spill.	event of a large-scale hydrocarbon spill to inform the analysis of impacts. • 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.
		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.	
		23/11/2021 (WAFIC-07) Email	WAFIC thanked EOG for the email (above) and stated they had no further comments regarding the proposed activities.	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 (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.	
		08/12/2021 (WAFIC-09) Email	WAFIC confirmed they had reviewed the latest information flyer and had no further comment.	No concerns raised.	
		28/02/2022 (WAFIC-10) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
		02/03/2022 (WAFIC-11) Email	WAFIC emailed EOG to confirm whether the following would be undertaken in the event of an unplanned discharge incident: • Established baseline scientific data on aquatic organisms and the aquatic environment. • Communication strategy and scenario/exercise training that considers the commercial fishing industry in the event of an incident. • Support to the commercial fishing industry with regards to	Not applicable	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
			traceability of fish products to manage tainting risks. • A detailed process for post spill scientific monitoring of aquatic organism and aquatic environment. • Commitment for financial adjustment to the commercial fishing industry.		
		09/03/2022 (WAFIC-12 & 13) Email	EOG responded to WAFIC outlining the proposed handling and management of oil spill response in the event of an unplanned discharge.	WAFIC thanked EOG for their comments and offered EOG any guidance or feedback on the compensation policy/procedure should EOG wish to take up the offer. WAFIC confirmed they had no further comment.	
42. 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).			
43. 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.
		06/10/2021 Phone call	EOG followed up with a phone call to RecFish West. RecFish West stated	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 project information sheet had been received.		No further consultation is considered necessary.
		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.	
		30/11/2021 (Recfish-04) Email	Recfish West emailed EOG to inform of new contact details to send future correspondence.	No concerns raised.	
		11/04/2022 (Recfish-05) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
44. 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.	

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		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.	
		11/04/2022 (NTSC-03) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
45. 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, and once received this will be checked with the CEO. EOG re-issued the email.	No concerns raised.	
		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 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
			No feedback received to date.		
46. 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, 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.	
		28/02/2022 (KLC-04) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
47. Miriuwong and Gajerrong Aboriginal Corporation	Native title holders of large areas in the north of the East Kimberley region.	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 Corporation, EOG considers there is no immediate need to chase up the Corporation for feedback.
		20/10/2021 (MGAC-01 & 02) Email	The Corporation replied to EOG advising they would be in contact	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
			shortly once the information flyer had been reviewed.		
		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.	
		28/02/2022 (MGAC-06) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
48. 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.	

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 (BAC-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.	
		28/02/2022 (BAC-03) Email	EOG emailed Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
49. Northern Land Council	Considered relevant due to its involvement in management of marine reserves.	14/03/2022 (NLC-01) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
50. 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.	

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 (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.	
		28/02/2022 (MTWA-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.	
51. Darwin Port Corporation	Privately owned, responsible for management of Darwin Port.	14/03/2022 (DPC-01) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	Flyer provided as a courtesy. No further consultation required at this stage.
52. NT Regional Harbourmaster	Responsible for moorings in the Port of Darwin	25/03/2022 (RH-01) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	Flyer provided as a courtesy. No further consultation required at this stage.
53. WA Cambridge Gulf Limited (CGLTD) - Wyndham Port	International supply chain link for the resources and agricultural industry, headquarters in Kununurra.	25/03/2022 (CGLTD-01) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	Flyer provided as a courtesy. No further consultation required at this stage.
54. Seafarms Group Limited	Developer of the land-based prawn aquaculture	25/03/2022 (SGL-01) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	EOG has assessed the impacts and risks of routine discharges from the MODU and vessels, including hydrocarbon spills.

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
	project (Sea Dragon) in NT.	31/03/2022 Phone call	The Area Manager of Sea Dragon Project contacted EOG and provided contact details to send through the Information Flyer #3.	No concerns raised.	Spill response strategies are included in the OPEP and the water intake in Forsyth Creek is nominated as a priority protection site in the event of a spill.
		04/04/2022 (SGL-02 & 03) Email	EOG emailed Area Manager of Sea Dragon Project the Information Flyer #3 to notify the stakeholder of the Beehive-1 exploration well drilling program as requested.	The Area Manager replied and noted their concern in relation to an event that could jeopardise sea water quality, including ballast water exchange, oil/fuel spills or any pollution that may impact on the quality of their seawater intake.	
		09/04/2022 (SGL-04) Email	EOG responded via email, advising that an oil spill environmental risk assessment is included in the drilling EP, and an OPEP and OSMP are in preparation. EOG asked for a status on the Sea Dragon Project to assist with their risk assessment and ensure the water intake area is nominated for priority protection in the event of a spill.	No response to date.	
55. 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.	Beehive-1 will be located 12 km south of the Blacktip subsea pipeline. Further consultation will be undertaken as required.

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.	
		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) Email	EOG followed up with request for Eni's pipeline GIS file and provided an update on the PDSA timing and reduced PDSA 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
		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.	
		28/02/2022 (ENI-09 & 10) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment. ENI notified EOG that of new contact details for future correspondence.	No concerns raised.	
56. 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 operational area does not overlap any of Woodside's operating assets, EOG considers there is no immediate need to chase them up 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	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
			Senior Corporate Affairs Advisor's phone. EOG left a message. No feedback received to date.		
		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.	
		28/03/2022 (WEL-03) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
57. 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	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
			is available for public exhibition on the NOPSEMA website.		
		28/03/2022 (Melbana-05) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	
58. 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 operational area does not overlap any of Neptune Energy's operating assets, EOG considers there is no immediate need to chase them up for feedback.
		06/10/2021 Phone call	EOG contacted Neptune Energy via reception who advised the Managing Director would send EOG an email to confirm receipt of project information.	No concerns raised.	
		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.	
		28/03/2022 (Neptune-04) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1	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
			exploration well drilling program and invited return comment.		
59. 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.	
		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.	
		28/03/2022 (Santos-04, -05 & -06) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	Santos replied the same day stating they have no concerns.	
60. BP Developments Australia Pty Ltd	Operator of permit WA-359-P.	14/03/2022 (BP-01)	EOG emailed Information Flyer #3 to provide notification of the Beehive-1	No concerns raised.	Given the activity area and EMBA do not overlap any of BP's operating assets, EOG

Relevant person	Function, interests and/or activities	Date and method (and reference)	Consultation conducted	Issues, objections and claims	EOG's assessment of merit
		Email	exploration well drilling program and invited return comment.		considers there is no immediate need to chase them up for feedback.
61. Chevron Australia Pty Ltd	Operator of permit WA-37-L.	14/03/2022 (CA-01) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	Given the activity area and EMBA do not overlap any of Chevron's operating assets, EOG considers there is no immediate need to chase them up for feedback.
62. Kufpec	Operator of permit WA-538-P.	14/03/2022 (KUF-01) Email	EOG emailed Information Flyer #3 to provide notification of the Beehive-1 exploration well drilling program and invited return comment.	No concerns raised.	Given the activity area and EMBA do not overlap any of Kufpec's operating assets, EOG considers there is no immediate need to chase them up for feedback.
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), this chapter provides a description of the environment that may be affected (EMBA) by the activity, together with its values and sensitivities. Regulation 4 of the OPGGS(E) defines the environment as:

- Ecosystems and their constituent parts, including people and communities;
- Natural and physical resources;
- The qualities and characteristics of locations, places and areas;
- The heritage value of places; and
- The social, economic and cultural features of the above-listed 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 impacts EMBA on 4th March 2022 (**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);
- Species recovery plans, conservation advice and scientific publications; and
- Seabed Habitats and Hazards of the JBG and Timor Sea, Northern Australia (Przeslawski *et al.*, 2011).

Where appropriate, descriptions of the JBG environment (beyond the immediate impacts EMBA) are provided for context. 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.

5.1. The Environment That May Be Affected

The spatial extent of the EMBA is divided into that for planned activities (impacts) and unplanned activities (risks).

5.1.1. Planned Activities

The extents of the EMBA for each of the impacts from the project is listed in Table 5.1 (see also Chapter 7). This indicates that the greatest extent of the EMBA for planned activities is no greater than a 20-km radius from Beehive-1. This EMBA is simply referred to as the ‘impacts EMBA’ (Figure 5.1) and is the area of focus for the description of the environment in this chapter.

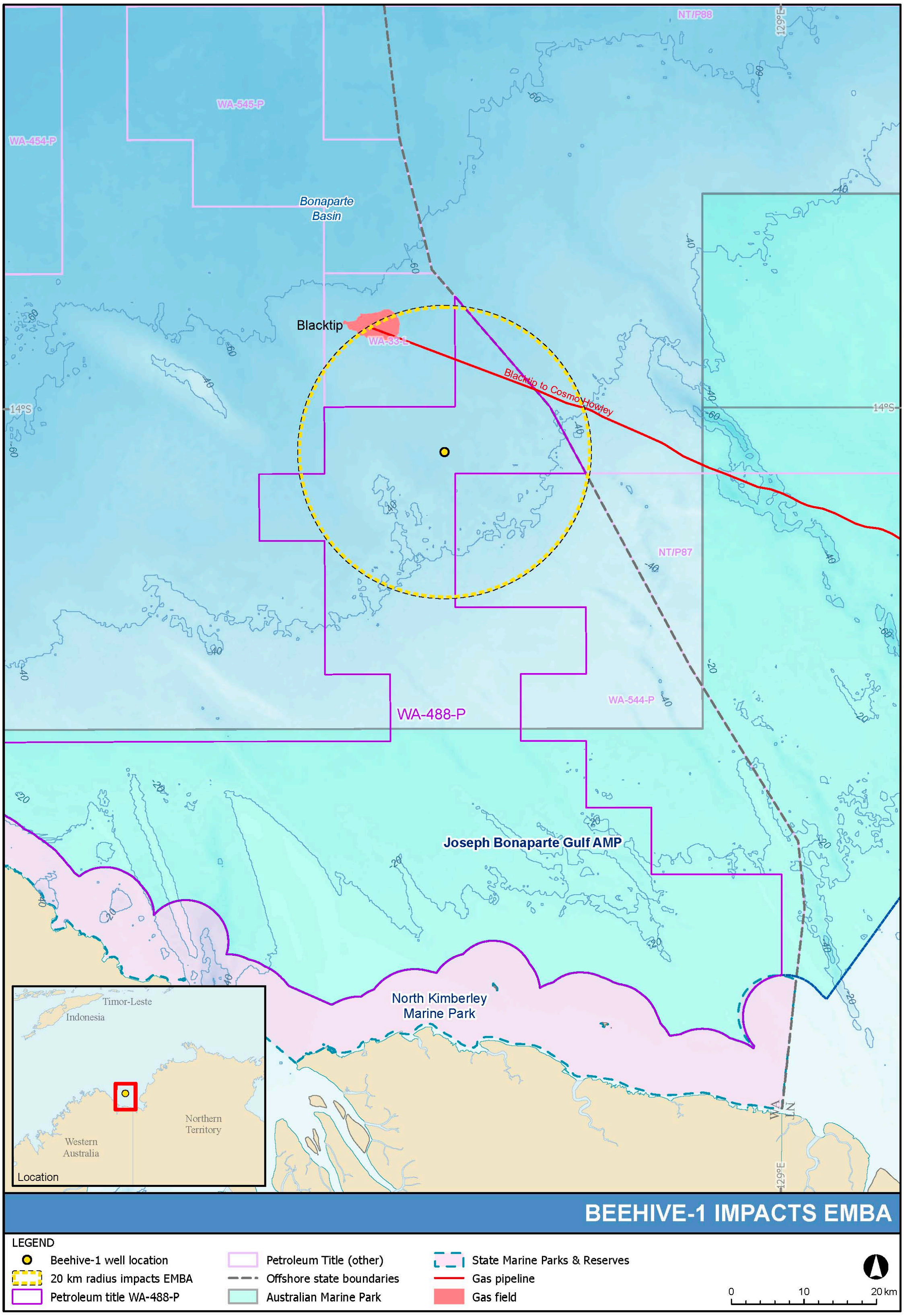


Figure 5.1. The impacts EMBA

Table 5.1. Extent of the impact EMBAs

Planned event	Extent of EMBA (radius around Beehive-1)	EIA section
Seabed disturbance	Tens of metres	7.1
Displacement of marine users	500 m	7.2
Light glow	20 km	7.3
Air emissions	Hundreds of metres	7.4
Underwater sound	Hundreds of metres	7.5
Drill cuttings discharges	1.55 km	7.6
Drill muds discharges	6.95 km	7.6
Cement discharges	6.95 km	7.7
Putrescible waste	100 m	7.8
Treated sewage discharges	50 m	7.9
Cooling water discharges	100 m	7.10
Bilge water discharges	100 m	7.11

5.1.2. Unplanned Activities

The EMBA for unplanned activities is defined by modelling of the loss of well control (LoWC), noting that the EMBA from an MDO spill is contained within the broader LoWC EMBA. The description of the existing environment for the EMBA defined by the LoWC is provided in **Appendix 5**.

The boundary for the EMBA associated with a LoWC is defined by the hydrocarbon spill thresholds defined in the *NOPSEMA Bulletin #1 Oil Spill Modelling* (NOPSEMA, 2019). This bulletin uses 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 (Table 5.2).

The low contact values used to inform the extent of the socio-economic 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 (2019) as having the potential to cause impacts to ecological receptors (see Table 5.2).

The socio-economic EMBA and the ecological EMBA are referred collectively as the 'spill EMBA', and the environment of the spill EMBA is described in **Appendix 5**.

Table 5.2. Oil spill thresholds used to define the spill EMBA

Hydrocarbon phase	Exposure values	
	Socio-economic EMBA	Ecological EMBA
Shoreline	Low - **10 g/m^2** (equivalent to 10 ml/m^2, or 2 teaspoons) Potential for some socio-economic impact.	Moderate - **100 g/m^2** (equivalent to 100 ml/m^2) Area likely to cause environmental impacts and to require clean-up effort.
		High - **1,000 g/m^2** (equivalent to 1 litre/m^2) Area likely to require intensive clean-up effort.
Sea surface (floating)	Low - **1 g/m^2** (equivalent to 1,000 L/km^2) Approximates socio-economic effects and planning area for scientific monitoring.	Moderate - **10 g/m^2** (equivalent to 10,000 L/km^2) Lower limit for harmful contact to birds and marine mammals.
		High - **50 g/m^2** (equivalent to 50,000 L/km^2) Approximates surface oil slick and informs response planning.
Dissolved	Low - **10 ppb** Planning area for scientific monitoring as potential water quality trigger exceedance.	Moderate - **50 ppb** Potential toxic effects, particularly sub-lethal effects to sensitive species.
		High - **400 ppb** Toxic effects, including lethal effects to sensitive species.
Entrained	Low - **10 ppb** Planning area for scientific monitoring as potential water quality trigger exceedance.	High - **100 ppb** To inform risk evaluation.

Source: NOPSEMA (2019).

5.2. Regional Context

Under the EPBC Act, management of Australian offshore waters is divided into six marine bioregions. Marine bioregional plans describe the marine environment and conservation values (protected species, protected places and key ecological features) of the marine region, sets broad biodiversity objectives, identify regional priorities, and outlines strategies and actions to achieve these (DAWE, 2021).

The impacts EMBA is located within the Northwest Marine Region (NWMR). Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, the impacts EMBA is situated completely within the 'Northwest Transition' provincial bioregion (CoA, 2006), as illustrated in Figure 5.3 and the 'Bonaparte Gulf' mesoscale bioregion (Figure 5.3).

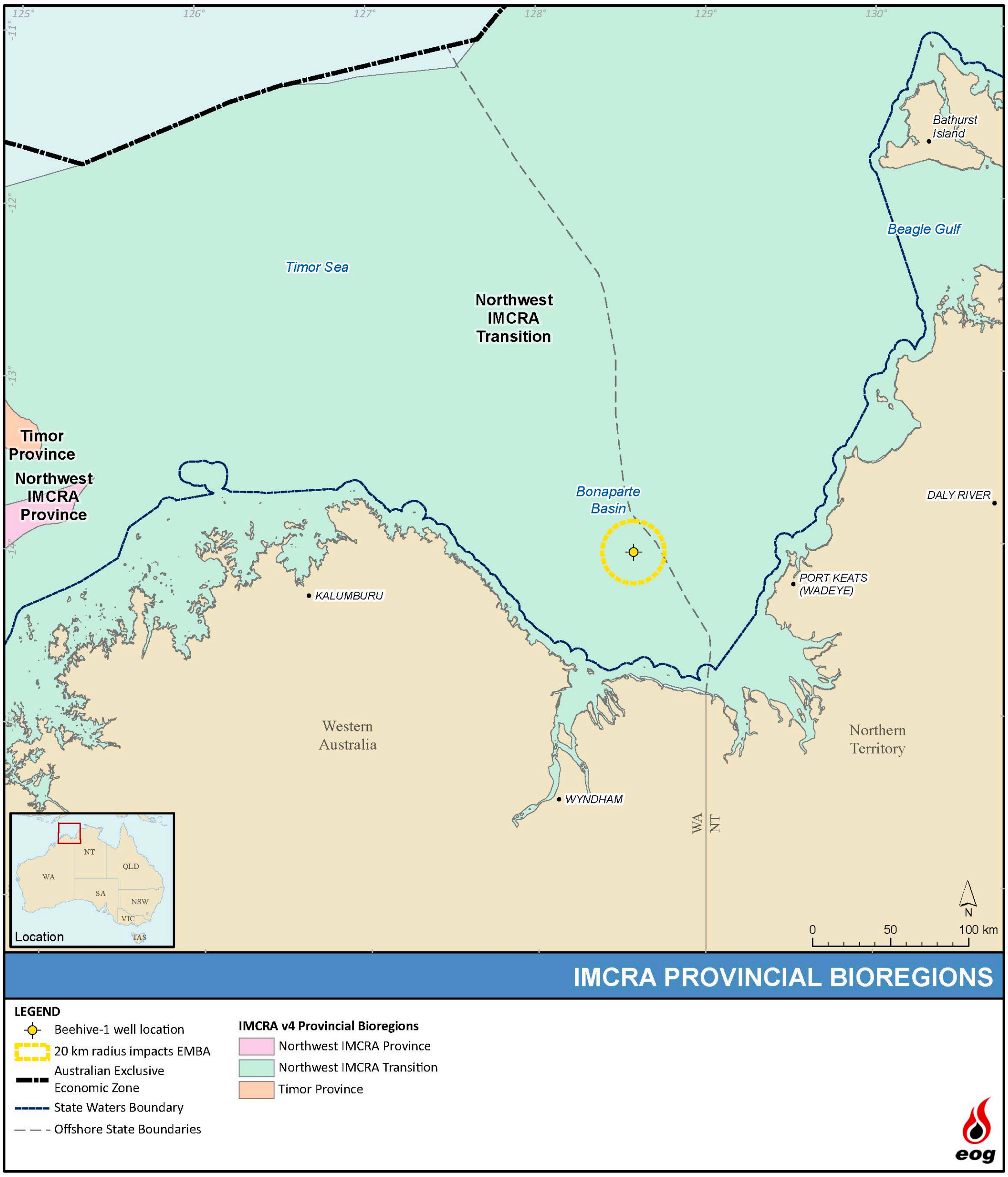


Figure 5.2. Provincial bioregion overlapped by the impacts EMBA

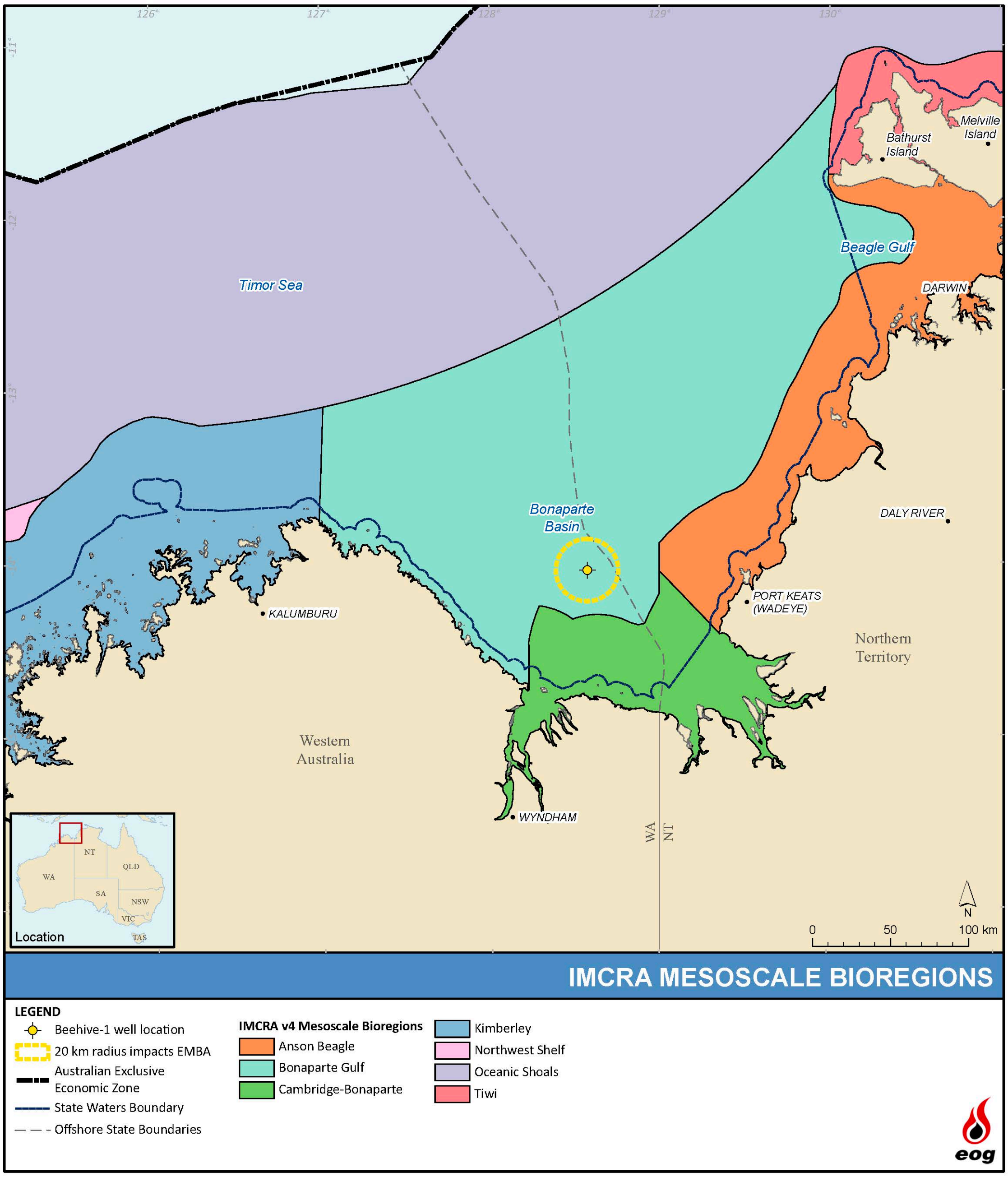


Figure 5.3. Mesoscale bioregion overlapped by the impacts EMBA

5.2.1. Climate

The impacts EMBA is located in a region with a pronounced tropical monsoonal climate consisting of two distinct seasons known as the northwest monsoon ('wet season') and southeast monsoon ('dry season').

The northwest monsoon occurs from late October to mid-March. 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 (DSEWPaC, 2012a).

The southeast monsoon occurs from May to mid-October. This originates from the southern hemisphere high-pressure belt and is relatively dry and cool (DSEWPaC, 2012a).

Temperature and Rainfall

Wadeye Airport (Port Keats), located on the NT mainland approximately 85 km east of Beehive-1, is the location of the nearest meteorological station. 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 5.3 and presented in Figure 5.4 (RPS, 2021).

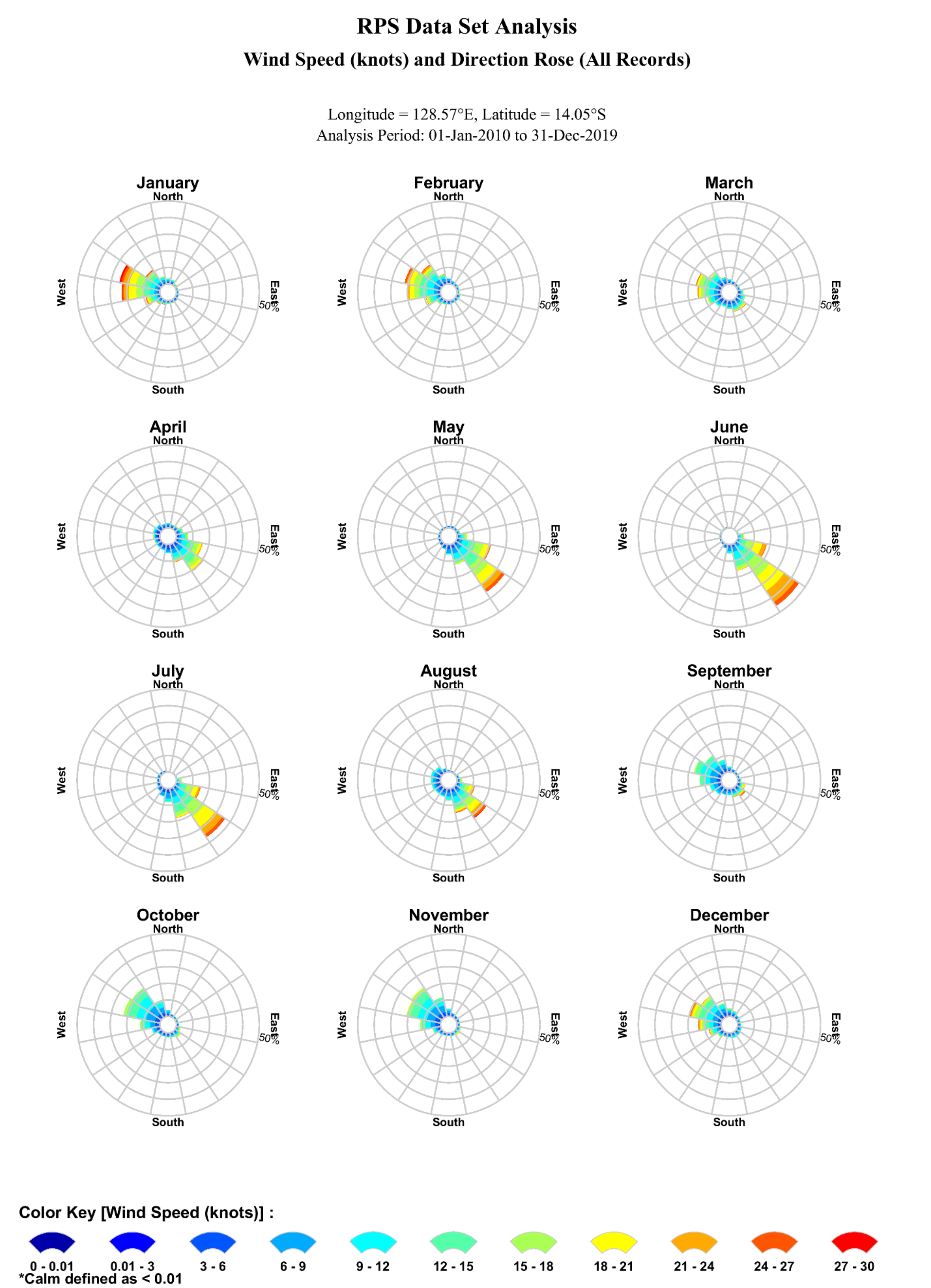
Cyclones

Tropical cyclones are common in the region, resulting in severe storms with gale force winds and a rapid rise in water levels. The cyclone season typically occurs between November and April (BoM, 2022).

Table 5.3. Predicted average and maximum winds for the wind station nearest the impacts EMBA 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).



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

Source: RPS (2021).

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

5.2.2. Oceanography

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).

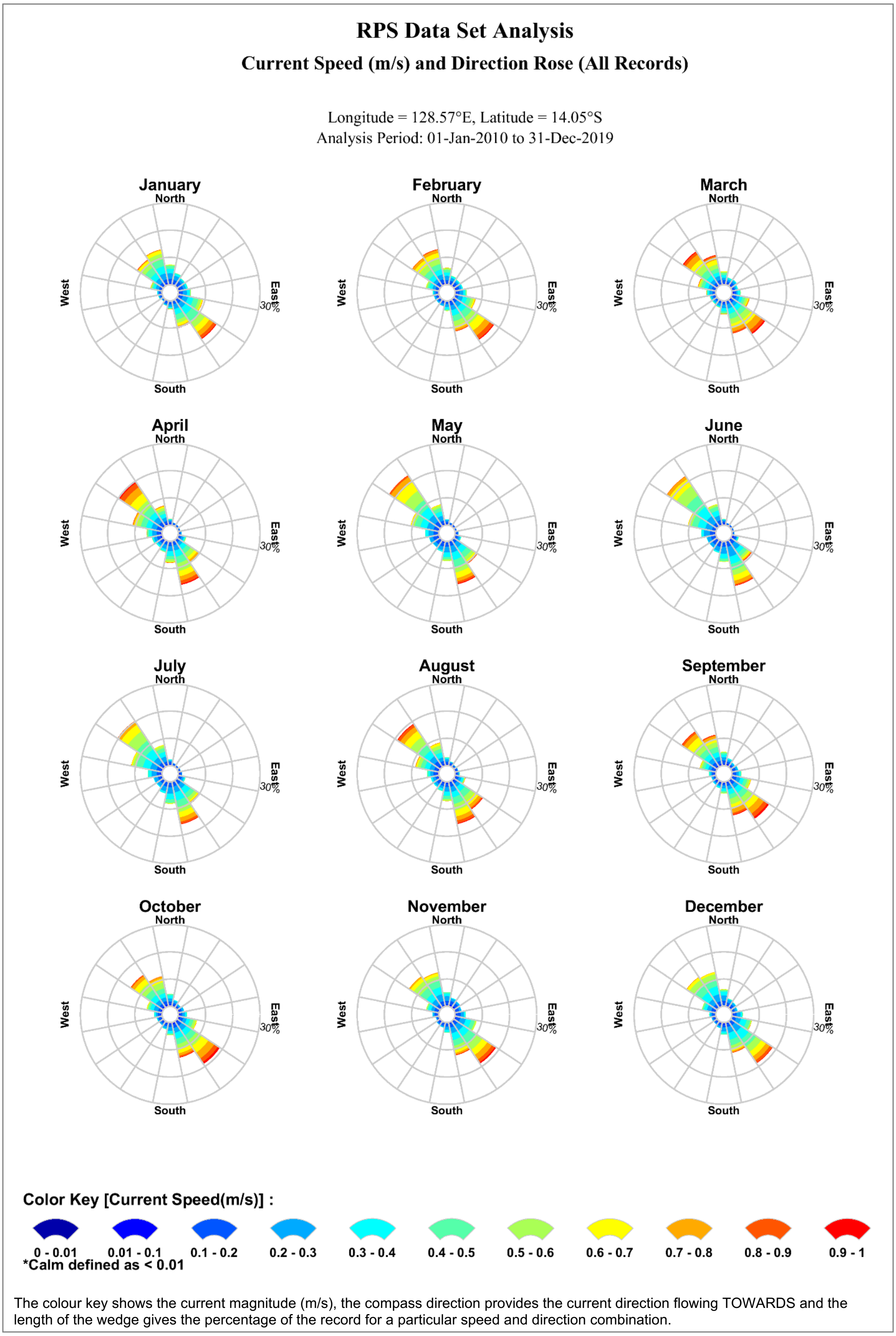
Table 5.4 provides the average and maximum combined surface current speeds (ocean plus tides) located within the impacts EMBA. This data indicates that surface currents flow predominantly along the northwest to southeast axis. The monthly current speeds averaged between 0.33 to 0.40 m/s and reached a peak of 0.96 to 1.17 m/s.

Figure 5.6 illustrates the monthly surface current rose plots located at the Beehive-1 location from 2010 to 2019 (inclusive). Figure 5.7 presents the major ocean currents in north-western Australian waters.

Table 5.4. Predicted average and maximum surface current speeds within the impacts EMBA from 2010-2019 (inclusive)

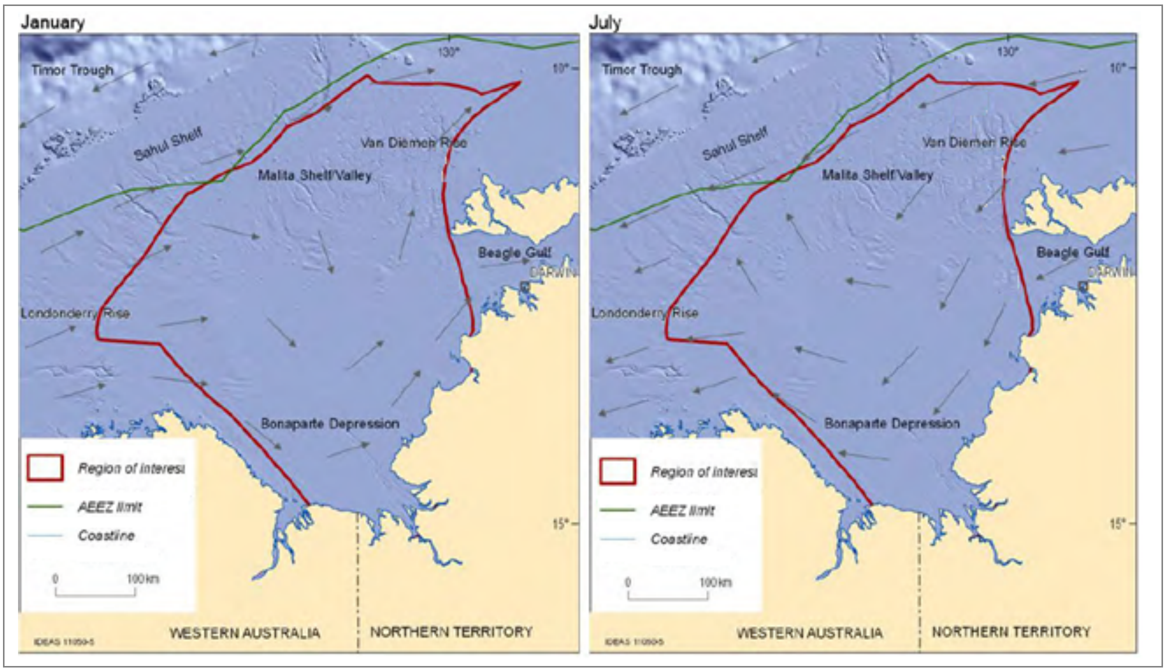
Season	Month	Avg. current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.35	1.10	Northwest and southeast
	February	0.37	1.12	
Transitional	March	0.40	1.05	
Winter	April	0.39	1.06	
	May	0.35	1.17	
	June	0.34	1.07	
	July	0.35	0.96	
	August	0.37	1.15	
Transitional	September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



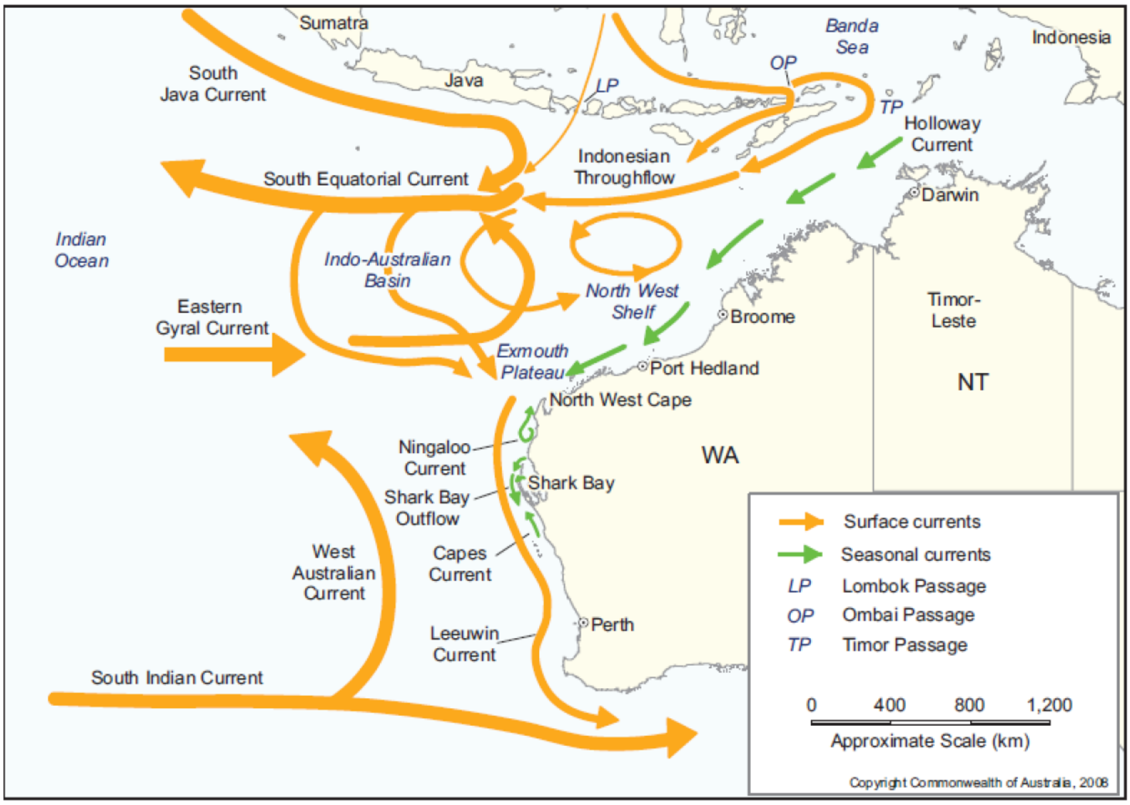
Source: RPS (2021).

Figure 5.5. Monthly surface current rose plots nearby the impacts EMBA (2010-2019 inclusive)



Source: Przeslawski et al 2011.

Figure 5.6. Currents of the JBG



Source: DEWHA, 2008b.

Figure 5.7. Ocean currents along the Northwest Australian continental shelf

Sea Temperature and Salinity

Sea surface temperatures and salinity in the region are heavily influenced by the Indonesian Throughflow, which transports warm, low salinity water from the western Pacific Ocean through to the Indian Ocean (DSEWPC, 2012a). 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 Bonaparte Gulf 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 JBG. 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 along the JBG coastline, 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 1µPa^2/Hz and magnitude 4 earthquakes have been reported to have spectral levels reaching 119 dB re 1µPa^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 5.5 presents a comparison of biological and anthropological sounds in the marine environment.

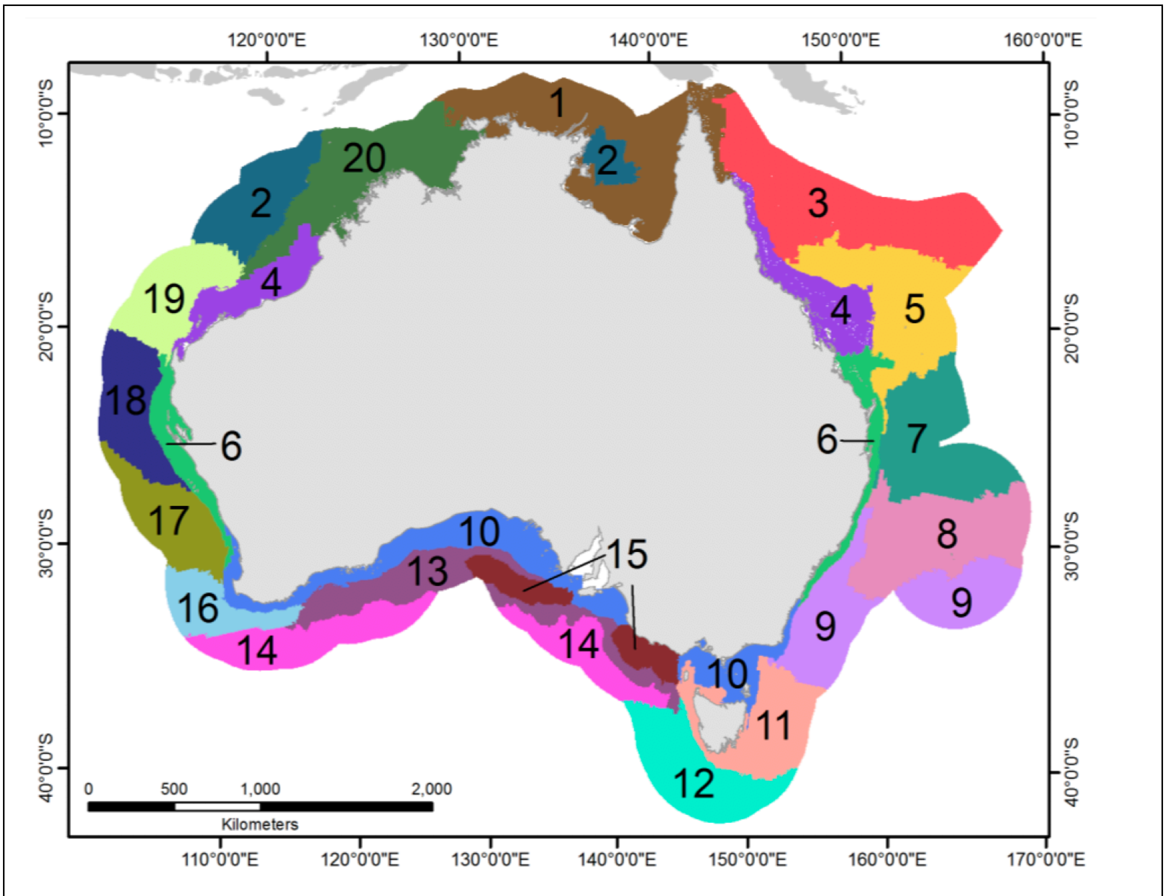
Table 5.5. Sound intensity and pressure (dB re 1µPa @ 1 m from source) for some common marine sources

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

Source	Sound intensity (dB re 1 µPa)	Frequency (Hz)	Reference
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
FPSO (maximum at Griffin Venture)	176	10 – 500 (up to 2,000)	6
References			
1 – Richardson et al (1995).	*2 – APPEA (2004).*	*3 – WDCS (2004).*	
4 – Matsumoto et al (2014).	*5 – Woodside (2003).*	*6 – Apache Energy (2008).*	

Erbe et al (2021) have classified the marine acoustic zones of Australia based on 10 km x 10 km grids that are characterised by sea surface temperature, salinity and sound speed profiles (for the month of July).

The study resulted in the creation of 20 acoustic zones around Australia, with the impacts EMBA occurring within zone 20 (‘Western Tropical Shelf’) (Figure 5.8). Zone 20 is described as having shallow water with a wide sandy continental shelf and a hot sea surface that is strongly downward refracting (Erbe *et al.,* 2021). For zone 20 at 40 m water depth (the water depth at Beehive-1), the sound speed profile ranges between -0.01 and 0.01 (m/s)/s.



Source: Erbe et al (2021).

Figure 5.8. Map of the 20 acoustic zones of the Australian EEZ for the Austral winter

5.2.3. 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 depth at Beehive-1 is 40 m, and in the impacts EMBA it ranges from 40-50 m.

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 impacts EMBA is presented in Figure 5.9.

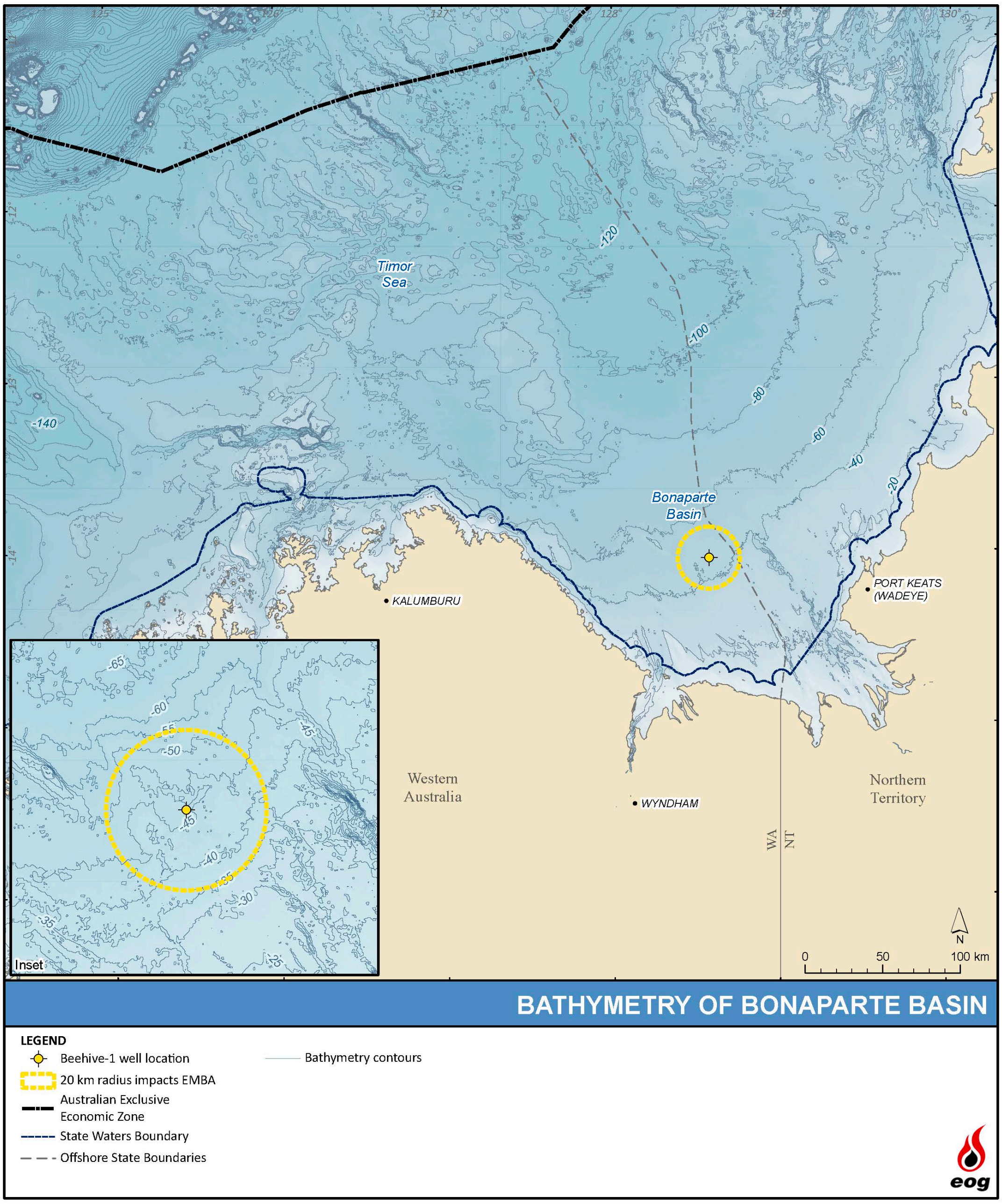


Figure 5.9. Bathymetry of the impacts EMBA and surrounds

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 impacts EMBA) confirms that the area is mainly dominated by sand, with similar proportions of smaller gravel, silt and clay (ERM, 2011).

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 20 km northwest of Beehive-1. 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 (near Lacrosse Island, at the mouth of Cambridge Gulf, about 50 km south of the impacts EMBA), have been generated by the strong outflows of sediment-laden water from Cambridge Gulf. Similar sandbars can be found in the southeast of the JBG. Beehive-1 is located on the ‘shelf’ geomorphic feature, which is typically characterised by extensive sediment plains and high sediment deposition from the coastal rivers to the south, while the impacts EMBA also overlaps the ‘tidal-sandwave/sand-bank’ geomorphic feature (Figure 5.10).

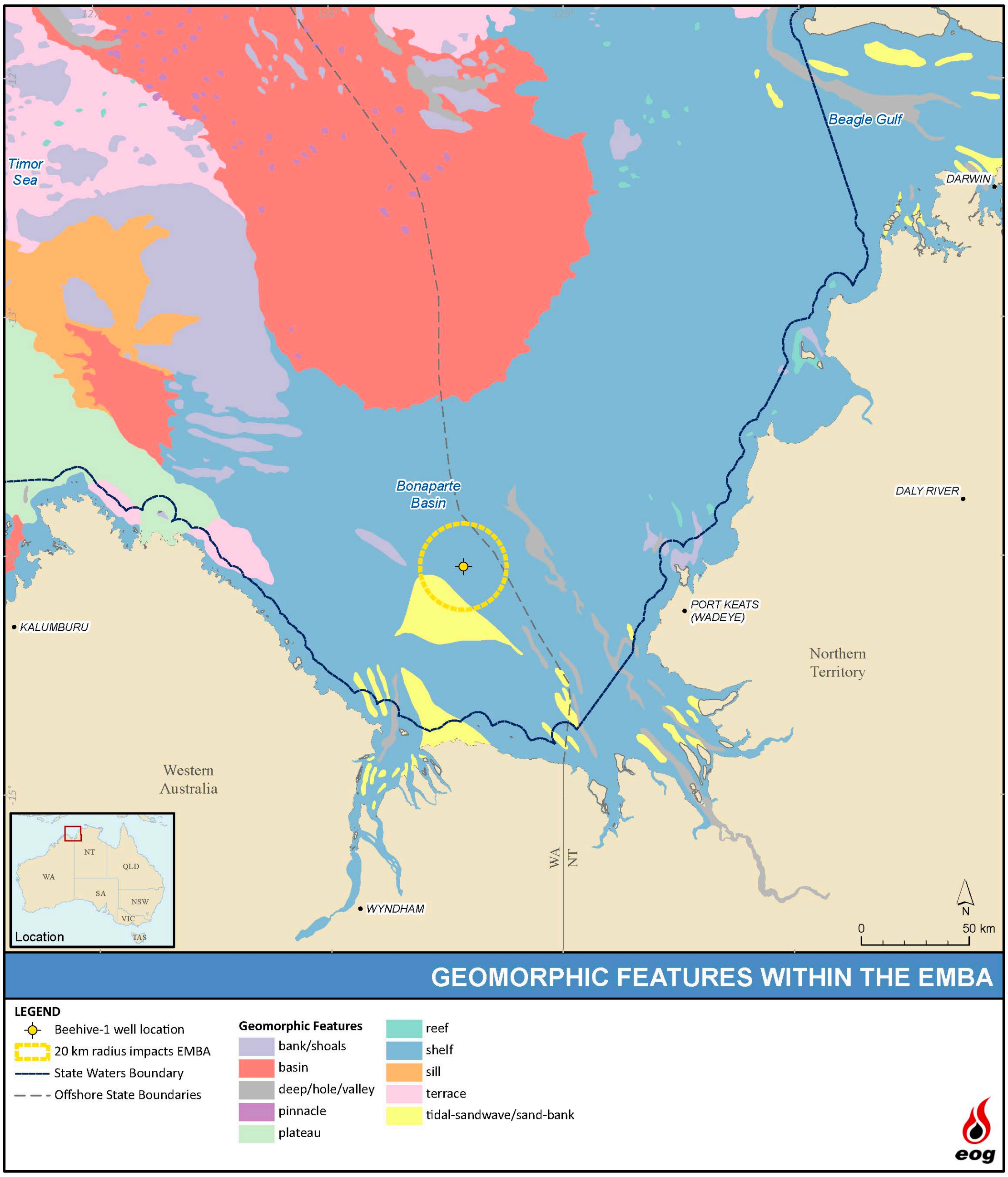


Figure 5.10. Geomorphic features of the impacts EMBA and surrounds

5.3. Coastal Environment

The coastal environment is outside the impacts EMBA and is described in **Appendix 5**.

5.4. Biological Environment

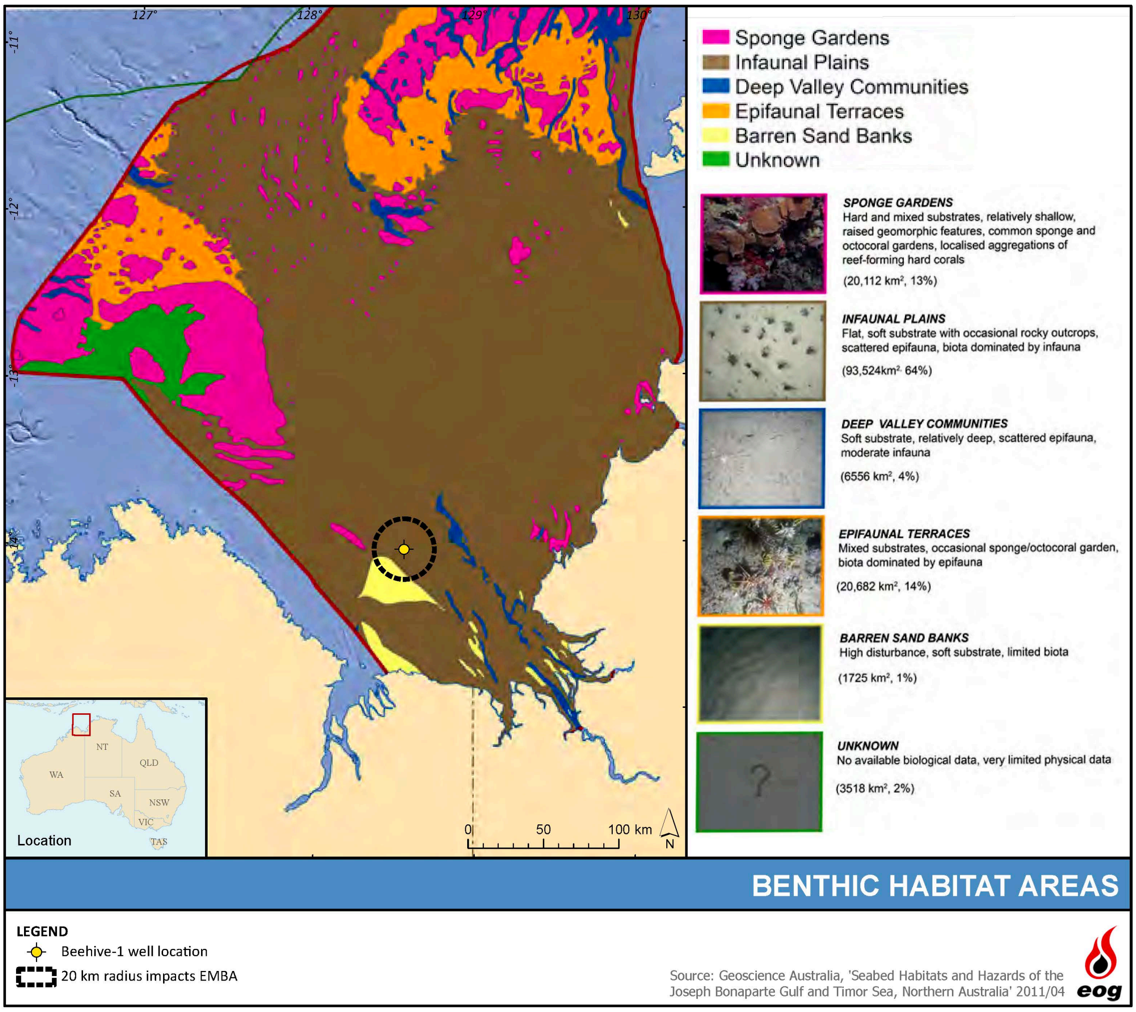
The sources listed at the start of this chapter have been used in the preparation of this section. Additionally, BIAs are identified for those species that may occur within the impacts EMBA. BIAs are spatially defined areas, defined by the DAWE based on expert scientific knowledge, where aggregations 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.

The PMST identifies that in total, there are 20 threatened species and 38 migratory species (or habitat for such species) that may occur in the impacts EMBA.

5.4.1. 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.

Figure 5.11 illustrates the habitat types in the JBG, with the impacts EMBA located within infaunal plains and barren sand banks, which are primarily characterised by flat soft substrate with occasional rocky outcrops, scattered epifauna and biota dominated by infauna (Przeslawski *et al*., 2011).



Source: Przeslawski et al (2011)

Figure 5.11. Generalised habitat map showing likely distribution of habitats and biological communities in the impacts EMBA and surrounds

Studies conducted on the infauna within the Blacktip Project area (the closest sampling station, located 20 km northwest of Beehive-1 and thus within the impacts EMBA) 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 (100 km southeast of the impacts EMBA), 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 close to the impacts EMBA, 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 5.8.1, prawns are commercially caught in areas of the JBG, mainly in the west of the gulf and in Fog Bay, NT (more than 200 km to the northeast of the impacts EMBA). The juvenile prawns that migrate offshore to the fishery come from mangrove nursery habitats from the Victoria River in the east of the JBG, 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 (over 900 km east of the impacts 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. 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. The habitat, distribution and reproduction of these species is presented in Table 5.6 based on several sources of literature, and Figure 5.12 illustrates the spawning periods for the key commercial prawn species.

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 impacts EMBA 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 impacts EMBA. The closest identified coral reef habitat is located within the JBG Australian Marine Park (JBG AMP). Reefs, shoals and banks present within the spill EMBA are described in Section 5.3.1 of **Appendix 5**.

5.4.2. Flora

Marine flora, such as macroalgae, seagrass beds and mangroves occur in shallow waters outside the impacts EMBA. As such, these are described in Section 5.3.2 of **Appendix 5**.

5.4.3. 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.

Table 5.6. Key prawn species habitat, distribution, and reproduction in the JBG

Species	Habitat	Stock structure & distribution	Spawning
Banana prawns Redleg banana prawn (*Penaeus indicus)* White banana prawn (*P. merguiensis*)	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). 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). Juvenile redleg banana prawns are found in estuarine habitats up to 120 km south and 240 km east-southeast of the southern and eastern limits of the *P. indicus* fishery in the JBG. Although mangrove habitats are the closest inshore habitats to the fishery, they are not used by *P. indicus.* Given the habitat preference for *P. indicus*, the larvae resulting from spawning in the fishing grounds rely on tides and currents. move large distances to the south and east to their nursery habitats (Loneragan *et al.,* 2002). This implies 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 deep-water fishery (on mud substrates about 50-80 m deep). Juvenile white banana prawns are found in estuarine habitats in the western part of JBG, about 50 km to the southwest of the *P. indicus* fishery.	Banana prawn species are mainly found in tropical and sub-tropical waters around Australia from Shark Bay in WA to the NT and Queensland coastlines (including waters in Torres Strait between Australia and Papua New Guinea) (AFMA, 2021). The biological stock structure of banana prawn is uncertain. Redleg banana prawns are widely distributed across the Indo-West Pacific Ocean. In the JBG, a single separate stock is assumed for stock assessment and management purposes (ABARES, 2021). In the NPF, there is some evidence of white banana prawn sub-stock structuring associated with significant river catchments and their annual flow regimes; however, there is an absence of clear evidence on biological stock structure, status is determined for a single fishery-level stock (ABARES, 2021).	Banana prawns reach reproductive maturity at approximately 6 months of age (AFMA, 2021). They spawn offshore throughout the year with two spawning peaks: the late dry season (September - November) and the late wet season (March – May) (AFMA, 2021) (see Figure 5.12). Banana prawns are serial spawners. Each female lays several egg batches each year. Females produce 100,000 to 450,000 eggs per year. Eggs hatch within 24 hours of fertilisation (AFMA, 2021). Less than 1% of larvae survive the 2-4 week planktonic larval phase to reach suitable coastal nursery habitats where they settle, however there are no written records to verify these statistics other than postlarval and juvenile mortality are known to be high (Rob Kenyon CSIRO Division of Marine Research, pers.comm. February 2022). After 1-3 months in the nursery grounds, the young prawns migrate offshore. Migration of the main cohort occurs November-March. A possible second cohort migrates April-June (Neil Loneragan, CSIRO Division of Marine Research, pers.comm., April 2000). Migration is thought to be triggered by rainfall and river discharge. Juveniles reach sexual maturity at 6 months and have a lifespan of 1-2 years (Yearsley *et al.,* 1999).

Species	Habitat	Stock structure & distribution	Spawning
Tiger prawns Brown tiger prawn (*Penaeus esculentus*) Grooved tiger prawn (*P. semisulcatus*).	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).	Brown tiger prawns are endemic to tropical and subtropical waters of Australia, while grooved tiger prawns have a wider Indo–West Pacific distribution. There is some genetic evidence of separation of brown tiger prawn stocks from the east and west coasts of Australia (Ward *et.al*., 2006). Assessment of stock status for the brown tiger and grooved tiger is undertaken at the management unit level – NPF (Commonwealth) (Butler *et al*., 2021b).	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 (see Figure 5.12) (AFMA, 2021). Grooved tiger prawns have a spawning peak in August-September, with a secondary peak in February (see Figure 5.12) (AFMA, 2021). Females produce about 186,000 eggs (brown tiger prawns) and 365,000 eggs (grooved tiger prawns) per year depending on their body size. Eggs hatch within 24 hours of fertilisation (AFMA, 2021). There is little to no information available on the spawning locations of tiger prawns (Rob Kenyon CSIRO Division of Marine Research, pers.comm. February 2022). Juveniles reach sexual maturity at about 6 months and have a lifespan of 2 years (Yearsley *et al.,* 1999).

Species	Habitat	Stock structure & distribution	Spawning
Endeavour prawns Blue endeavour prawn (*Metapenaeus endeavouri*) Red endeavour prawn (*M. ensis*).	Endeavour prawns live in tropical coastal waters (AFMA, 2021). Blue endeavour prawns are 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).	Endeavour prawn fisheries are located in Shark Bay, Exmouth Gulf, the north coast of WA, the Gulf of Carpentaria, the Torres Strait and the east coast of Queensland. Little is known about the biological stock structure of the populations of blue and red endeavour prawns. Assessment of stock status for each species is undertaken at the NPF (Commonwealth) management level (Roelofs *et al*., 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 (see Figure 5.12) (AFMA, 2021). There is little to no information available on the spawning locations of endeavour prawns (Rob Kenyon CSIRO Division of Marine Research, pers.comm. February 2022). Females produce about 296,000 eggs per year (AFMA, 2021). Juveniles reach sexual maturity at 6 months and have a lifespan of 1-2 years (Yearsley *et al.,* 1999).

Note: AFMA and CSIRO were contacted by EOG in February 2022 to verify gaps in information specifically spawning locations for banana prawns, tiger prawns and endeavour prawns. Where available, data is referenced within the table.

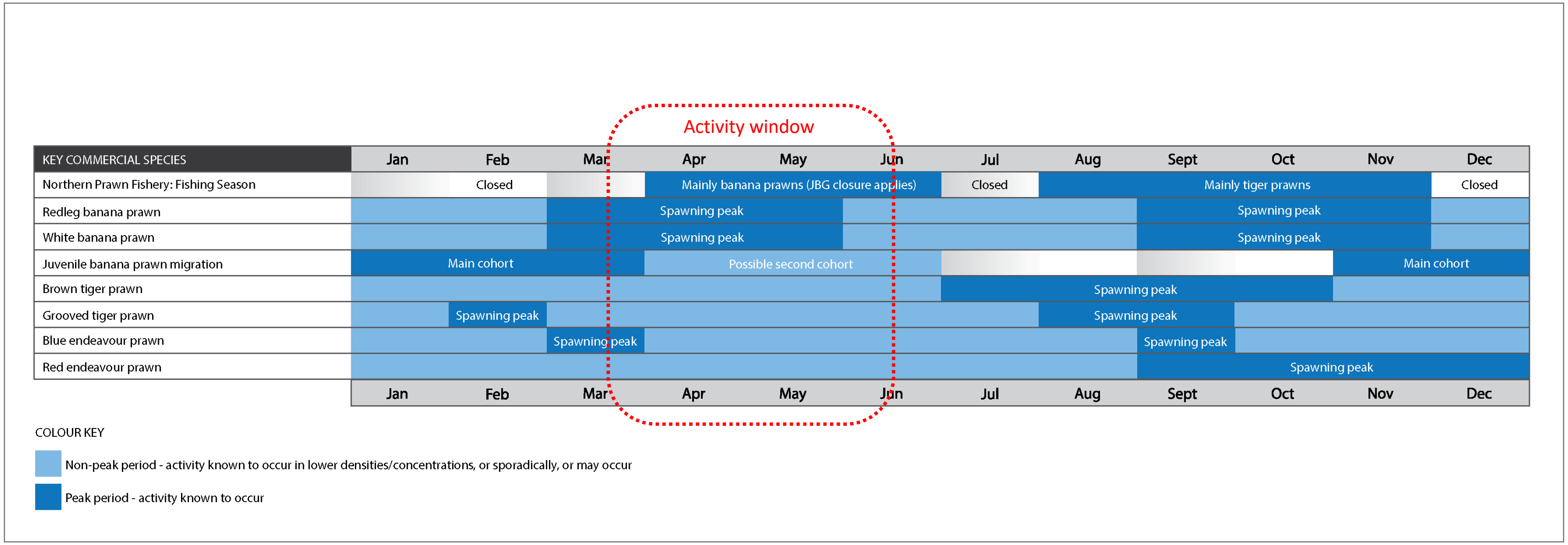


Figure 5.12. Commercial prawn species spawning periods

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 5.7).

Table 5.7. 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
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 impacts EMBA 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 impacts EMBA.

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 5.7.1 for more information.

Silver lipped pearl oysters are known to be sparsely distributed in the JBG up 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). Pearling licensees have not raised any concerns with EOG regarding the presence of pearl oysters or pearling activities in and around the impacts EMBA.

5.4.4. Finfish, Sharks and Rays

There are 37 fish species listed under the EPBC Act that are known to occur, likely to occur or may occur in the impacts EMBA (Table 5.8) (DAWE, 2021a). Of these, there are six shark, four sawfish and 24 sygnathiforme (seahorses, pipefishes and their relatives) species. Seven species are listed as threatened and 11 are migratory (five of the migratory species are also listed as threatened).

Figure 5.13 illustrates the likely temporal presence and absence of these fish species in the impacts EMBA. The species listed as threatened or migratory are described in this section.

Table 5.8. EPBC Act-listed finfish, sharks and rays that may occur in the impacts EMBA

Scientific name	Common name	EPBC Act Status			Type of presence	BIA intersected by impacts EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine			
Classed as sharks							
Anoxypristis cuspidate	Narrow sawfish	-	Yes	-	Likely	No	-
Carcharodon carcharias	Great white shark	V	Yes	-	May occur	No	RP
Carcharhinus longimanus	Oceanic whitetip shark	-	Yes	-	May occur	No	-
Glyphis garricki	Northern river shark	E	-	-	May occur	No	CA, RP
Isurus oxyrinchus	Shortfin mako	-	Yes	-	Likely	No	-
Isurus paucus	Longfin mako	-	Yes	-	Likely	No	-
Manta alfredi	Reef manta ray	-	Yes	-	May occur	No	-
Manta birostris	Giant manta ray	-	Yes	-	May occur	No	-
Pristis clavata	Dwarf sawfish	V	Yes	-	Known	No	CA, RP
Pristis pristis	Largetooth sawfish	V	Yes	-	Known	No	CA, RP
Pristis zijsron	Green sawfish	V	Yes	-	Known	No	CA, RP
Rhincodon typus	Whale shark	V	Yes	-	May occur	No	CA
Sphyrna lewini	Scalloped hammerhead shark	CD	-	-	Likely	No	-
Classed as fish							
Campichthys tricarinatus	Three-keel pipefish	-	-	Yes	May occur	No	-
Choeroichthys brachysoma	Pacific short-bodied pipefish	-	-	Yes	May occur	No	-
Choeroichthys suillus	Pig-snouted pipefish	-	-	Yes	May occur	No	-
Corythoichthys amplexus	Fijian banded pipefish	-	-	Yes	May occur	No	-

Scientific name	Common name	EPBC Act Status			Type of presence	BIA intersected by impacts EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine			
Corythoichthys flavofasciatus	Reticulate pipefish	-	-	Yes	May occur	No	-
Corythoichthys schultzi	Schultz's pipefish	-	-	Yes	May occur	No	-
Doryrhamphus excisus	Bluestripe pipefish	-	-	Yes	May occur	No	-
Doryrhamphus janssi	Cleaner pipefish	-	-	Yes	May occur	No	-
Halicampus brocki	Brock's pipefish	-	-	Yes	May occur	No	-
Halicampus grayi	Mud pipefish	-	-	Yes	May occur	No	-
Halicampus spinirostris	Spiny-snout pipefish	-	-	Yes	May occur	No	-
Haliichthys taeniophorus	Ribboned pipehorse	-	-	Yes	May occur	No	-
Hippichthys penicillus	Beady pipefish	-	-	Yes	May occur	No	-
Hippocampus histrix	Spiny seahorse	-	-	Yes	May occur	No	-
Hippocampus kuda	Spotted seahorse	-	-	Yes	May occur	No	-
Hippocampus planifrons	Flat-face seahorse	-	-	Yes	May occur	No	-
Hippocampus spinosissimus	Hedgehog seahorse	-	-	Yes	May occur	No	-
Micrognathus micronotopterus	Tidepool pipefish	-	-	Yes	May occur	No	-
Solegnathus hardwickii	Pallid pipehorse	-	-	Yes	May occur	No	-
Solegnathus lettiensis	Gunther's pipehorse	-	-	Yes	May occur	No	-
Solenostomus cyanopterus	Robust ghost pipefish	-	-	Yes	May occur	No	-
Syngnathoides biaculeatus	Double-end pipehorse	-	-	Yes	May occur	No	-
Trachyrhamphus bicoarctatus	Bentstick pipefish	-	-	Yes	May occur	No	-
Trachyrhamphus longirostris	Straightstick pipefish	-	-	Yes	May occur	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 (@ March 2022)	V	Vulnerable
	E	Endangered
	CE	Critically endangered
BIA	A	Aggregation
	D	Distribution (i.e., presence only)
	F	Foraging
	M	Migration
Recovery plans (under EPBC Act 1999)	CA	Conservation Advice
	CMP	Conservation Management Plan
	RP	Recovery Plan

Type of presence	Known	Species or species habitat known to occur in area
	Likely	Species or species habitat likely to occur in area
	May occur	Species or species habitat may occur in area
	Congregate	Congregation/aggregation known to occur in area

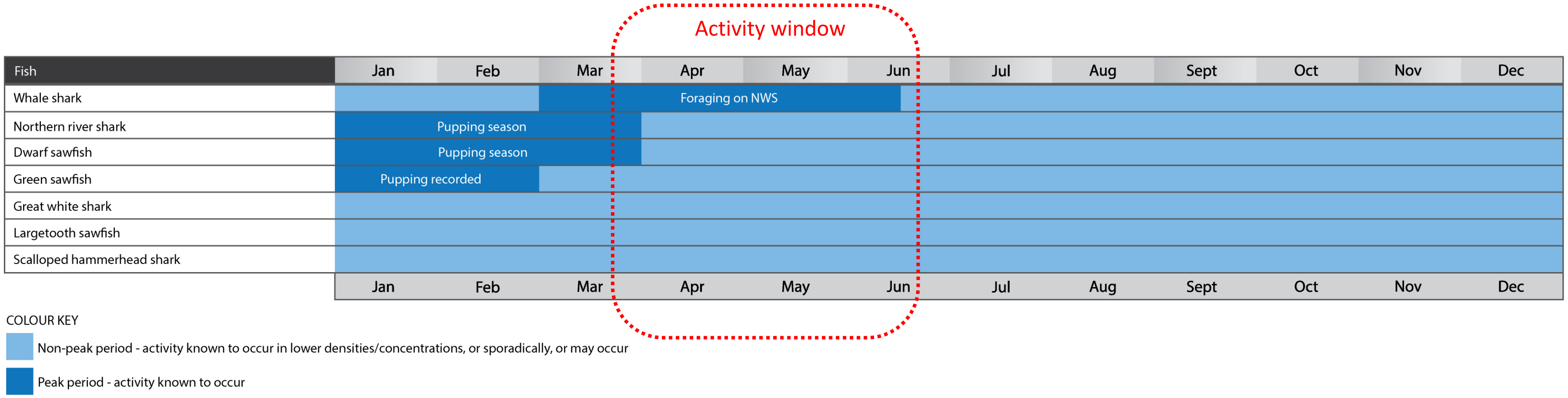


Figure 5.13. Likely temporal presence and absence of EPBC Act-listed threatened fish species in the impacts EMBA

Threats and pressures on fish

Several of the fish species listed in Table 5.8 are subject to pressures, which are described in various recovery plans and conservation advice. Table 5.9 summarises the pressures listed in the plans/advice relevant to each of these species that could result from drilling activities.

Table 5.9. Summary of threats to fish species

Species	Recovery Plan, Management Plan or Conservation Advice	Key threat/s relevant to drilling
Great white shark	Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013b)	Ecosystem effects as a result of habitat modification
Northern river shark	Approved conservation advice for Glyphis garricki (northern river shark) (TECC, 2014)	Habitat degradation and modification
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015b)	Habitat degradation and modification
Dwarf sawfish	Approved Conservation Advice for *Pristis clavata* (dwarf sawfish) (DEWHA, 2009)	Habitat degradation
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015b)	Habitat degradation and modification
Largetooth sawfish	Approved Conservation Advice for *Pristis pristis* (large sawfish) (DEWHA, 2014) <new version?>	Habitat degradation and modification
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015b)	Habitat degradation and modification
Green sawfish	Approved Conservation Advice for green sawfish (DEWHA, 2008c) <new version?>	Habitat degradation and modification
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015b)	Habitat degradation and modification
Whale shark	Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d)	Boat strike Habitat disruption from mineral exploration Marine debris
Scalloped hammerhead shark	Listing Advice *Sphyrna lewini* (scalloped hammerhead) (TSSC, 2018)	None. Historic and current fishing.

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 impacts 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 impacts 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 impacts 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).

While the whale shark foraging BIA is not intersected by the impacts EMBA, it may migrate through it.

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 impacts EMBA.

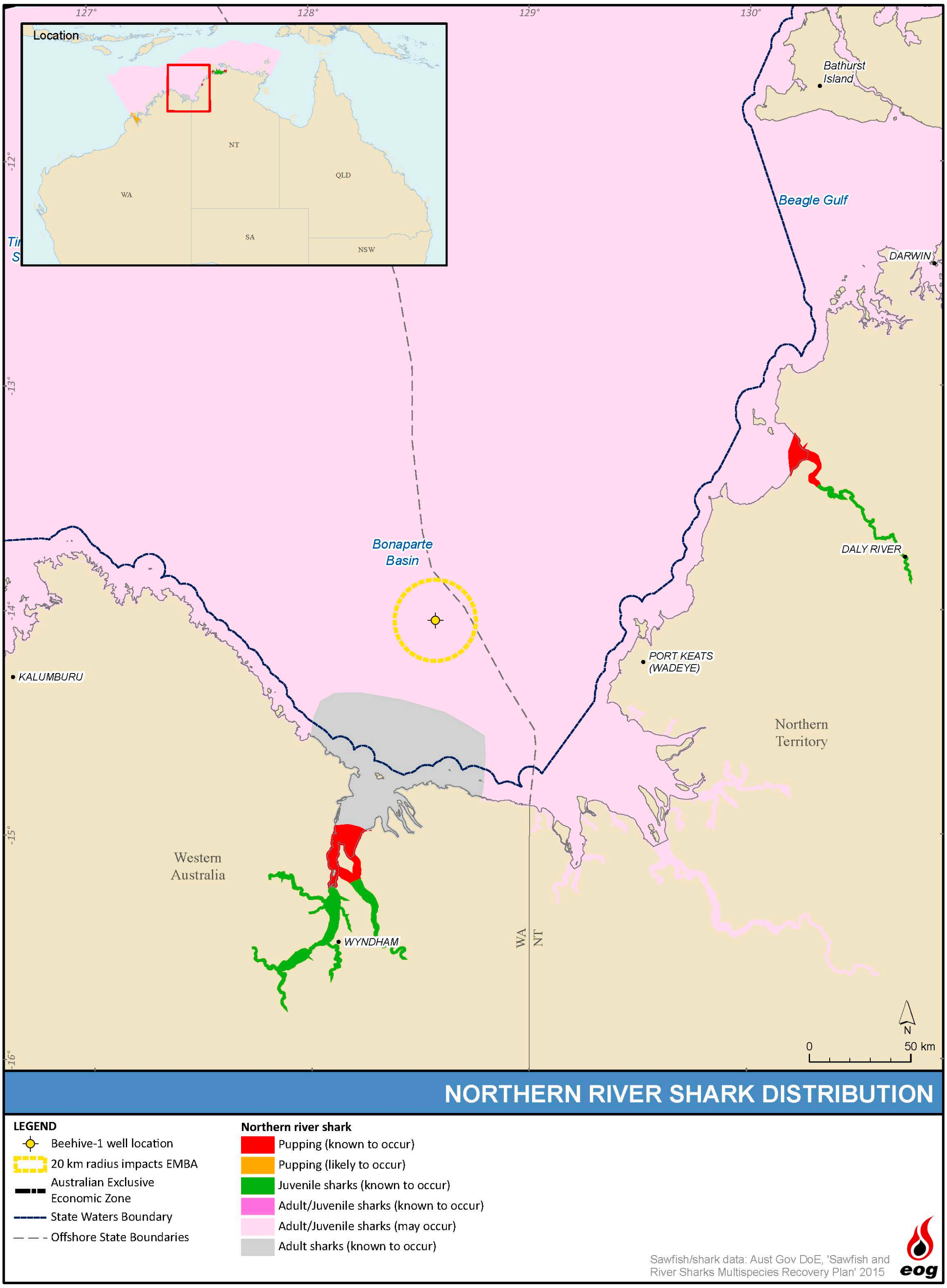


Figure 5.14. Northern river shark presence in the impacts EMBA and surrounds

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 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 circum-global 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 species is unlikely to occur within the impacts EMBA.

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 operational, reef manta rays may be present in the impacts 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 AMP, which is located 138 km north-northwest of the impacts EMBA (Nichol *et al*., 2013). Despite there being no known aggregation sites within close proximity to the impacts EMBA, giant manta rays may be present in it 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 impacts 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 impacts 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 impacts EMBA overlaps areas where adult largetooth sawfish are known to occur (Figure 5.16).

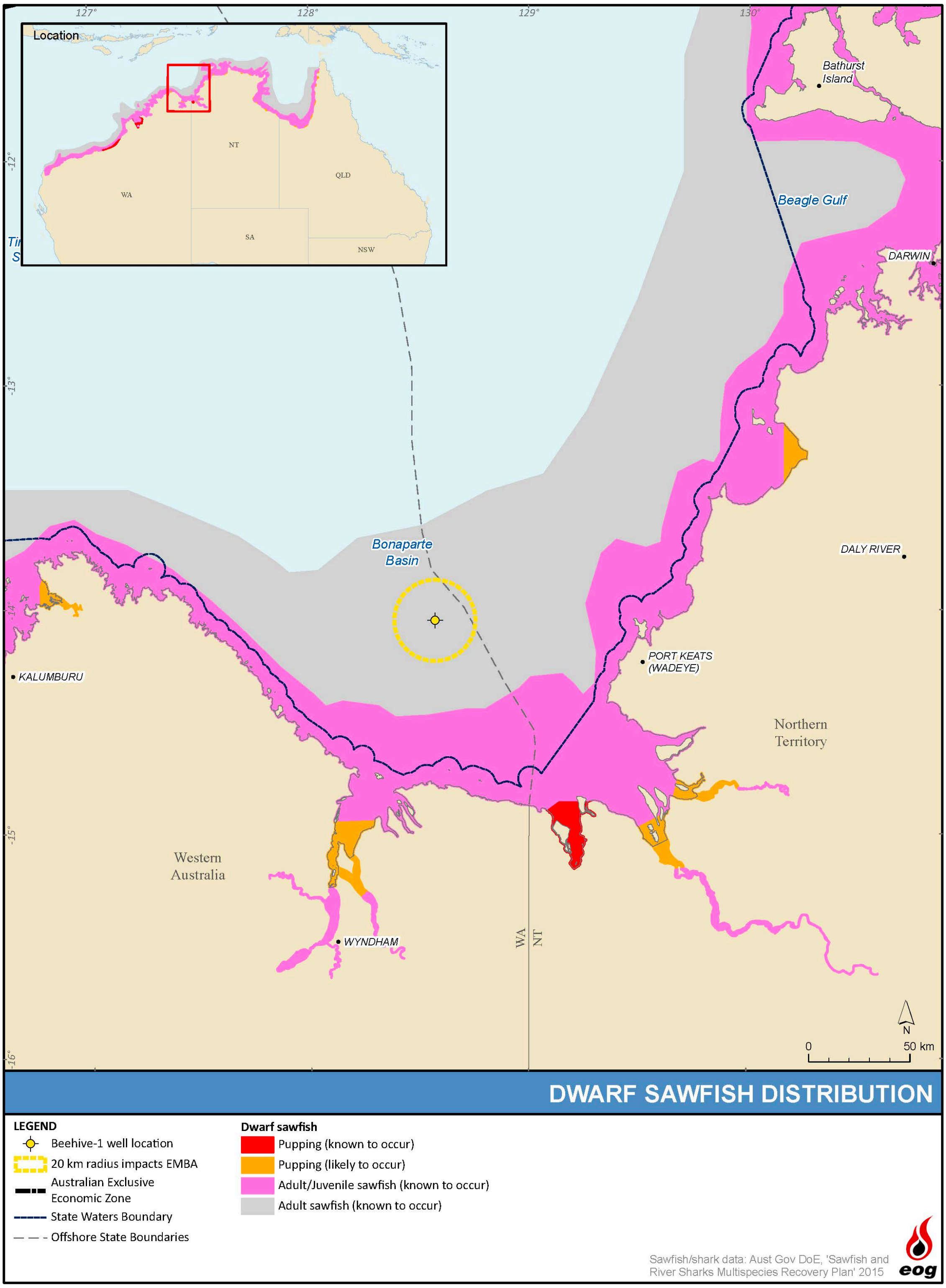


Figure 5.15. Dwarf sawfish presence in the impacts EMBA and surrounds

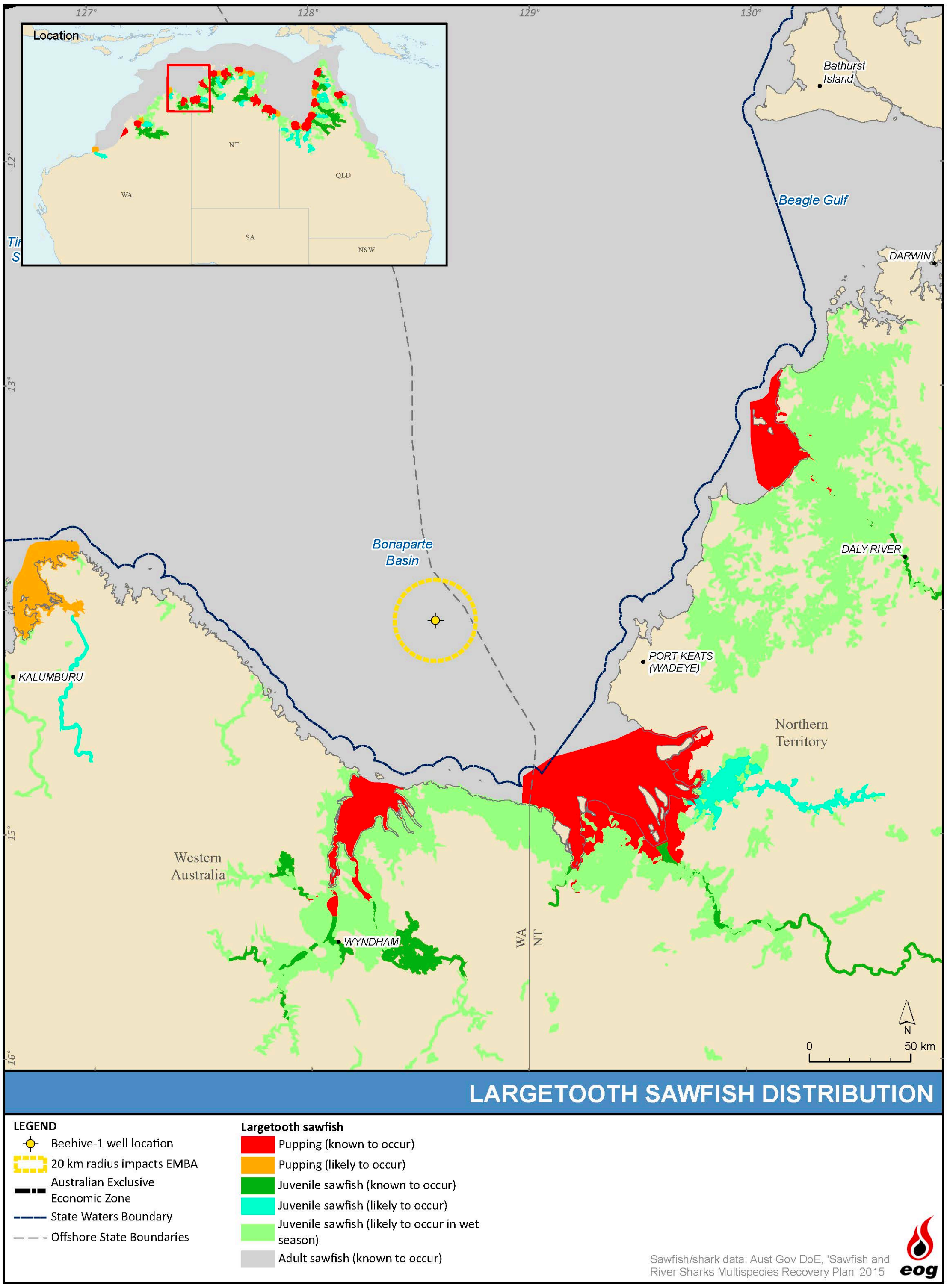


Figure 5.16. Largetooth sawfish presence in the impacts EMBA and surrounds

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 impacts EMBA overlaps areas where adult sawfish are known to occur and is adjacent to waters where juveniles are known to occur (Figure 5.17). It has also been caught as bycatch from the NPF in the area overlapped by the impacts EMBA and therefore is likely to be present (Tonks *et al.*, 2008).

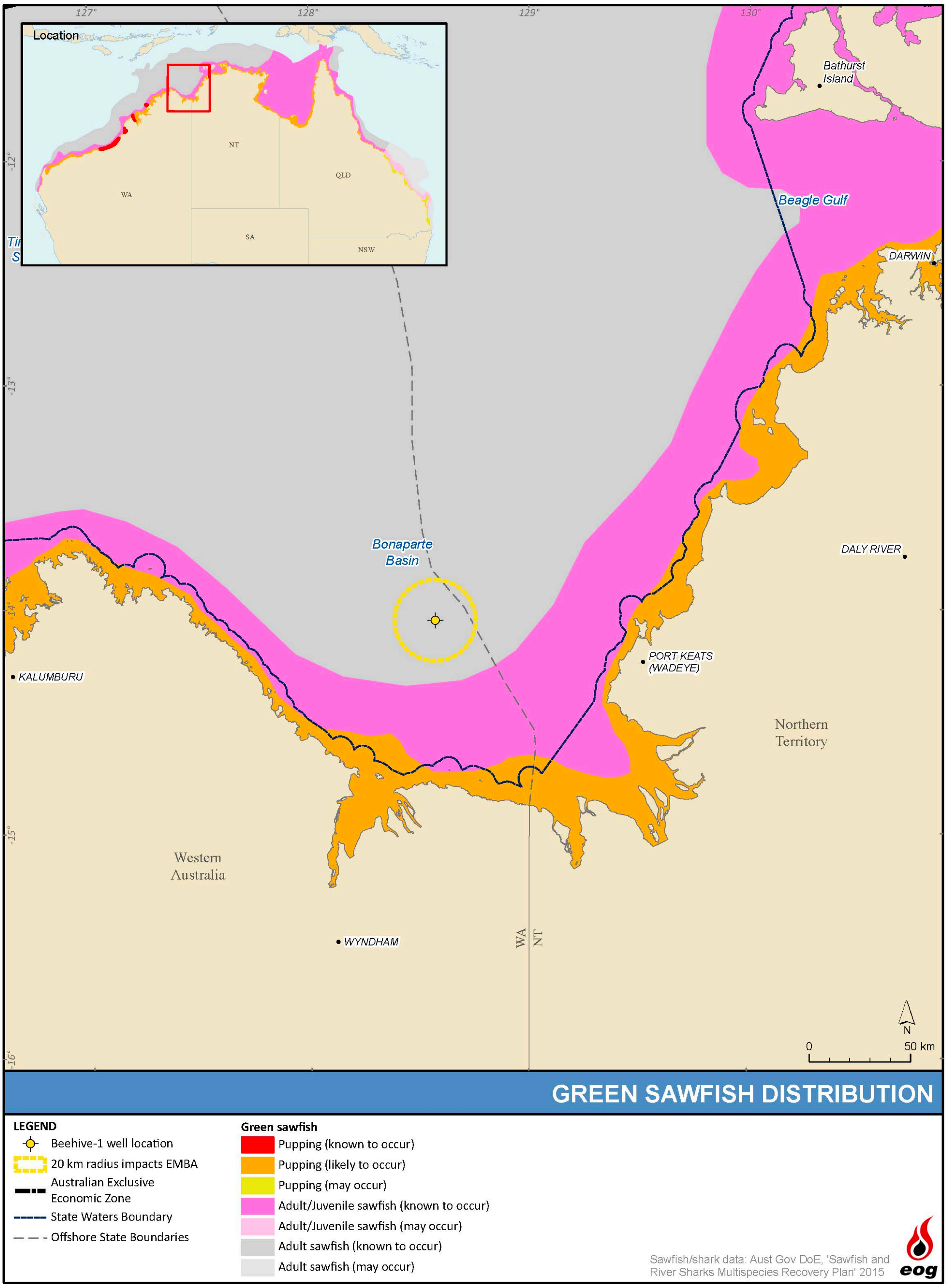


Figure 5.17. Green sawfish presence in the impacts EMBA and surrounds

Scalloped hammerhead shark (EPBC Act: Conservation Dependent)

The scalloped hammerhead shark (*Sphyrna lewini*) was listed as Conservation Dependent in 2018 (TSSC, 2018). This species is a long-lived large slender shark (growing up to 3.5 m) with a laterally expanded skull shaped like a hammer, known as a cephalofoil (TSSC, 2018).

The scalloped hammerhead shark has a circum-global distribution in tropical and sub-tropical waters, ranging widely over shallow coastal shelf waters but rarely venturing into or across deep ocean waters (TSSC, 2018). In Australia, the species range occurs from the southern coast of WA, across the north coast and extending south along the Australian coast to south of Sydney (TSSC, 2018). Little is known of the scalloped hammerhead's movements in Australia, though it is known to sometimes form large migratory schools (Last & Stevens, 2009). Their diet is reported to comprise ray-finned fish and cephalopods, suggesting a pelagic life (Last & Stevens, 2009). Adult females are rarely caught inshore and may live in deeper water, only moving into shallower coastal waters to mate and give birth (Last & Stevens, 2009). The pups remain in the shallow inshore waters for the first few years of their lives (TSSC, 2018).

The scalloped hammerhead shark is threatened by fishing (TSSC). Given the species' wide distribution in Australian tropical and sub-tropical waters and its preference for the continental shelf, it may occur within the impacts EMBA.

Sygnathids (EPBC Act: Listed marine species)

Twenty-four (24) species identified in the EPBC Act PMST are sygnathiformes, which includes seahorses, seadragon, pipehorse and pipefish. They are all listed as 'may' occur within the impacts EMBA.

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 occur in high numbers in the impacts EMBA given the likely absence of reef and seagrass habitat that they prefer.

5.4.5. Marine Mammals

The PMST indicates that five whale species, nine dolphin species and the dugong are likely to occur or may occur within or migrate through the impacts EMBA (DAWE, 2022a). These species are presented in Table 5.10 and a description focused on threatened species follows.

Figure 5.18 illustrates the likely temporal presence and absence of cetaceans in the impacts EMBA. The species listed as threatened or migratory are described in this section.

Table 5.10. EPBC Act-listed marine mammals that may occur in the impacts EMBA

Scientific name	Common name	EPBC Act Status			Type of presence	BIA intersected by impacts EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine			
Whales							
Balaenoptera edeni	Bryde's whale	-	Yes	-	May occur	No	-
B. borealis	Sei whale	V	Yes	-	May occur	No	-
B. physalus	Fin whale	V	Yes	-	May occur	No	CA
Balaenoptera musculus	Blue whale	E	Yes	-	May occur	No	CMP
Megaptera novaeangliae	Humpback whale	-	Yes	-	Likely	No	CA
Dolphins							
Delphinus delphis	Common dolphin	-	-	-	May occur	No	-
Grampus griseus	Risso's dolphin	-	-	-	May occur	No	-
Orcinus orca	Killer whale	-	Yes	-	May occur	No	-
Pseudorca crassidens	False killer whale	-	-	-	Likely	No	-
Sousa sahulensis	Australian humpback dolphin	-	Yes	-	May occur	No	-
Stenella attenuata	Spotted bottlenose dolphin	-	Yes	-	May occur	No	-
Tursiops aduncus	Indian Ocean bottlenose dolphin	-	-	-	May occur	No	-
Tursiops truncatus	Bottlenose dolphin	-	-	-	May occur	No	-
Other							
Dugong dugon	Dugong	-	Yes	Yes	May occur	No	-

Key is the same as per Table 5.8.

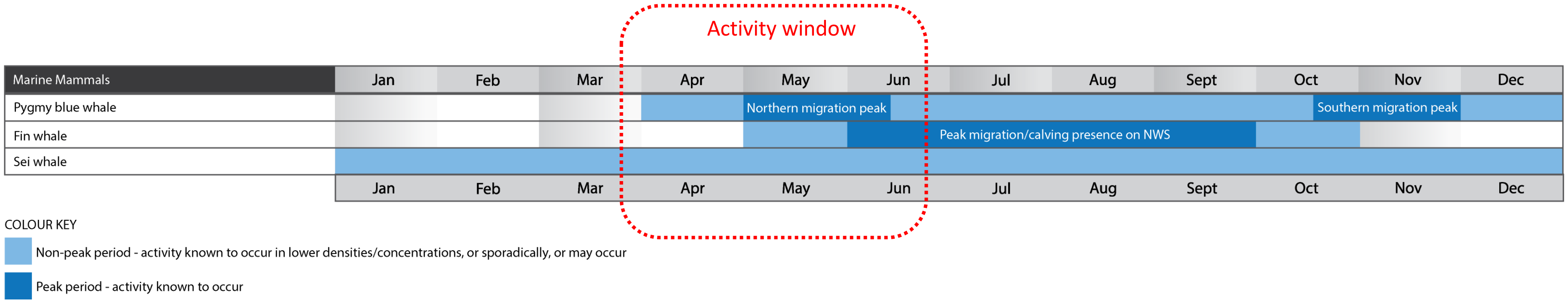


Figure 5.18. Likely temporal presence and absence of EPBC Act-listed threatened marine mammal species in the impacts EMBA

Threats and pressures on marine mammals

Four of the whale species listed in Table 5.10 are subject to pressures, which are described in various recovery plans and conservation advice. Table 5.11 summarises the pressures listed in the plans/advice relevant to each of these whale species relevant to drilling activities.

Table 5.11. Summary of threats to marine mammals

Species	Recovery Plan, Management Plan or Conservation Advice	Key threat/s relevant to drilling
Blue whale	Conservation management plan for the blue whale 2015-2025 (DoE, 2015a)	Noise interference Habitat modification (marine debris) Vessel disturbance (collisions)
Humpback whale	Conservation advice *Megaptera novaeangliae* (humpback whale) (DoE, 2015)	Noise interference Habitat degradation Vessel disturbance and strike
Sei whale	Conservation advice *Balaenoptera borealis* (sei whale) (TSSC, 2015)	Noise interference Habitat degradation Pollution Vessel strike
Fin whale	Conservation advice *Balaenoptera physalus* (fin whale) (TSSC, 2015)	

Blue whale (EPBC Act: Endangered, Listed migratory)

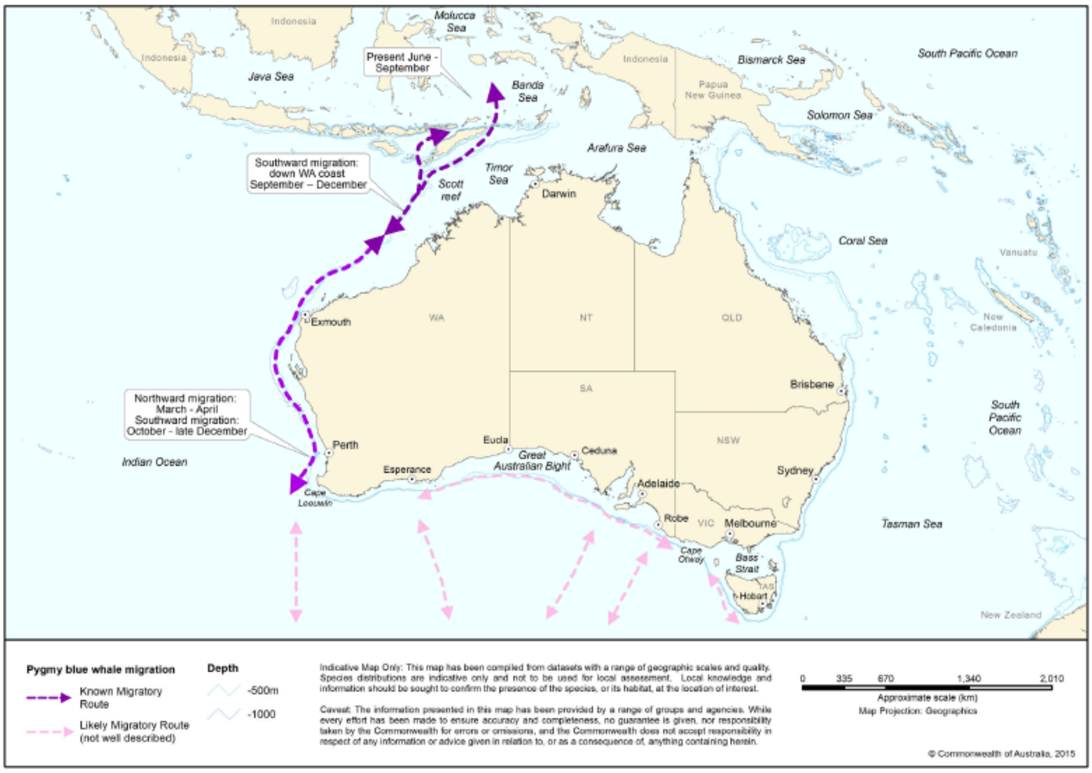
Blue whales (*Balaenoptera musculus*) are the largest living animals, growing to a length of over 30 m and weighing up to 180 tonnes (DoE, 2015a). In Australia, there are two recognised sub-species of blue whale; the Antarctic blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*B.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

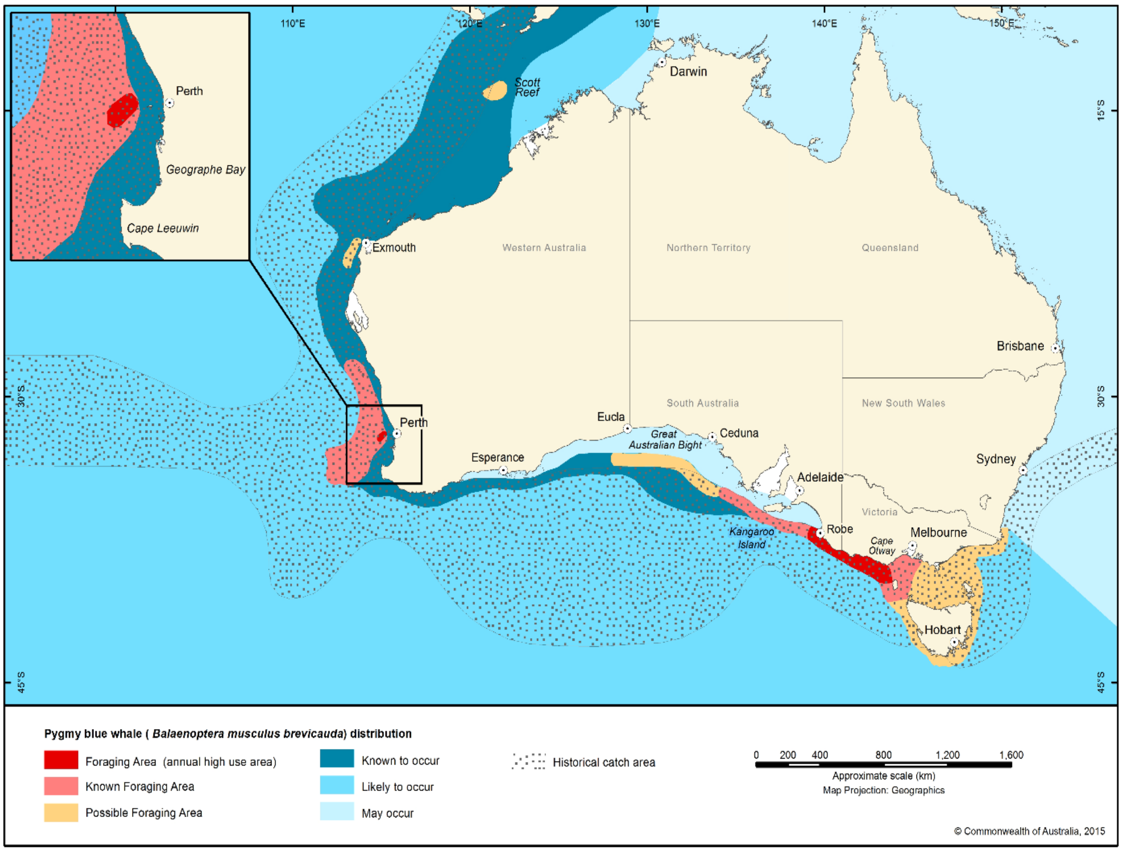
Figure 5.19 shows the migration of pygmy blue whales around Australia.

There is a foraging, migration and distribution BIA located off the North West Shelf (Figure 5.20), which is not intersected by the impacts EMBA. Though there are no BIAs that are intersected by the impacts EMBA, the impacts EMBA occurs within the ‘may occur’ distribution of the species (DoE, 2015a).



Source: DoE (2015a)

Figure 5.19. Pygmy blue whale migration routes



Source: DoE (2015a)

Figure 5.20. Pygmy blue whale BIAs

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). There are no known mating or calving areas in Australia.

Based upon the species preference for deep offshore waters, the wide-ranging nature of this species, and the small number of sei whale sightings in Australia, there is likely to be a low likelihood of sei whales migrating through the impacts 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. In Australia, there are confirmed records of fin whales for all coastal waters except in New South Wales and the NT, but the available information suggests that the species is more commonly present in deeper water (DEH, 2005a) of the Indonesian Archipelago, using north western Australia as a migration route.

Based on the fin whale preference for deep offshore waters, there is likely to be a low likelihood of fin whales migrating through the impacts EMBA.

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 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.

There are no feeding or breeding BIAs within the impacts EMBA for this species, and there is a low likelihood of Bryde's whale migrating through the impacts EMBA.

Humpback whale (EPBC Act: migratory)

Humpback whales (*Megaptera novaeangliae*) have a global distribution. In Australia, they occur along the east and west coasts during their annual migrations. The whales migrate north from their Antarctic feeding grounds around May each year, and reach the tropical calving grounds in the NWMR in early June (DAWE, 2021b). The exact timing of migration varies each year by up to six weeks in response to water temperature, sea ice distribution, predation risk, prey abundance and the location of feeding grounds (DEWR, 2007).

Humpback whales travel northbound from North West Cape, along the continental shelf and pass the west of the Muiron, Barrow and Montebello Islands, peaking in late July (Jenner *et al*., 2001). Southbound migrations are more diffuse and irregular with no obvious peak. The southerly migration extends parallel to the coast on the 20-30 m depth contour from Lacepede Islands (north of Broome) (Jenner *et al*., 2001; DEWHA, 2008a). An increase in southerly migrating individuals may be observed between the North West Cape and the Montebello Islands around November (Jenner *et al*., 2001).

In the NWMR, humpback whales are known to have breeding and foraging grounds between Broome and the northern end of Camden Sound, 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 (Jenner *et al*., 2001).

Given the well-known distribution of humpback whales in Australia, it is unlikely that this species migrates through the impacts EMBA.

Omura's whale (EPBC Act: not listed)

Omura's whale (*Balaenoptera omurai*) may occur in and around the impacts 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 (440-470 km northeast of the impacts EMBA) 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 impacts EMBA.

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 impacts EMBA and EMBA are unlikely to represent important habitat for this species. Therefore, killer whales are unlikely to be present in the impacts EMBA 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.

Humpback dolphin foraging BIAs are located along the Kimberley coastline, including breeding, and calving. A breeding BIA for the species are also located in Darwin Harbour (approximately 300 km north-east of the drill site). Foraging BIAs are also located in Van Diemen Gulf and Port Essington (Cobourg Peninsula).

Given their habitat preferences, it is unlikely that this species occurs in the impacts EMBA.

Spotted bottlenose dolphin (EPBC Act: Listed migratory)

The spotted bottlenose dolphin (Arafura/Timor Sea) (*Tursiops aduncus*) resemble common bottlenose dolphins (*T. truncatus*) in their general colour pattern, but can be differentiated from the *T. truncatus* by the absence of a blaze on the dorsal cape and by the presence of ventral spotting in sexually mature individuals (DAWE, 2022).

Spotted bottlenose dolphin occur in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean and occur in estuarine and coastal waters of northern Australia, including the eastern Indian Ocean and Arafura/Timor Seas (DAWE, 2022). The total population size of this species is not known, though it is likely that this species is common in inshore and nearshore waters of eastern, western and northern Australia where they feed on a range of fish and cephalopods (DAWE, 2022).

Movement patterns in Australia are variable, and include year-round residency in small areas, long-range movements and migration (DAWE, 2022). The largest threat to the species is bycatch in trawl nets and gillnets and habitat degradation (DAWE, 2022).

It is likely that spotted bottlenose dolphins occur in the impacts EMBA, either residing in the area or migrating through.

Dugong (EPBC Act: Listed migratory, Listed marine)

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 to Pearce Point with the main populations concentrated around Dorcherty Island (Woodside, 2004), approximately 102 km east of the drill site. The closest dugong foraging BIA is located south of Ashmore Reef (585 km to the west of the impacts EMBA), with additional foraging BIA on the Kimberley coastline off the Dampier Archipelago.

Based on their habitat preferences, dugongs are unlikely to be present in the impacts EMBA.

5.4.6. Marine Reptiles

Six species of marine turtle are listed is the PMST results as known or likely to occur in the impacts EMBA (Table 5.12) (DAWE, 2021a). Three of the turtle species are listed as endangered with the other three listed as vulnerable.

Additionally, 17 species of sea snake are identified as ‘may occur’ in the impacts EMBA, along with the saltwater crocodile being ‘likely to occur.’

The species listed as threatened or migratory are described in this section. Ecological stages and temporal occupation of the turtle species is presented in Figure 5.21.

Table 5.12 EPBC Act-listed marine reptiles that may occur in the impacts EMBA

Scientific name	Common name	EPBC Act Status			Habitat type/ presence	BIA intersected by impacts EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine			
Turtles							
Caretta caretta	Loggerhead turtle	E	Yes	Yes	Likely	No	RP for all turtles in Australia
Chelonia mydas	Green turtle	V	Yes	Yes	Known	Yes	
Dermochelys coriacea	Leatherback turtle	E	Yes	Yes	Likely	No	
Eretmochelys imbricate	Hawksbill turtle	V	Yes	Yes	Likely	No	
Lepidochelys olivacea	Olive ridley turtle	E	Yes	Yes	Known	Yes	
Natator depressus	Flatback turtle	V	Yes	Yes	Known	Yes	
Sea snakes							
Acalyptophis peronii	Horned sea snake	-	-	Yes	May occur	No	-
Aipysurus duboisii	Dubois' sea snake	-	-	Yes	May occur	No	-
Aipysurus eydouxii	Spine-tailed sea snake	-	-	Yes	May occur	No	-
Aipysurus foliosquama	Leaf-scaled sea snake	CE	-	Yes	May occur	No	-
Aipysurus laevis	Olive sea snake	-	-	Yes	May occur	No	-
Astrotia stokesii	Stokes' sea snake	-	-	Yes	May occur	No	-
Chitulia ornata	Spotted sea snake	-	-	Yes	May occur	No	-
Disteira kingii	Spectacled sea snake	-	-	Yes	May occur	No	-
Disteira major	Olive-headed sea snake	-	-	Yes	May occur	No	-
Emydocephalus annulatus	Turtle-headed sea snake	-	-	Yes	May occur	No	-
Enhydrina schistosa	Beaked sea snake	-	-	Yes	May occur	No	-

Scientific name	Common name	EPBC Act Status			Habitat type/ presence	BIA intersected by impacts EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine			
Hydrelaps darwiniensis	Black-ringed sea snake	-	-	Yes	May occur	No	-
Hydrophis atriceps	Black-headed sea snake	-	-	Yes	May occur	No	-
Hydrophis elegans	Elegant sea snake	-	-	Yes	May occur	No	-
Hydrophis mcdowelli	Small-headed sea snake	-	-	Yes	May occur	No	-
Lapemis curtus	Spine-bellied sea snake	-	-	Yes	May occur	No	-
Pelamis platurus	Yellow-bellied sea snake	-	-	Yes	May occur	No	-
Crocodiles							
Crocodylus porosus	Salt-water crocodile	-	Yes	Yes	Likely	No	-

Key is the same as per Table 5.8.

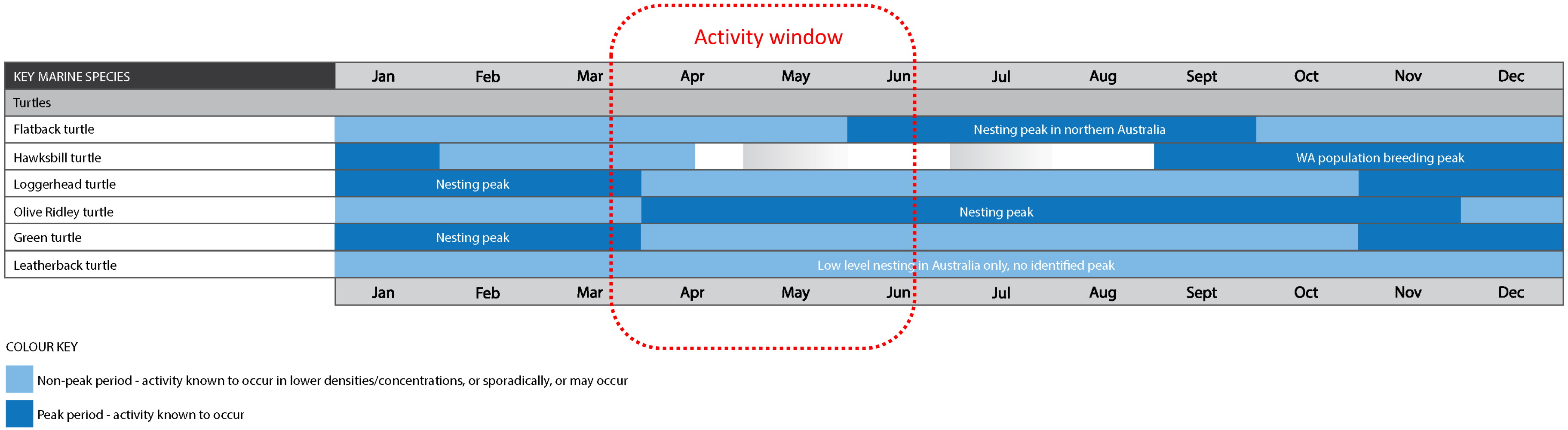


Figure 5.21. Likely temporal presence and absence of EPBC Act-listed threatened turtle species in the impacts EMBA

Threats and pressures on marine reptiles

Five of the turtle species listed in Table 5.12 are subject to pressures, which are described in various recovery plans and conservation advice. Table 5.13 summarises the pressures listed in the plans/advice relevant to each of these species relevant to drilling activities.

Table 5.13. Summary of threats to marine reptiles

Species	Recovery Plan, Management Plan or Conservation Advice	Key threat/s relevant to drilling
Loggerhead turtle	Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017)	Marine debris Light pollution Habitat modification Vessel disturbance Noise interference
Green turtle		
Leatherback turtle		
Hawksbill turtle		
Flatback turtle		
All turtles	Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE, 2018)	Marine debris (plastics)
	National Light Pollution Guidelines for Wildlife including marine turtles, seabirds and migratory shorebirds	Artificial light

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 impacts 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 (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 impacts 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 not intersected by the impacts EMBA (Figure 5.22).

Given the proximity of the foraging BIA, it is likely that loggerhead turtles are present in the impacts EMBA.

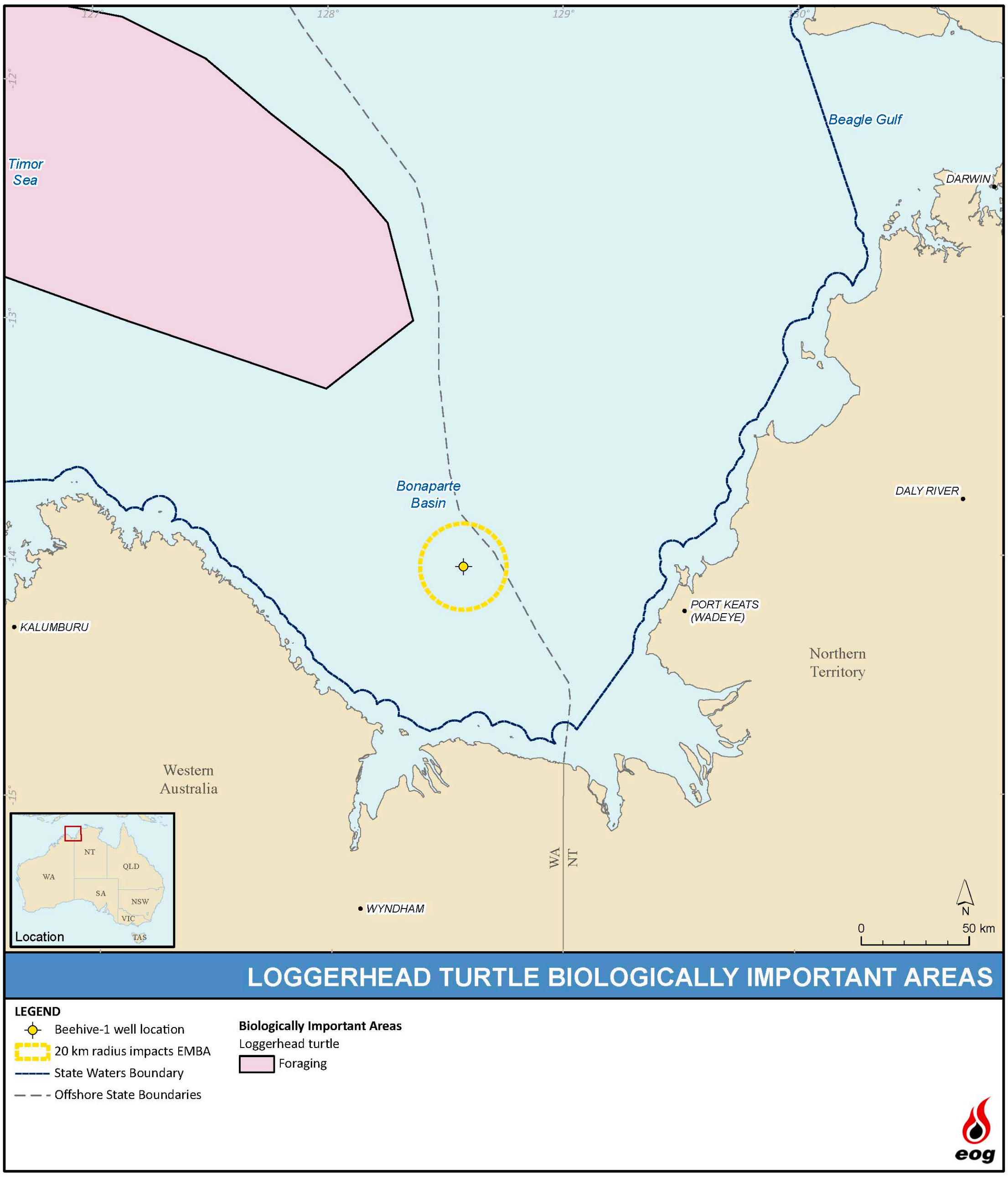


Figure 5.22. Loggerhead turtle BIA near the impacts EMBA

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 KEF 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 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 impacts EMBA overlap with a foraging BIA for this species (Figure 5.23). The closest nesting and inter-nesting BIAs are located 286 km west of the impacts EMBA along the northwest Kimberley coastline. Within foraging areas, adult green turtles feed on seagrass, sponges and algae (DAWE, 2021b).

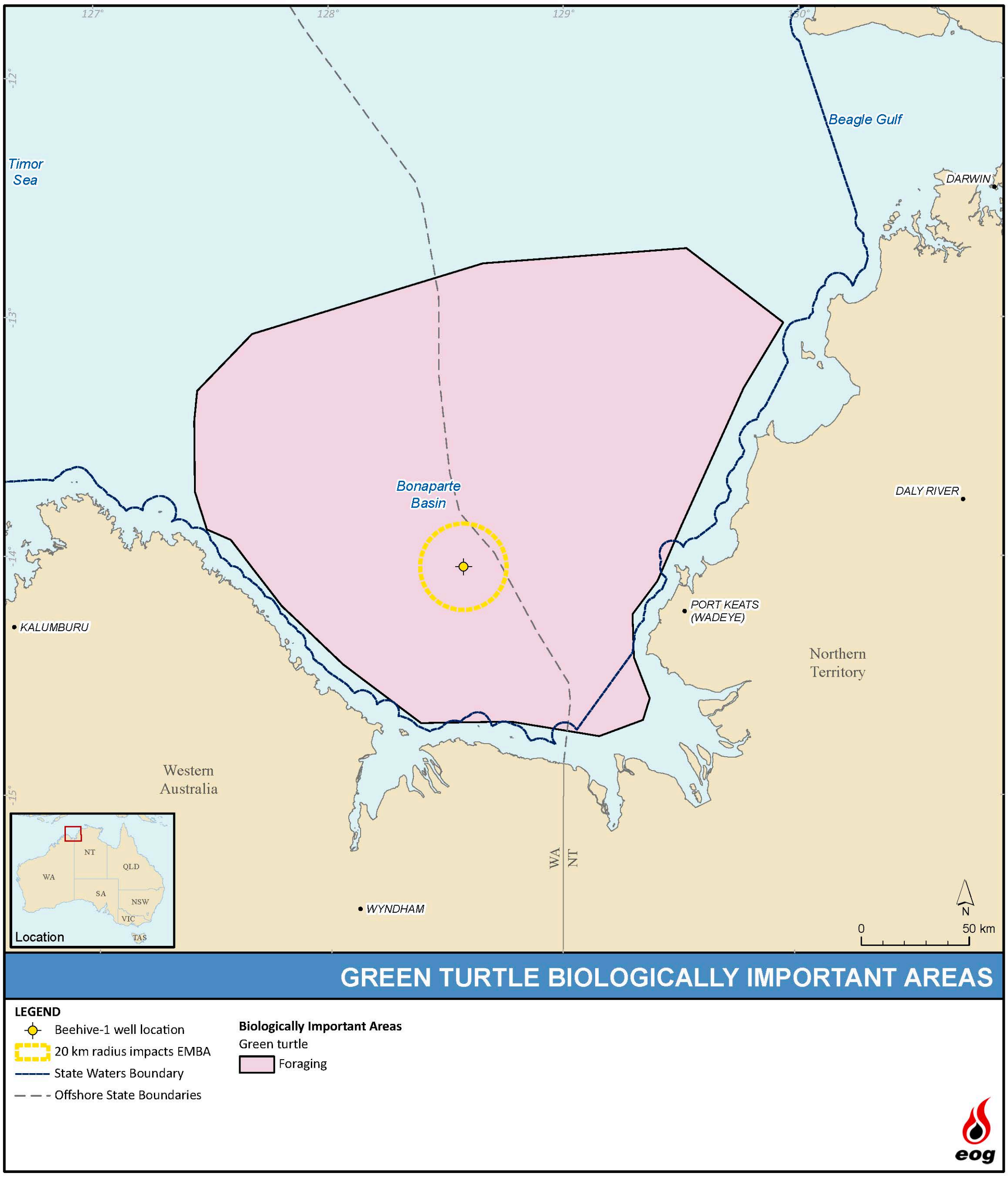


Figure 5.23. Green turtle BIA overlapped by the impacts EMBA

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 nests and forages in northern Australia.

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 (87 km south of the impacts EMBA) 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 North West Shelf reported by Whittock et al (2014). 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 impacts EMBA intersects an inter-nesting BIA, as illustrated in Figure 5.24.

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.

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 impacts EMBA overlaps with a foraging BIA for this species (Figure 5.25); hence it is possible that individuals could be encountered in the impacts EMBA, though nesting is unlikely to occur in the coastal sections of the EMBA.

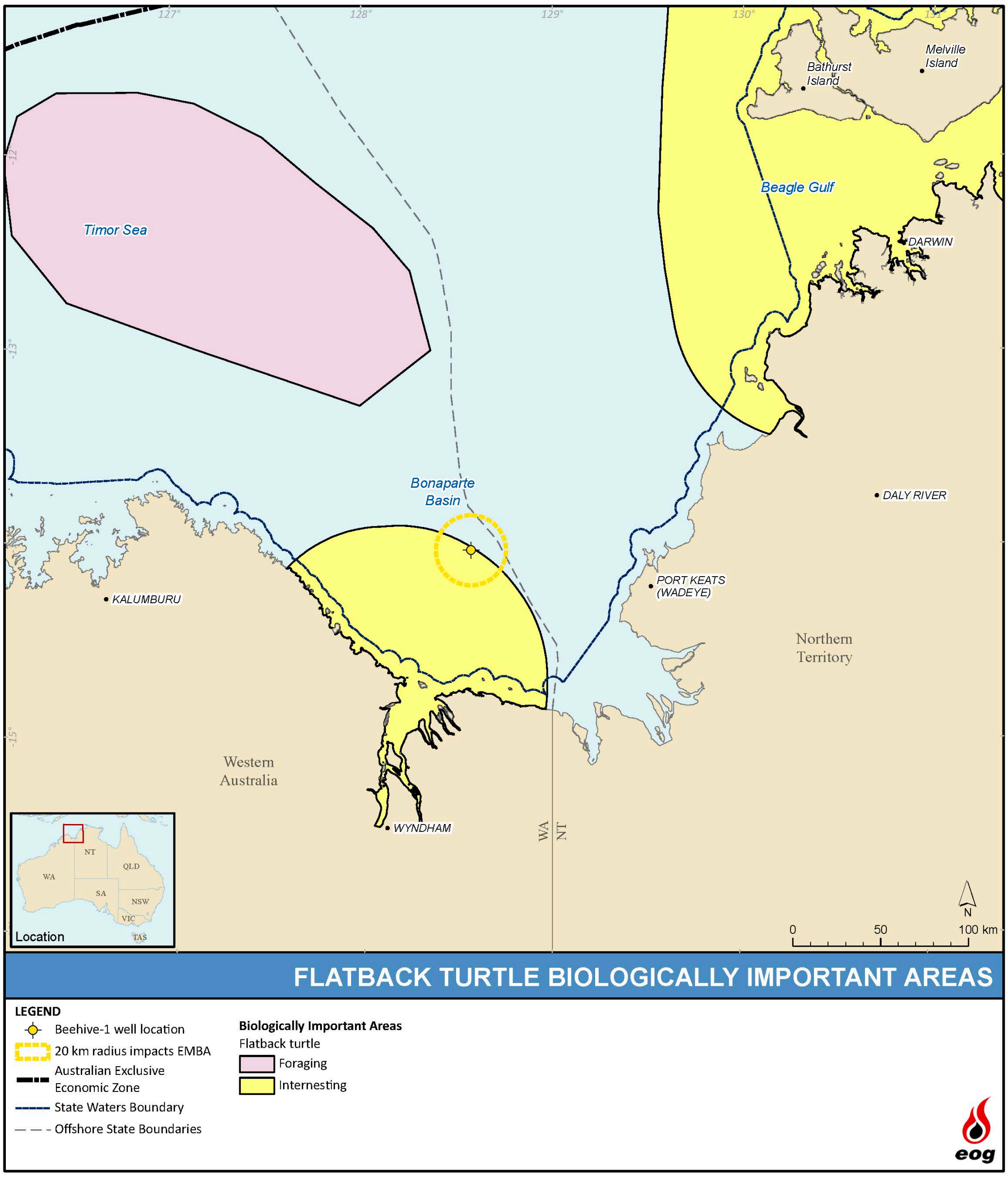


Figure 5.24. Flatback turtle BIA overlapped by the impacts EMBA

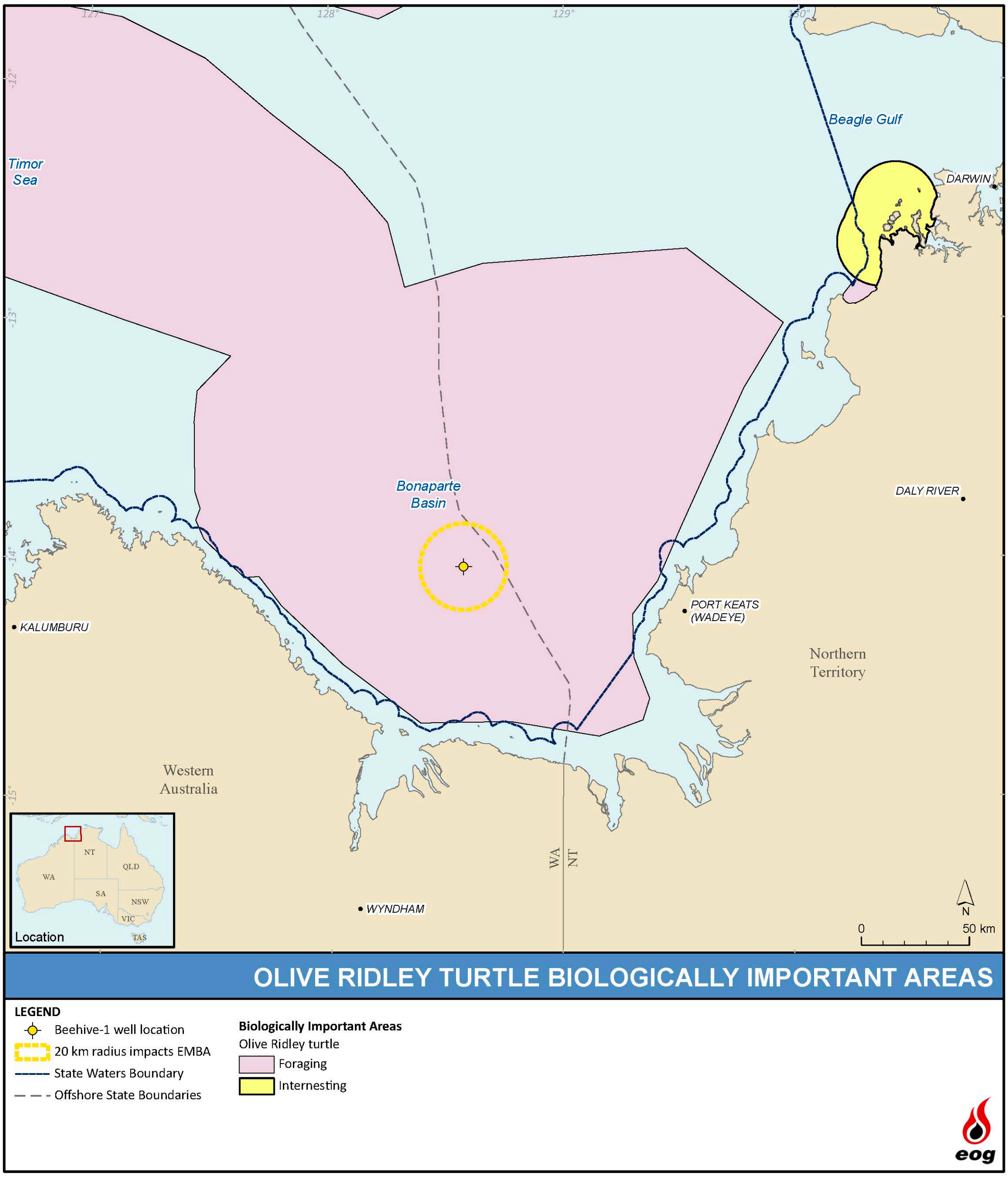


Figure 5.25. Olive Ridley turtle BIA overlapped by the impacts EMBA

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, nesting extensively along the coasts and foraging in the region.

As a juvenile, the hawksbill turtle feeds on plankton 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 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 impacts 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 impacts EMBA. The species may be encountered in the impacts EMBA as transient individuals.

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 northwest banks of rivers (DAWE, 2021b). The species nest during the wet season with peak nesting during January and February. While sightings of saltwater crocodiles far out to sea have been recorded, it is more likely to be encountered in coastal areas than in the impacts EMBA.

Sea snakes

Sea snakes occur in tropical and subtropical waters around the world and are reported to occur in offshore and nearshore waters in northern Australia, mostly in shallower waters around reefs and inshore environments (DEWHA, 2008b).

Of the 17 species of sea snake listed in the PMST that may occur in the impacts area, the leaf-scaled sea snake (*Aipyurus foliosquama*) is listed as Critically Endangered due to its restricted geographic range and severe reduction in numbers from 2000-2010 caused by coral reef bleaching, which reduces fish diversity and abundance and therefore a food source (DSEWPC, 2011). Unsustainable and illegal fishing are reported as the most significant direct threat to this species (DSEWPC, 2011).

This species is most likely to occur along the WA coast from Shark Bay north to the Eighty Mile Beach (outside the impacts EMBA), and less likely from there north to the western part of the JBG (also outside the impacts EMBA). The leaf-scaled sea snake occurs mostly on reef flats or in shallow waters of outer reef edges to depths of 10 m, and is known from Ashmore and Hibernia reefs (600 km west of the impacts EMBA) (DSEWPC, 2011).

The habitat preferences of the leaf-scaled sea snake means it is not likely to occur in the impacts EMBA.

5.4.7. Avifauna

There are seven bird species (five migratory wetland species and two migratory marine species) listed in the PMST that 'may occur' in the impacts EMBA (Table 5.14) (DAWE, 2022a). Three of these birds are listed as threatened.

The birds listed in Table 5.14 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).

Figure 5.26 illustrates the likely temporal presence and absence and ecological stages of these bird species in the impacts EMBA. The species listed as threatened are described here.

In brief, the two seabird species listed in Table 5.14, the common noddy and streaked shearwater, are birds with widespread global distributions and no breeding in or near the impacts EMBA.

Red knot (EPBC Act: Endangered, Listed Migratory)

The red knot (*Calidris canutus*) is a small migratory shorebird that is common in all the main suitable habitats around the coast of Australia and with a global distribution and extremely large range (TSSC, 2016). Very large numbers are regularly recorded in northwest Australia, with Eighty Mile Beach and Roebuck Bay being particular strongholds. 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. Red knots feed in intertidal mudflats or sandflats exposed during low tide and during high tide, they feed in lakes and other inundated areas (TSSC, 2016). They roost on sandy beaches, spits and islets and mudflat (TSSC, 2016).

The species does not breed in Australia. Based on its habitat preferences, this species is not likely to occur within the impacts EMBA but may fly over it.

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

The curlew sandpiper (*Calidris ferruginea*) is a migratory species with a global distribution and in Australia, they occur around the coasts and is also quite widespread inland, though in smaller numbers (TSSC, 2015). They are rarely recorded in the northwest Kimberley, around Wyndham and Lake Argyle, and in the NT, they are mostly recorded around Darwin, north to Melville Island and Cobourg Peninsula (TSSC, 2015). Curlew sandpiper habitat in Australia occurs in intertidal mudflats in sheltered coastal areas and non-tidal swamps, lakes and lagoons close to the coast, where they feed on invertebrates and seeds (TSSC, 2015). The main threats to the species are human disturbance, habitat loss and degradation from pollution, altered water regimes and invasive plants (TSSC, 2015).

The species does not breed in Australia. Based on its habitat preferences, this species is not likely to occur within the impacts EMBA but may fly over it.

Table 5.14. EPBC Act-listed bird species that may occur in the impacts EMBA

Scientific name	Common name	EPBC Act Status			Type of presence	BIA intersected by impacts EMBA?	Recovery Plan in place?
		Threatened	Migratory	Marine			
Seabirds							
Anous stolidus	Common noddy	-	Yes	Yes	May occur	No	-
Calonectris leucomelas	Streaked shearwater	-	Yes	Yes	Likely	No	-
Shorebirds/wetland species							
Calidris acuminata	Sharp-tailed sandpiper	-	Yes	Yes	May occur	No	-
Calidris canutus	Red knot	E	Yes	Yes	May occur	No	CA
Calidris ferruginea	Curlew sandpiper	CE	Yes	Yes	May occur	No	CA
Calidris melanotos	Pectoral sandpiper	-	Yes	Yes	May occur	No	-
Numenius madagascariensis	Eastern curlew	CE	Yes	Yes	May occur	No	CA

Key is the same as per Table 5.8.

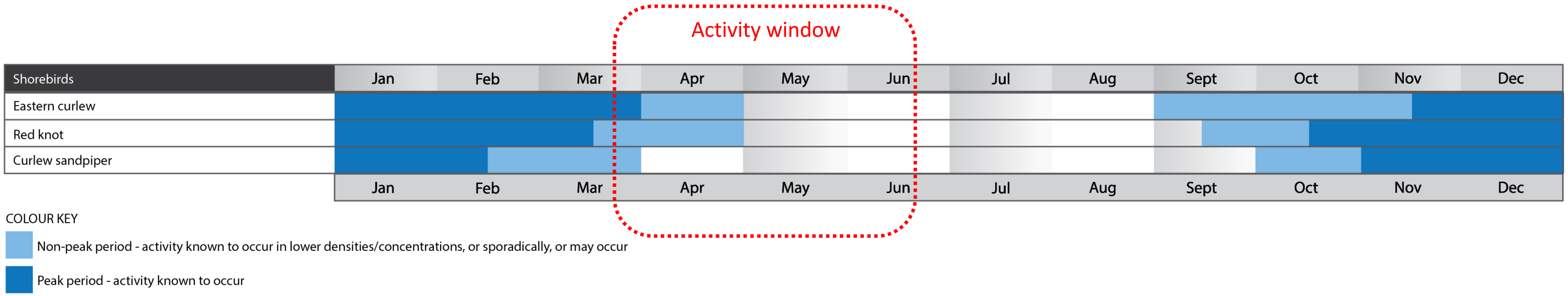


Figure 5.26. Likely temporal presence and absence of EPBC Act-listed threatened seabird species in the impacts EMBA

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

The eastern curlew (*Numenius madagascariensis*) is the world's largest migratory shorebird, with a wingspan of 110 cm (DoE, 2015).

It does not breed in Australia and while here, it has a coastal distribution around the whole country (DoE, 2015). Eastern curlews feed on crustaceans and insects in 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, 2015). They typically roost in large flocks on snady spits, sandbars and islets and among coastal vegetation (DoE, 2015). During the non-breeding season in Australia, they feed mainly on crustaceans and insects (DoE, 2015).

Based on its habitat preferences, the eastern curlew is not likely to occur within the impacts EMBA but may fly over it.

Threats and pressures on birds

Three of the shorebirds listed in Table 5.14 are subject to pressures, which are described in various recovery plans and conservation advice. Table 5.15 summarises the pressures listed in the plans/advice relevant to each of these species that could result from drilling activities.

Table 5.15. Summary of threats to birds

Species	Recovery Plan, Management Plan or Conservation Advice	Key threat/s relevant to drilling
Red knot	Conservation advice for *Calidris canutus* (red knot) (TSSC, 2016)	Pollution/contamination Disturbance Direct mortality (bird strike from aircraft)
Curlew sandpiper	Conservation advice for *Calidris ferruginea* (curlew sandpiper) (TSSC, 2015)	Human disturbance Degradation from pollution
Eastern curlew	Conservation advice for *Numenius madagascariensis* (eastern curlew) (TSSC, 2015)	Human disturbance Degradation from pollution
All seabirds and shorebirds	Threat Abatement Plan for the impacts of marine debris on the vetebrate wildlife of Australia's coasts and oceans (DoEE, 2018)	Marine debris (plastics)
	National Light Pollution Guidelines for Wildlife including marine turtles, seabirds and migratory shorebirds	Artificial light

5.4.8. 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, 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 shallow 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.

5.5. Conservation Values and Sensitivities

The conservation values and sensitivities within the impacts EMBA are described in this section, with Table 5.16 providing an outline of the conservation categories described.

Table 5.16. Conservation values in the impacts EMBA

Category	Conservation classification	EP section
MNES under the EPBC Act	Australian Marine Parks (AMP)	5.5.1
	World Heritage-listed properties	5.5.2
	National Heritage-listed places	5.5.3
	Wetlands of international importance	5.5.4
	Nationally threatened species and threatened ecological communities	5.4
	Migratory species	5.4
	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	5.5.6
	Key Ecological Features (KEF)	5.5.7
	Nationally important wetlands (NIW)	5.5.8
State protected areas	State/territory protected areas	5.5.9

5.5.1. Australian Marine Parks

The impacts EMBA does not overlap any AMPs. The closest AMP is the JBG AMP, located 15 km to the east of the impacts EMBA and 35 km east of Beehive-1.

AMPs in the spill EMBA are described in Section 5.4.1 of **Appendix 5**.

5.5.2. 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 impacts EMBA. The closest World Heritage Property is Kakadu National Park (onshore), which is located over 400 km northeast of the impacts EMBA.

World Heritage-listed places intersected by the spill EMBA are described in Section 5.4.2 of **Appendix 5**.

5.5.3. 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 within or adjacent to the impacts EMBA. The closest National Heritage Place is the 'West Kimberley', which is located 51 km south-southwest of the impacts EMBA and 71 km south-southwest of Beehive-1.

National Heritage-listed places intersected by the spill EMBA are described in Section 5.4.3 of **Appendix 5**.

5.5.4. 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 within or adjacent to the impacts EMBA. The closest Ramsar wetland is the 'Ord River Floodplain', which is located 70 km south of the impacts EMBA and 90 km south of Beehive-1.

Ramsar wetlands intersected by the spill EMBA are described in Section 5.4.4 of **Appendix 5**.

5.5.5. 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 within or adjacent to the impacts EMBA. The closest TEC is the 'Holothuria Banks', which is located 237 km west of the impacts EMBA and 257 km west of Beehive-1.

TECs intersected by the spill EMBA are described in Section 5.4.5 of **Appendix 5**.

5.5.6. 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.

There are no Commonwealth Heritage-listed places within or adjacent to the impacts EMBA. Commonwealth Heritage-listed places intersected by the spill EMBA are described in Section 5.4.6 of **Appendix 5**.

5.5.7. 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.

There are no KEFS within or adjacent to the impacts EMBA. The closest KEF is the 'Carbonate bank and terrace system of the Sahul Shelf', which is located 6 km west of the impacts EMBA and 26 km east of Beehive-1.

KEFs intersected by the spill EMBA are described in Section 5.4.7 of **Appendix 5**.

5.5.8. 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 within or adjacent to the impacts EMBA. The closest NIW is the Ord Estuary System, which is located 70 km south west of the impacts EMBA and 90 km east of Beehive-1.

NIWs intersected by the spill EMBA are described in Section 5.4.8 of **Appendix 5**.

5.5.9. State/Territory Protected Areas

The impacts EMBA does not overlap any State- or Territory-managed protected areas.

State and territory marine protected areas intersected by the spill EMBA are described in Section 5.4.9 of **Appendix 5**.

5.6. 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 impacts EMBA, which are broadly categorised as Indigenous and non-Indigenous (maritime archaeology).

5.6.1. 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 impacts EMBA. Sites within the spill EMBA are listed in Section 5.5.1 of **Appendix 5**.

5.6.2. 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 identifies no shipwrecks within the impacts EMBA. Shipwrecks within the spill EMBA are listed in Section 5.5.2 of **Appendix 5**.

5.6.3. Native Title

A search of the National Native Title Tribunal (NNTT) Register does not identify any Native Title areas or any pending titles within the impacts EMBA.

The Native Title areas within the spill EMBA are described in Section 5.5.3 of **Appendix 5**.

5.7. Socio-economic environment

This section describes the social and economic environment of the impacts EMBA.

5.7.1. Commercial Fishing

Several Commonwealth, WA and NT commercial fisheries are licensed to operate in the impacts 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 in the impacts EMBA are the:

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

Of these fisheries, only the NPF has evidence of recent (within the last three years) fishing activity in the impacts EMBA. Table 5.17 summarises the key facts and figures of the NPF and Figure 5.27(a;b) illustrates the overlap between the fishery and the impacts EMBA.

Commonwealth-managed fisheries intersected by the spill EMBA are described in **Appendix 5**.

Table 5.17. Commonwealth-managed NPF

Target species	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*) Red endeavour prawn (*M. ensis*)
Fishing season	The NPF operates in two seasons; • First – April to June, when banana prawns are the key catch species. • Second – August to November, when tiger prawns are the key catch species.
Fishing methods, vessels and licences	Otter trawl is the primary fishing method. In the 2020 fishing season, there were 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 other information	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).

Northern Prawn Fishery

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 5.27). 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 redleg 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. The migration of juvenile *P. indicus* in the JBG (as described in Table 5.5) is illustrated in Figure 5.28.

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, deeper than the majority of the waters of the impacts EMBA.

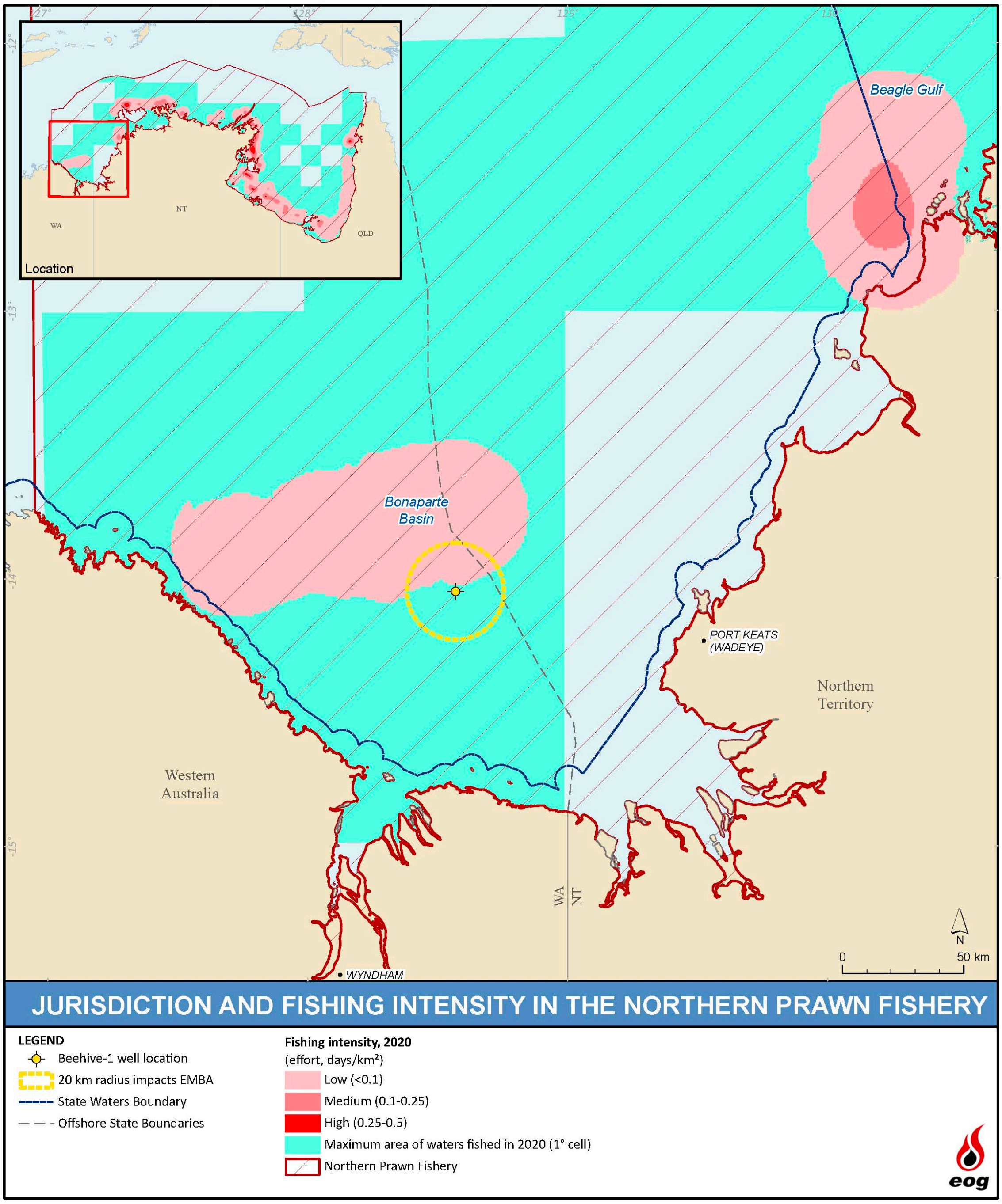


Figure 5.27a. NPF fishing intensity in the impacts EMBA (2020)

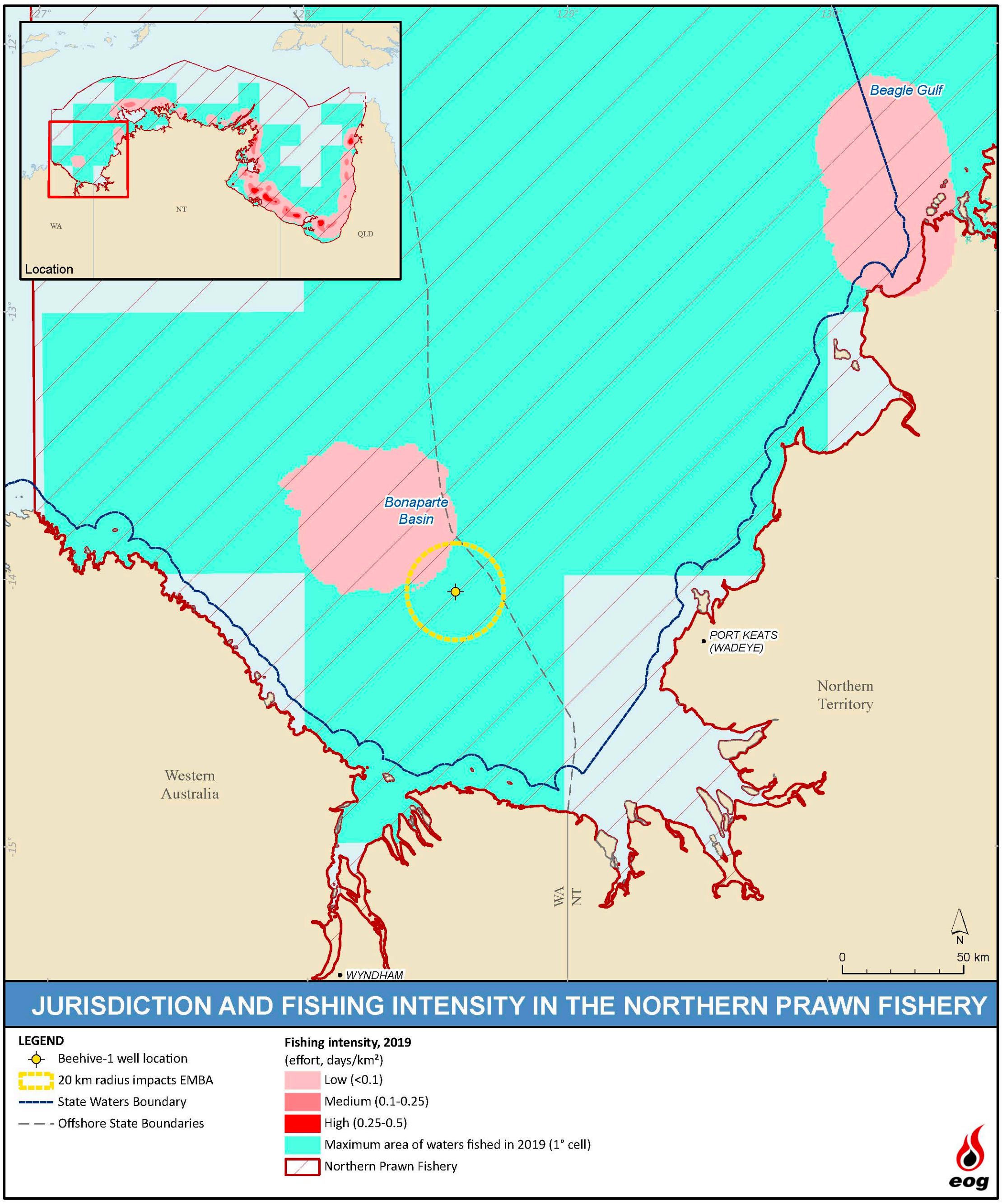
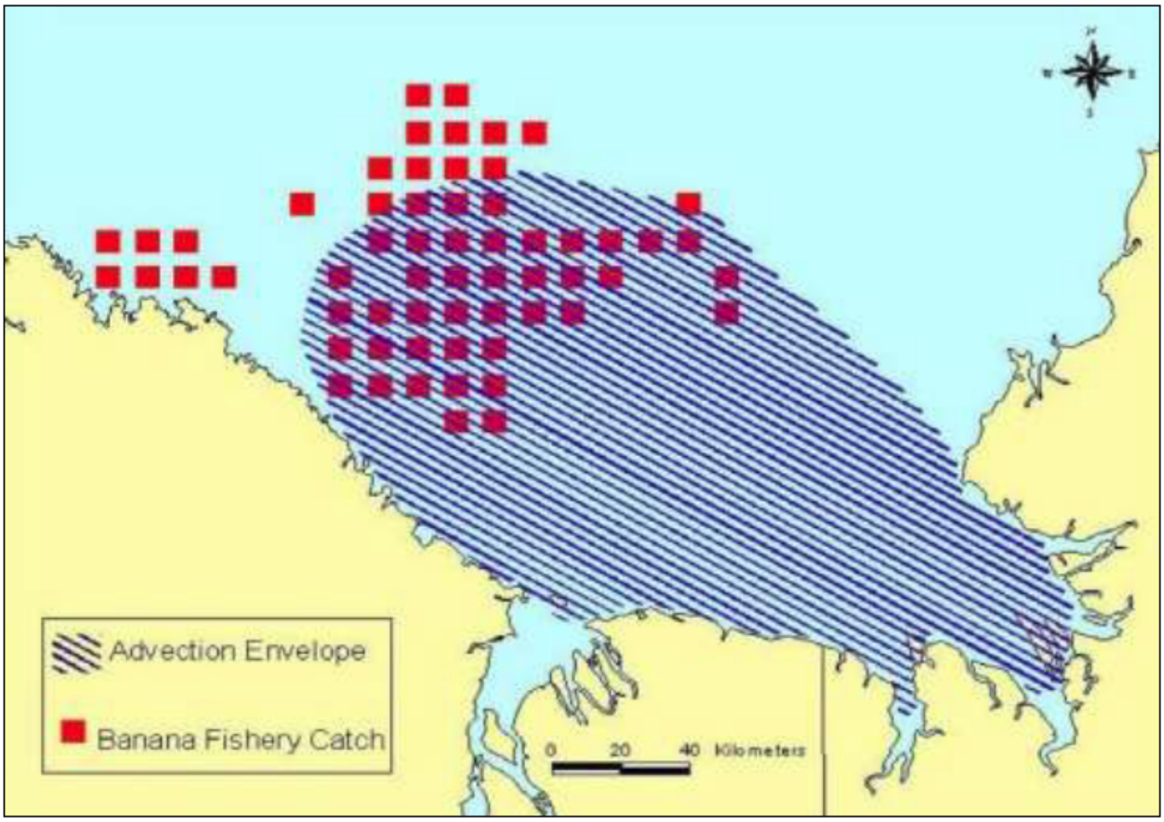


Figure 5.27b. NPF fishing intensity in the impacts EMBA (2019)



Source: Loneragan et al (2002).

Figure 5.28. Size and the probable advection envelope for post-larval redleg banana prawn (*Fenneropenaeus indicus*) in the JBG

A seasonal closure for the NPF in the JBG exists in the period 31 March –15 June (Figure 5.29) (AFMA, 2021). 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 impacts EMBA 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 redleg 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).

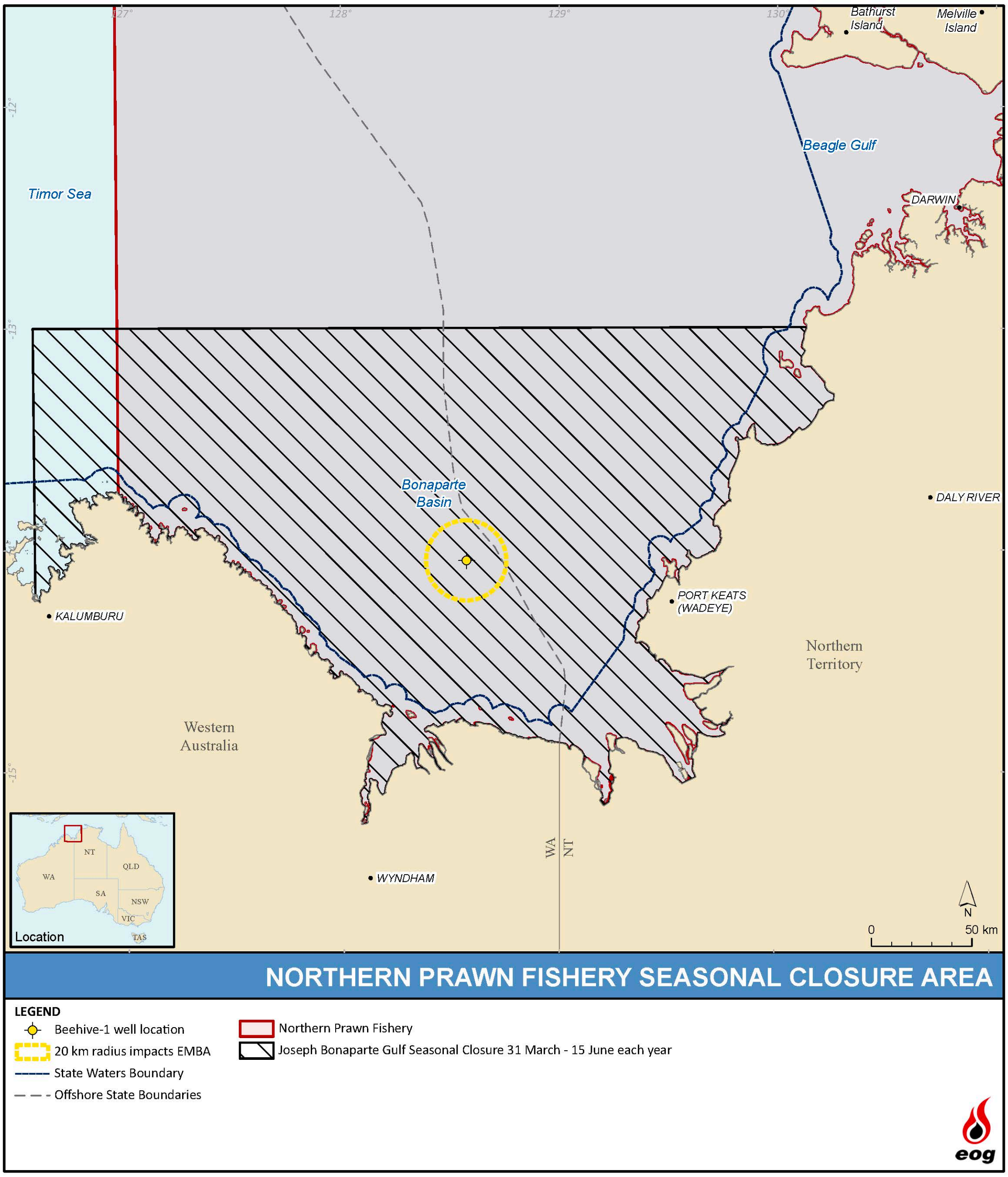


Figure 5.29. JBG closure area of the NPF

Western Australia-managed Fisheries

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

- Northern Demersal Scalefish Managed Fishery (NDSMF);
- Mackerel Managed Fisheries (MMF) (Area 1 – Kimberley);
- Kimberley Crab Managed Fishery (North Coast Crab Fishery);
- Kimberly Prawn Managed Fishery;
- Kimberley Gillnet and Barramundi Fishery;

- Pearl Oyster Managed Fishery (Zone 3)
- Abalone Managed fishery (Area 8);
- Marine Aquarium Fish Fishery; and
- Specimen Shell Fishery.

Through its consultation process with the WA DPIRD, EOG identified that only the NDSMF and MMF may fish in the impacts EMBA.

Table 5.18 presents information for the fisheries that have recent evidence of fishing in the impacts EMBA.

Western Australian-managed fisheries intersected by the spill EMBA are described in Section 5.6.1 of **Appendix 5**.

Northern Territory-managed Fisheries

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

Northern Territory-managed fisheries intersected by the spill EMBA are described in Section 5.6.1 of **Appendix 5**.

Table 5.18. Western Australian-managed commercial fisheries with recent fishing effort in the impacts EMBA

Fishery	Target species	Fishing activity in the impacts EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
NDSMF – Kimberley sector, Fishing Area 2, Zone A (Figure 5.30)	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*).	1,507 tonnes was caught in the Kimberley sector in 2019, with the majority of the catch (66%) was landed in Pilbara Zone B, 325 km west of the impacts EMBA.	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 (employing 20 people), which is down from seven vessels operating in 2016.	Catch data available for the last five years* for the whole fishery: • 2019 – 1,507 t. • 2018 – 1,297 t. • 2017 – 1,317 t. • 2016 – 1,173 t. • 2015 – 1,046 t. Catch value of $10-20 million in the Kimberley sector in 2019.
MMF - Area 1 (Kimberley) (Figure 5.31)	Spanish mackerel (*Scomberomorus commerson*)	The WA DoF reports that catch rates in the Kimberley are generally decreasing, partially due to changes in operators but also a decline in spawning stock after the 2016 northern heat pulse during the spawning period.	Fishing was primarily from May to November in 2019.	A total of 15 vessels operated during 2019 across the fishery, employing 35-40 people. 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* for the whole fishery: • 2019 – 291 t, valued at $2.5 million. • 2018 – 213 t. • 2017 – 283 t. • 2016 – 276 t. • 2015 – 302 t.

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

** 2020 and 2021 catch data not available at the time of EP preparation.*

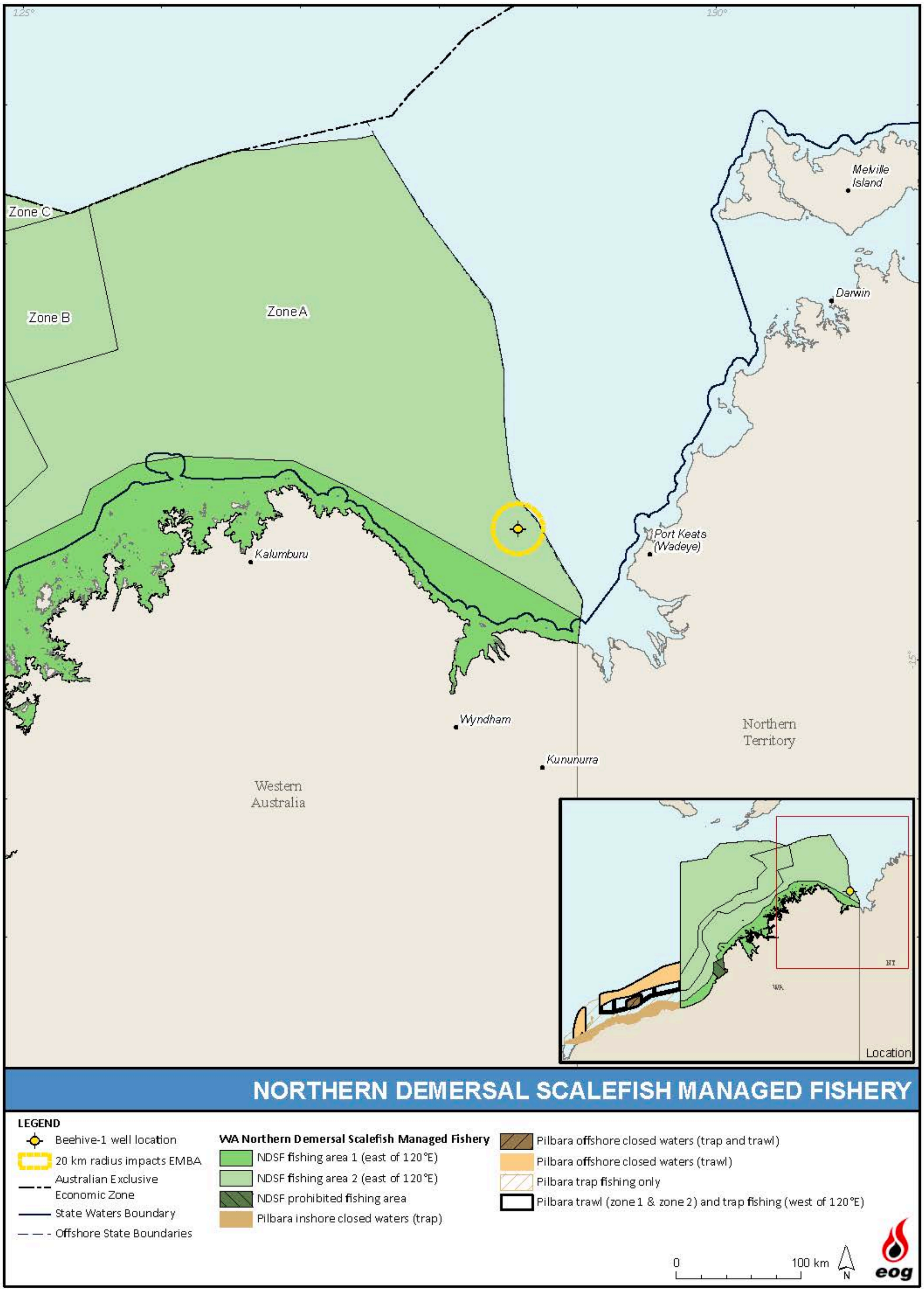


Figure 5.30. WA Northern Demersal Scalefish Fishery overlapped by the impacts EMBA

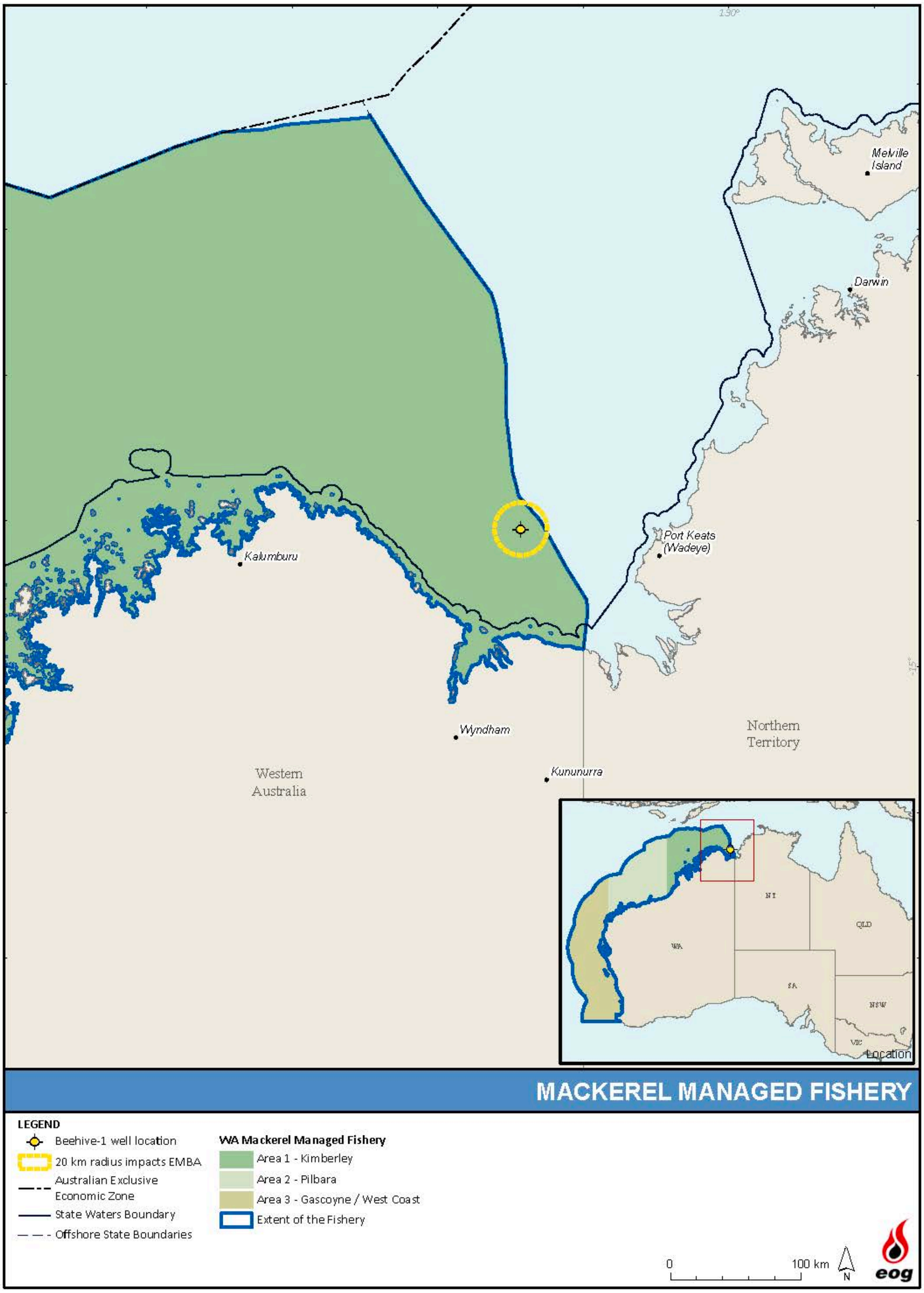


Figure 5.31. WA Mackerel Managed Fishery overlapped by the impacts EMBA

5.7.2. 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).

Recreational fishing activities are primarily based out of Darwin, located 280 km northeast of the impacts EMBA. Given the long distance between the impacts EMBA and the mainland (60 km at its closest point) and main population areas (e.g., Wadeye), recreational fishing activities in the impacts EMBA are not expected.

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

5.7.3. Traditional Fishing

Traditional Aboriginal fishing in NT waters predominately occurs within inshore tidal waters. Approximately 85% of the NT's intertidal zone is recognised as Aboriginal land under the *Aboriginal Land Rights (Northern Territory) Act*.

In the NT, there are generally three recognised Aboriginal fishery zones, which extend to 3 nm, 15 nm and 200 nm from the coast. Almost all Aboriginal fishing effort is concentrated within the 3 nm coastal waters boundary (93%) (65 km from the impacts EMBA at its closest point), with fishing spanning the entire coastline (NT Government, 2017a), though it is mostly focused around the Tiwi Islands (275 km northeast of the impacts EMBA). Aboriginal activities within the coastal waters of the Tiwi Islands includes fishing and hunting (including for turtles and dugongs) and gathering (e.g., turtle eggs).

5.7.4. 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 and the city of Darwin (280 km northeast of the impacts EMBA) being the largest nearby city.

5.7.5. Tourism

The JBG is very 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 access 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 (e.g., known reefs, shipwrecks, canyons) in the impacts EMBA or immediate surrounds to attract tourists.

Charter boats operating out of Darwin and Broome/Derby may occasionally visit or pass through the JBG.

No scuba diving or snorkelling sites or dive shops or clubs have been identified in the JBG or adjacent townsites. The presence of saltwater crocodiles and other potentially dangerous fauna generally makes these waters unsuitable for such activities.

5.7.6. 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 5.32). The Blacktip Gas Field consists of an unmanned wellhead platform (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 12 km northeast of Beehive-1 and is overlapped by the impacts EMBA. Vessels servicing the Blacktip WHP and GEP may occasionally pass through the impacts EMBA.

There are numerous exploration and production permits and leases throughout the WA, NT and Commonwealth waters within the spill EMBA, and these are described in Section 5.6.6 of **Appendix 5**.

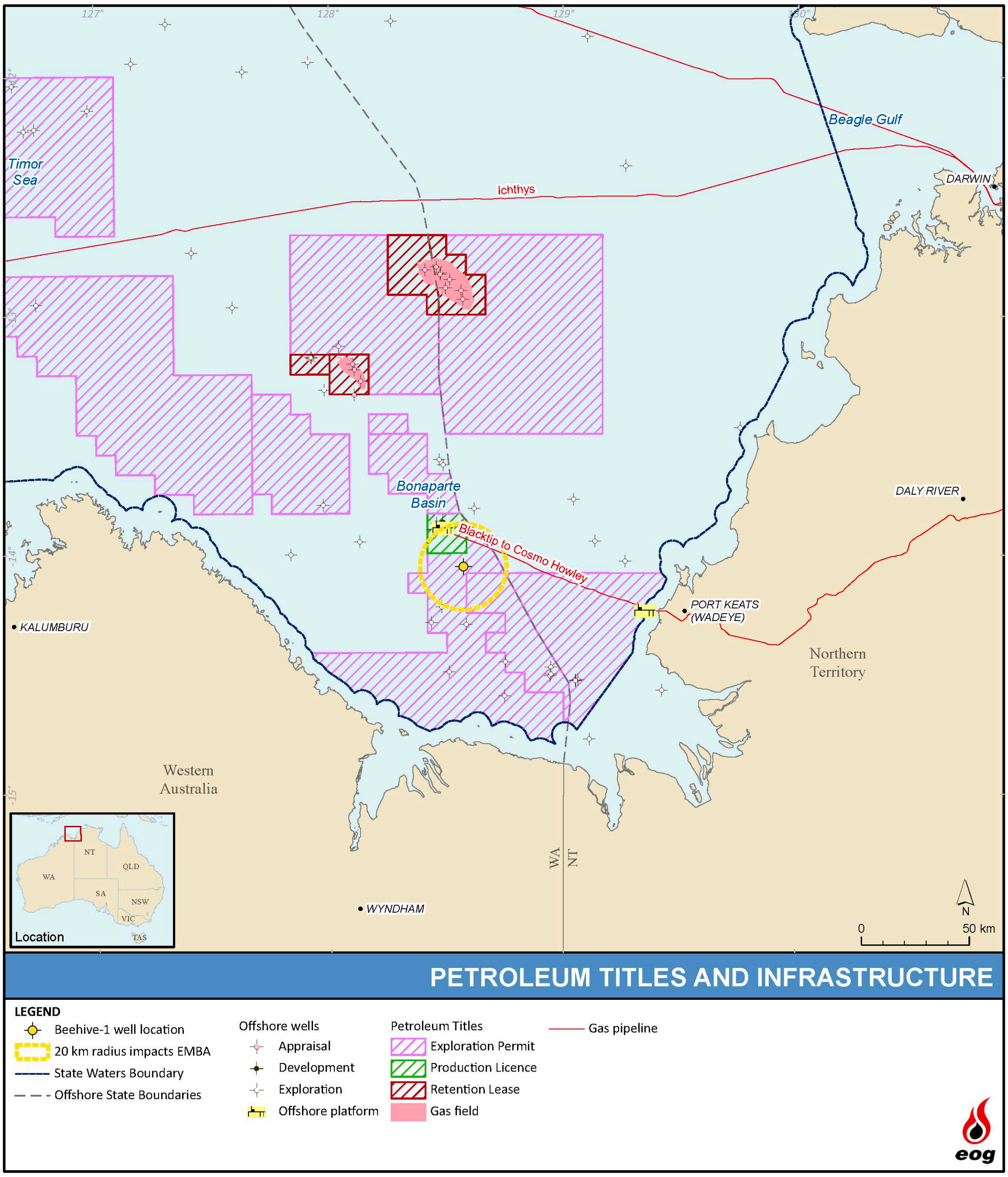


Figure 5.32. Petroleum activity in the impacts EMBA

5.7.7. Commercial Shipping

The closest major commercial shipping port is Darwin, located 280 km northeast of the impacts EMBA and 300 km northeast of Beehive-1. The location of the Darwin Port relative to Asia and the region's offshore oil and gas fields makes the surrounding area a key shipping region.

Very low levels of shipping traffic occur through the impacts EMBA. 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 and immediately around the impacts EMBA and that vessels in this area are mainly transiting and not lingering. An analysis of the shipping traffic for the 2021 calendar year recorded from the impacts EMBA (20-km radius around the drill site) is presented in Table 5.19. This shipping traffic is also illustrated in Figure 5.33, which shows that the impacts EMBA 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 area. The concentration of shipping activity in the northwest part of the impacts EMBA is associated with the Blacktip wellhead platform.

The highest volume of traffic is recorded in the months of June, July and August, with the latter months likely to occur outside the activity window.

Table 5.19. Commercial shipping traffic recorded in the impacts EMBA

Type	2021											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Undefined	-	-	-	-	4	4	-	1	-	-	-	-
Fishing	-	-	-	-	-	1	-	1	-	2	-	-
Other	-	-	-	-	-	-	1	1	1	-	-	-
Passenger ship	-	-	-	-	-	-	-	-	-	1	-	-
Pleasure craft	-	-	-	-	-	1	-	1	-	-	-	-
Port tender	-	-	-	-	-	-	2	1	1	-	-	1
Sailing	-	-	-	-	-	-	1	1	-	-	-	-
Tankers	-	1	-	-	-	-	-	-	-	-	-	1
Total	**0**	**1**	**0**	**0**	**4**	**6**	**4**	**6**	**2**	**3**	**0**	**2**

Activity window

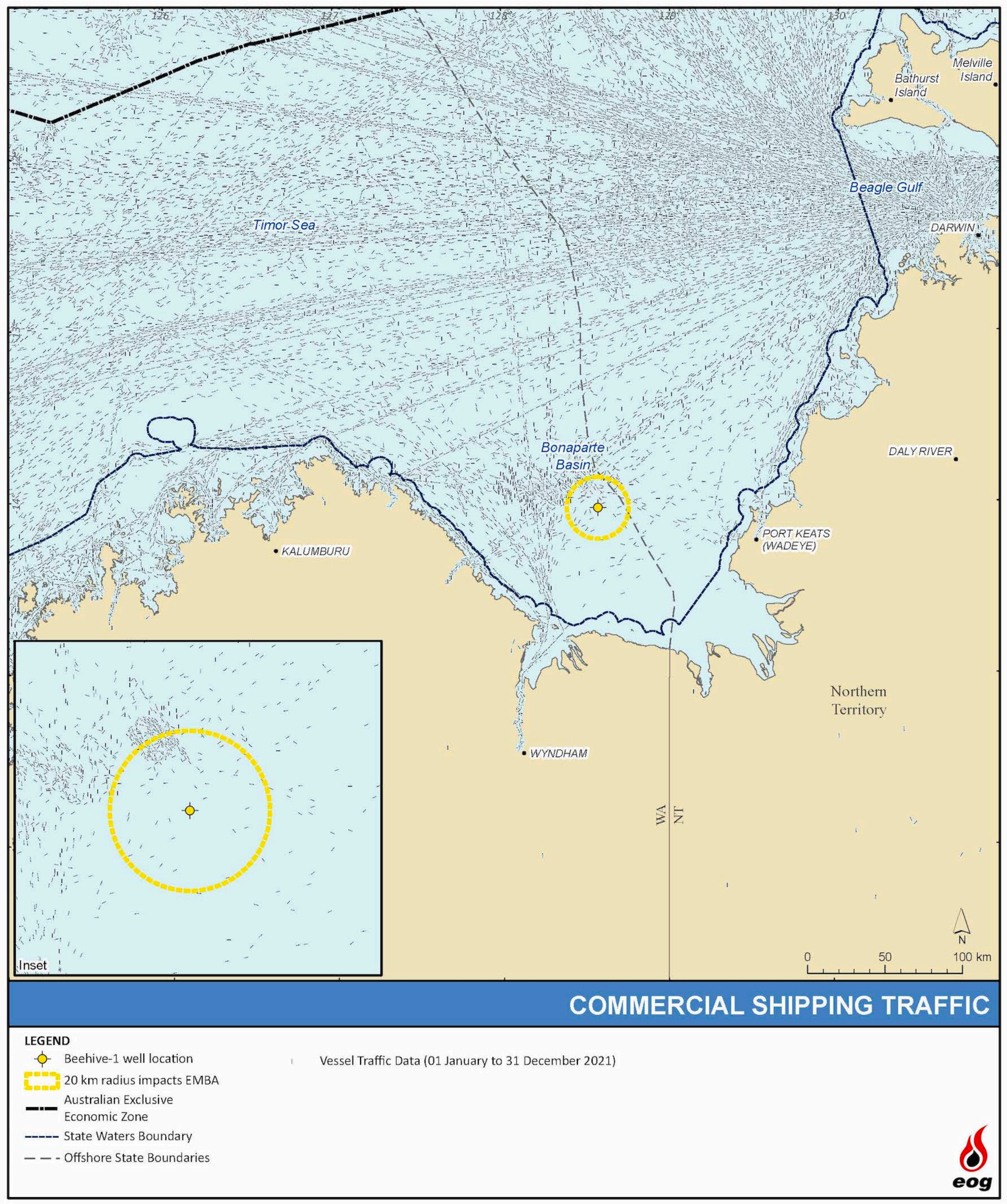


Figure 5.33. Commercial shipping traffic in the impacts EMBA

5.7.8. Defence Activities

The impacts EMBA is overlapped by a defence training area, which is a maritime military zone administered by the Australian Defence Force (Figure 5.34). This is an area where exercises such as operational flying 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 impacts EMBA.

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.

The DoD 'Where Is UXO' database indicates there is no potential for unexploded ordnance (UXO) to occur within the impacts EMBA (Figure 5.35). The DoD has advised EOG that beyond the data presented in this database, there are no records of specific UXO in the area.

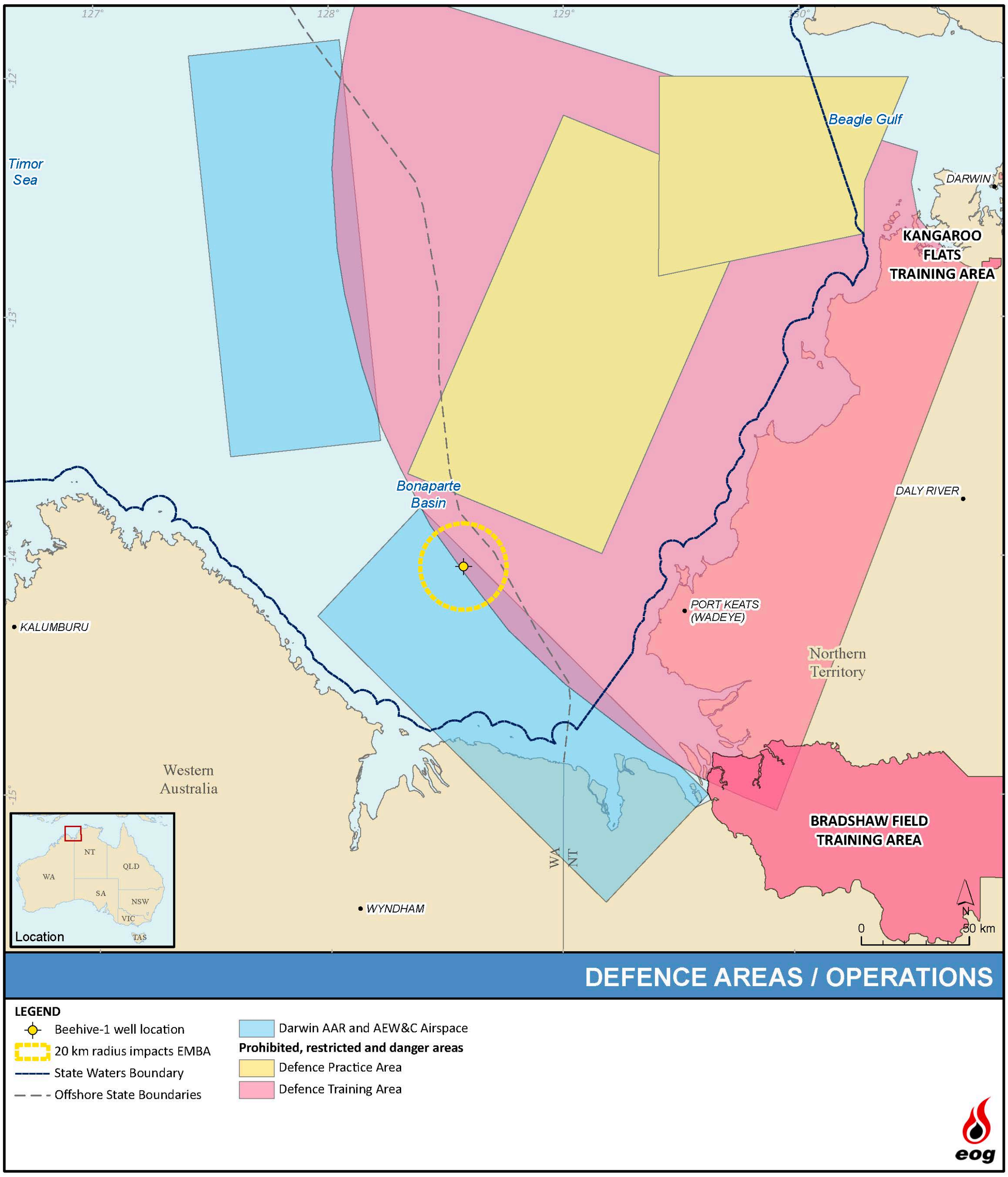


Figure 5.34. Defence areas overlapped by the impacts EMBA

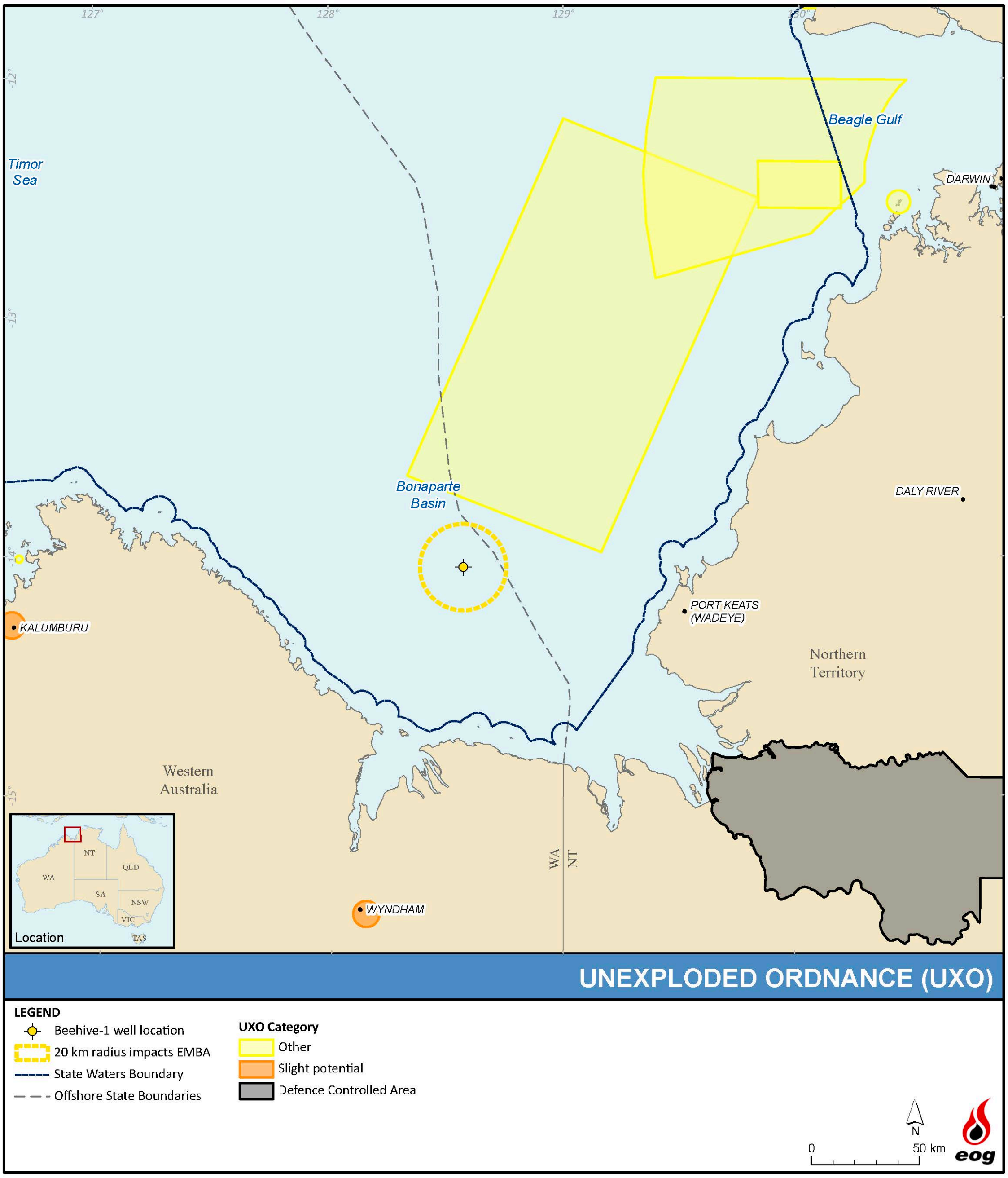


Figure 5.35. Unexploded ordnance risks near the impacts EMBA

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 and Appendix 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).

The key impacts and risks associated with the activity have been reviewed by EOG. 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.

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, drill cuttings will be generated and discharged overboard 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 a support 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

		Consequence				
		Beneficial	Negligible	Minor	Moderate	Severe
Likelihood	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
HIGH The risk is intolerable	• 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. • Repeat threat identification and risk evaluation processes to verify and, where possible, quantify the risk estimation; determine the accuracy and uncertainty of the estimation. • 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.
NEGLIGIBLE 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).

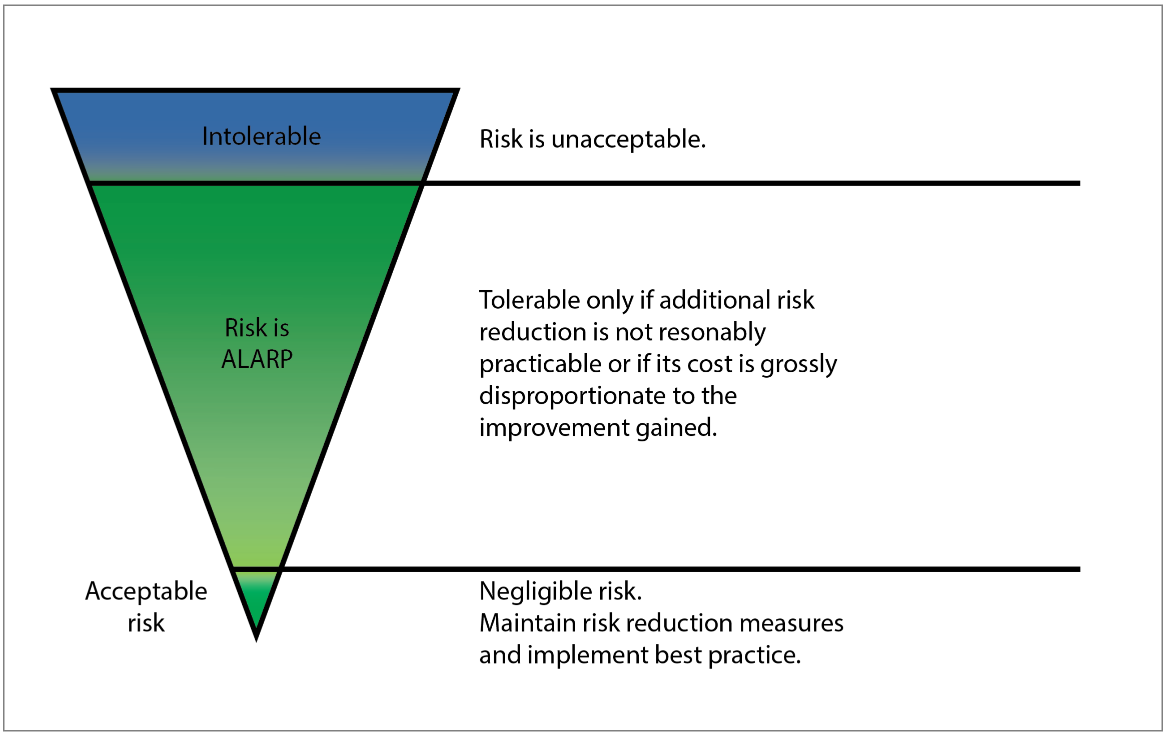
Each of these considerations is described in more detail in this section.

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 risk 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 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 Chapters 7 and 8 of this EP take into account the hierarchy of controls, in the order listed above.

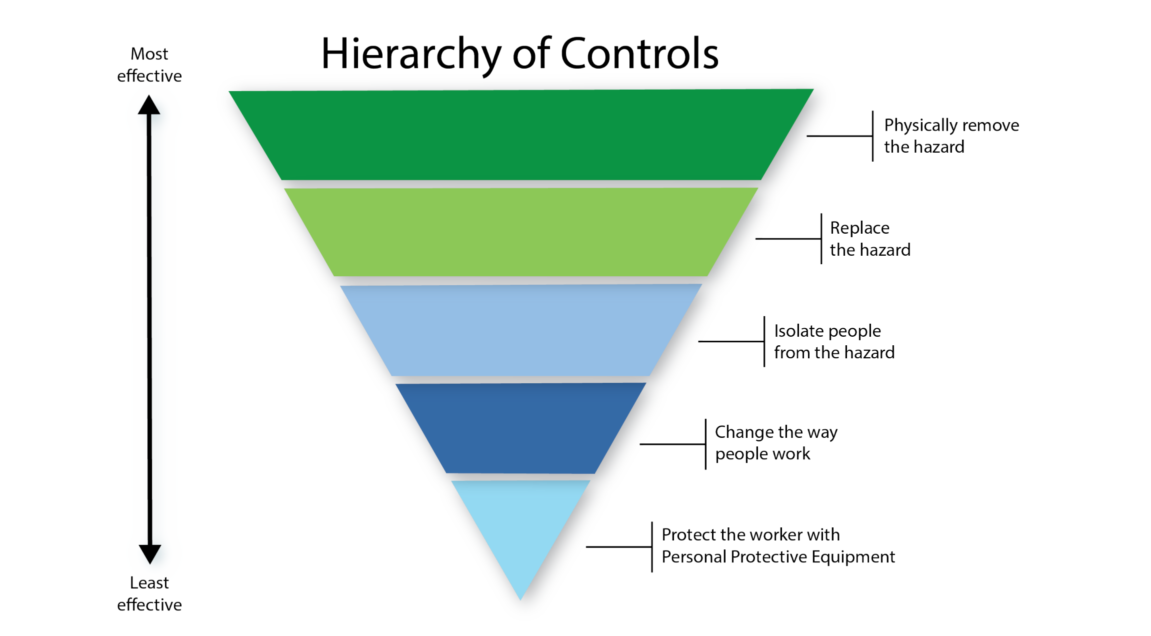


Figure 6.3. The Hierarchy of Controls

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 Chapters 7 and 8.

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: ○ Sensitivity of the receptor; ○ Current level of risk with the existing controls; ○ Amount of additional risk reduction that the control will deliver; ○ Level of confidence that the risk reduction impact will be achieved; and ○ 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', 'low' or 'medium' (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 '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.

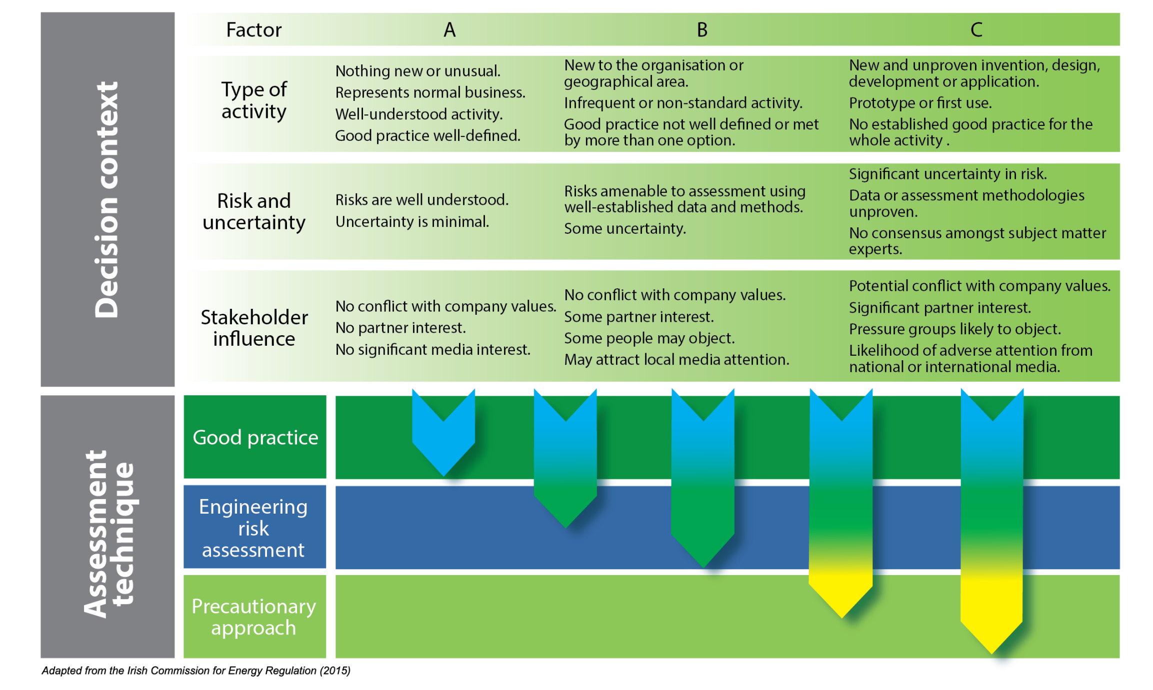


Figure 6.4. Impact and risk 'uncertainty' decision-making framework

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 Chapters 7 and 8.

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 9).

7. Environmental Impact Assessment – Planned Activities

This chapter presents the environmental impact assessment (EIA) for the environmental impacts 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 impact. 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 summary

Identifier	Hazard	Inherent	Residual
Impacts			
1	Physical presence - seabed disturbance	Negligible	Negligible
2	Physical presence - displacement of other marine users	Negligible	Negligible
3	Routine emissions - light	Negligible	Negligible
4	Routine emissions - atmospheric	Negligible	Negligible
5	Routine emissions - noise		
	- Plankton	Negligible	Negligible
	- Crustaceans (i.e., prawns)	Negligible	Negligible
	- Fish (with and without swim bladders)	Negligible	Negligible
	- Marine mammals	Negligible	Negligible
	- Marine reptiles (i.e., turtles)	Negligible	Negligible
	- Avifauna	Negligible	Negligible
6	Routine discharges - drill cuttings and muds	Negligible	Negligible
7	Routine discharges - cement	Negligible	Negligible
8	Routine discharges - putrescible waste	Negligible	Negligible
9	Routine discharges - sewage and grey water	Negligible	Negligible
10	Routine discharges - cooling and brine water	Negligible	Negligible
11	Routine discharges - bilge water and deck drainage	Negligible	Negligible

The following sections assess environmental impacts (arising from planned events, being events that do or will happen), as listed in Table 7.1 and presented pictorially in Figure 7.1.

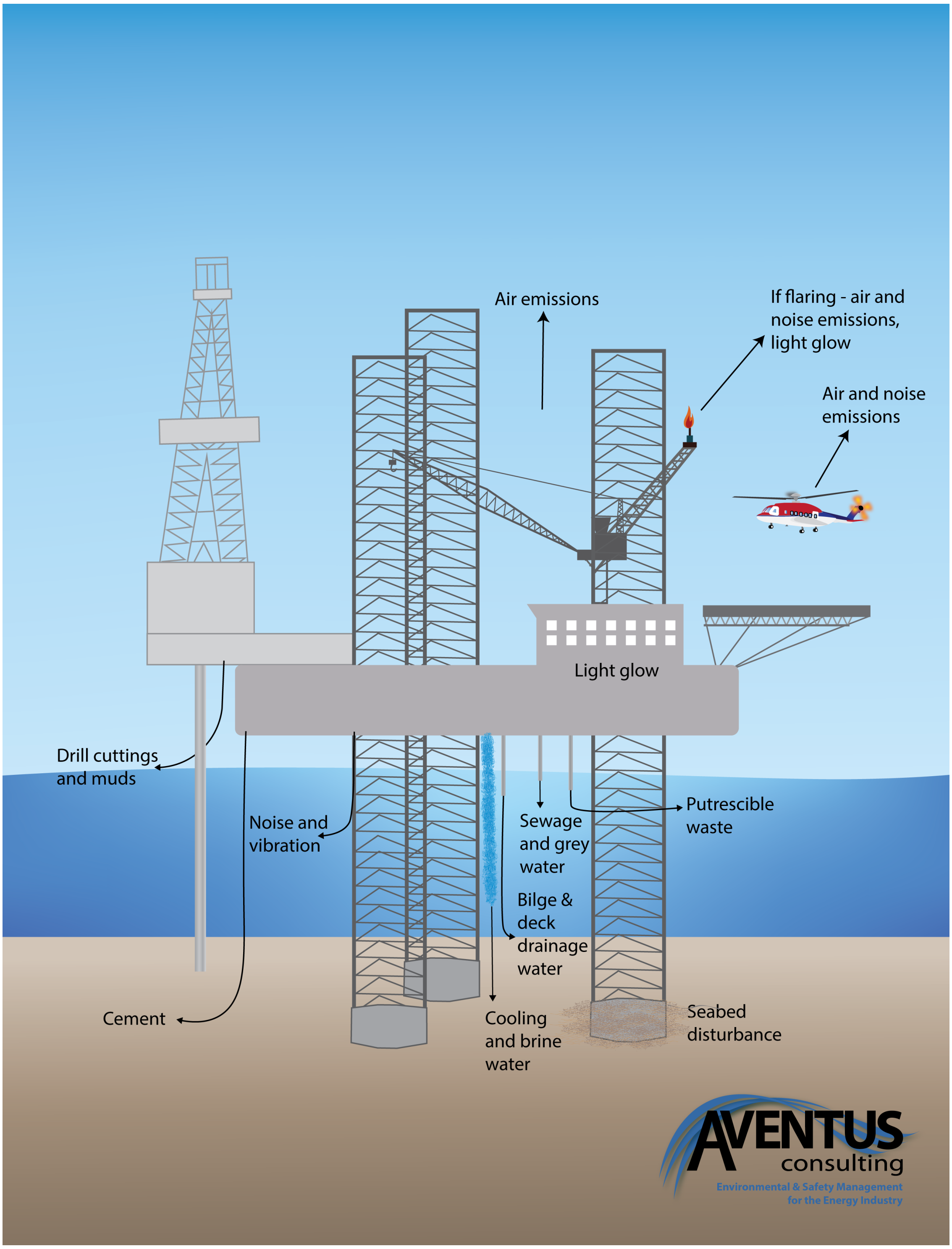


Figure 7.1. Simplified pictorial representation of impacts arising from the planned activities during Beehive-1 drilling

7.1. IMPACT 1 – Physical Presence - Seabed Disturbance

7.1.1. Hazard

The following elements of the activity will result in seabed disturbance:

- MODU positioning – pinning of the jack-up MODU's legs to the seabed, with the spud cans penetrating the seabed sediments to a depth of about 16 m (based on previous drilling at the nearby Blacktip field).
- Drilling – the drilling activity will result in the generation of drill cuttings and discharge of cement, which will be deposited either directly at the seabed or settle to the seabed when discharged at the sea surface. Seabed disturbance resulting from the discharge of drilling cuttings and cement is addressed in Section 7.6 and Section 7.7, respectively.
- Well P&A – a mudline suspension wellhead receptacle will be retained on the seabed at the completion of drilling. The wellhead receptacle, 36" (914 mm) surface hole and 30" (762 mm) conductor casing, will occupy an area of 0.66 m^2.
- Support vessel anchoring – the use of anchors.

7.1.2. Known and Potential Environmental Impacts

Seabed disturbance has the potential to impact on marine receptors because of:

- Physical removal or disturbance of seabed sediments; and
- Increase in turbidity of the water column near the seabed.

These impacts will result in localised and temporary disturbance, displacement or smothering of benthic habitats and fauna.

The area of benthic habitat that will be disturbed is limited to that occupied by the well itself (1 m^2), the three spud cans (with a diameter of 18 m each, each one occupies an area of 254 m^2) and the support vessel anchors (~5 m^3 each). This will result in a total of 769 m^2 of seabed disturbance, noting that the support vessels are highly unlikely to anchor in the same position each time, so this figure may be slightly higher.

There are no listed shipwrecks present within the impacts EMBA (see Section 5.6.2), therefore impacts to shipwrecks are not discussed further.

7.1.3. EMBA

The EMBA for seabed disturbance created by MODU positioning is likely to be restricted to tens of metres around each leg ('soft pinning' is usually only required when approaching a platform, and as such, furrows created in this process will not be created for this activity).

Receptors that are known to occur or may occur within this EMBA are:

- Benthic species; and
- Demersal fish species.

7.1.4. Evaluation of Environmental Impacts

Physical removal of seabed sediments

Within the activity area, there are no known sensitive seabed features (such as reef, sponge gardens, seagrass meadows or scallop beds), so MODU positioning will not result in a loss of sensitive or geographically restricted habitats.

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 spud cans and the well bore is extremely small and will not pose a threat to seabed habitats or fauna communities.

The area that will be disturbed is very small compared with the overall extent of the sandy seabed habitat in the region and consequently, there will be no long-term impacts to the diversity and abundance of benthic fauna, with impacts being extremely localised.

Water column turbidity

Turbidity may occur when seabed sediments are stirred up during the drilling process and during jack-up and jack-down of the MODU legs. Any turbidity created is likely to be within the limits of natural variability when considering the turbidity created by tides and storm events in the shallow waters of the activity area. This turbidity would limit light penetration into the water column but given its temporary nature, it 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.

Given the dominance of soft sediments (sand) in the activity area, 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.

Direct mortality of benthic fauna

Mortality of benthic fauna may result in areas that are directly disturbed, or disturbed a result of suspended sediments settling back onto the seabed. The area that will be disturbed is very small compared with the overall extent of the habitat in the region and consequently, there will be no long-term impacts to the diversity and abundance of benthic fauna populations, with impacts being extremely localised and temporary.

7.1.5. Impact Assessment

Table 7.2 presents the impact assessment for seabed disturbance.

Table 7.2. Impact assessment for seabed disturbance

Summary		
Summary of impacts	Removal/disturbance of seabed sediments. Turbidity of the water column at the seabed.	
Extent of impacts	Localised – around individual points of disturbance.	
Duration of impacts	Temporary – returning to pre-impact condition soon after impact.	
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 MODU positioning	

Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Seabed disturbance is kept to the minimum area necessary for safe operations **(IMP-01:EPS-01, -02, -03)**.	Elimination	Yes	**EB:** Reduces the footprint of seabed disturbance. **C:** No additional cost due to the nature of the activity. **Ev:** The environmental benefits outweigh the negligible costs.
No anchoring of support vessels.	Elimination	No	**EB:** Reduces the area of seabed disturbance. **C:** Cost of additional diesel fuel will be substantial (tens of thousands of dollars). **Ev:** The only other option to no anchoring is constantly running the support vessel engines, which results in unnecessary use of fuel and associated atmospheric emissions. The environmental benefits of not anchoring are outweighed by the savings in atmospheric emissions.
Avoid objects being dropped overboard **(IMP-01:EPS-04, -05, -06, -07)**.	Elimination	Yes	**EB:** Reduces the likelihood of seabed disturbance from dropped objects overboard. **C:** No additional cost due to the nature of the activity. **Ev:** The environmental benefits outweigh the negligible costs.
Large objects dropped overboard from the MODU will be retrieved wherever possible	Engineering	No	**EB:** The MODU will not have an inspection class ROV onboard – this is only standard on semi-submersible MODUs. Only an observation class ROV will be available. The retrieval of large objects from the seabed is therefore not possible. **C:** Significant cost (hundreds of thousands of dollars) involved in having an inspection class ROV onboard during the campaign. **Ev:** The environmental benefits are outweighed by the substantial costs.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Seabed disturbance is kept to the	**(IMP-01:EPS-01)** The MODU will be pinned directly on location and will not	The MODU positioning report confirms direct pinning occurred.

minimum area necessary for safe operations.	undergo a soft-pinning exercise, thereby preventing the creation of scour channels in the seabed.	
	(IMP-01:EPS-02) MODU-specific jack-up procedures are used to ensure compliance with stability criteria, reduce the risk of foundation shift or failure.	The MODU positioning report confirms MODU-specific jack-up procedures were used.
	(IMP-01:EPS-03) Vessel anchoring will only occur in locations deemed suitable from the results of the PDSA.	PDSA report identifies suitable seabed for anchoring (i.e., absence of sensitive seabed habitat such as rocky reef).
Avoid objects being dropped overboard.	**(IMP-01: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-01: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-01: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-01: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 MODU/vessel PMS.	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.
Large objects dropped overboard from the MODU will be reported.	**(IMP-01:EPS-08)** Large objects left behind at the end of the activity (that cannot be retrieved) will be reported internally and to NOPSEMA.	Incident report/s verify that the report was issued to NOPSEMA.

Impact Consequence (residual)
Negligible
The consequence of seabed disturbance is assessed as negligible because: • Impacts are extremely localised, thereby reducing temporary turbidity in water column; • Spud can depressions will collapse in on themselves and fill in quickly with sediments and recolonise with benthic fauna; and • There is an 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 9 describes the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual consequence is negligible, which is considered acceptable.	
External context	Relevant persons	There have been no objections or claims made by relevant persons regarding 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. • Reduce footprint (**IMP-01: EPS-01, -02**).
	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.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	Section 2.3.13 (marine operations and site assessment) of this guideline states that location-specific seabed assessments are undertaken to assure suitability of the equipment for the operating environment. Section 3.2.3.3 (foundation stability for jack-ups) also states that obtaining and analysing geotechnical data and information from seabed surveys should be undertaken. This will be achieved by conducting the G&G investigations and using the results to guide the placement of the MODU. Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	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 drilling operations: • To reduce the impacts to benthic communities to acceptable levels and to ALARP.

Environmental context	MNES	
	AMPs	This hazard will not impact the conservation values of nearby AMPs.
	Ramsar wetlands	This hazard will not impact any Ramsar wetlands.
	TECs	This hazard will not impact any TECs.
	Nationally threatened and migratory species	This hazard will not impact any threated or migratory species.
	Other matters	
	KEFs	This hazard will not impact any KEFs.
	NIWs	This hazard will not impact any NIWs.
	State marine parks	This hazard 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 and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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

- MODU positioning report
- Daily reports.
- PTWs.
- Equipment pre-deployment inspection checklist.
- Handling and transfer procedure.
- Completed handling and transfer checklists.
- PMS records and Lifting Register
- Load ratings and load test certificates.
- PMS records.
- Training records.
- Crane/A-frame operator qualification and training records.
- Incident reports.
- Operations reports.

7.2. IMPACT 2 – Physical Presence - Displacement of Other Marine Users

7.2.1. Hazard

The physical presence of the MODU and support vessels undertaking the activity necessitates the temporary displacement of other marine users from around the MODU for the safety of other marine users and the MODU crew. 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 8.4.

7.2.2. 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.

7.2.3. EMBA

Other marine users will be excluded from operating within a 500-m radius of the MODU (in line with the PSZ and Notice to Mariners) so as to avoid potential damage to the MODU.

Receptors in the EMBA may include:

- Commercial fishing vessels; and
- Merchant shipping vessels.

7.2.4. Evaluation of Environmental Impacts

Merchant Shipping

As illustrated in Figure 5.49 and detailed in Table 5.17, the activity area and the immediate surrounds has recorded 35 vessel trips (tankers, cargo chips, fishing vessels, etc) over a 12-month period 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 5.49).

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 MODU undertaking drilling activities will have a negligible consequence.

Fisheries

The primary fishery with recent fishing history in the activity area is the NPF. Historically, the activity timing (first few months of the year) would fall within the banana prawn fishing season. However, under an agreement between AFMA and the NPFI, the JBG will be closed to prawn fishing for the first fishing season, from 1st April to 15th June (until 2026). Thus, the activity will be undertaken at a time when the activity area is not open for fishing, thereby eliminating the potential for displacement with license holders of this fishery.

The WA-managed NDSF and MMF may operate within the activity area. Given the short duration of the activity, the small area of potential displacement and the low volume of catch recorded from the activity area, the consequence of temporary displacement to these fisheries will have a negligible consequence.

7.2.5. Impact Assessment

Table 7.3 presents the impact assessment for displacement with other marine users.

Table 7.3. Impact assessment for displacement of other marine users

Summary		
Summary of impacts	Presence of the MODU and support vessels 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.	
Extent of impacts	Highly localised – 500 m around MODU.	
Duration of impacts	Short-term – minutes for a third-party vessel detour.	
Level of certainty of impacts	HIGH – the impacts associated with displacement of other marine users is 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 & 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	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.	

Impact Consequence (inherent)	
Receptor	Consequence
Merchant shipping	Negligible
Commercial fisheries	Negligible

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Do not conduct the activity in waters available to fisheries.	Eliminate	No	**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.
Reduce the exclusion zone (PSZ) to the smallest area possible for safe operations **(IMP-02: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 minimum safe distance from the MODU. **C:** No cost to gazette the PSZ. **Ev:** Reducing the extent of displacement to the smallest area possible for safe operations outweighs the cost.
Conduct the activity during the NPF JBG closure period (1st April to 15th June) **(IMP-02:EPS-02)**.	Eliminate	Yes	**EB:** Eliminates the potential for displacement of NPF fishers by conducting the activity only when JBG waters are closed to prawn fishing. **C:** No additional cost. **Ev:** Reducing the impact of displacement by conducting the activity at a time when a major stakeholder will not be present outweighs the cost.
Communicate the required area of displacement for the duration of the activity. **(IMP-02:EPS-03, -04)**.	Administrative	Yes	**EB:** Informed stakeholders allows 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-02:EPS-01)** The exclusion zone is limited to a 500-m radius around the MODU, as gazetted through the PSZ.	The PSZ is gazetted by NOPSEMA and available on its website.
	(IMP-02:EPS-02) The activity is conducted during the JBG closure period for the NPF (1st April to 15th June).	DDRs confirm the activity is conducted during the period 1st December to 1st August.
	(IMP-02:EPS-03) 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-02:EPS-04) EOG provides pre-activity notification to the AHO at least three weeks prior to activity commencement to enable the promulgation of the NTM.	NTM is issued prior to the commencement of the activity and includes activity MODU/vessel details, location and timing.
Impact Consequence (residual)		

<table>
<tr><th colspan="2">Receptor</th><th colspan="2">Consequence</th></tr>
<tr><td colspan="2">Merchant shipping</td><td colspan="2">Negligible</td></tr>
<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;
• The activity will be conducted during the NPF JBG closure period; 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 9 describes 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>External context</td><td>Relevant persons</td><td colspan="2">No concerns regarding displacement of third-party marine users have been raised with EOG.</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 (IMP-02:EPS-01).
• Issue a ‘Notice to Mariners’ through the relevant government agencies, detailing the area of operations (IMP-02:EPS-04).</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.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	There is no specific guidance regarding displacement of other marine users. Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.
	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.
	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives for offshore drilling operations: • To reduce disturbance to fishing operations or other marine users to ALARP and to an acceptable level. • To reduce the risk of collision with other vessels in accordance with maritime standards.
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 and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) 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 from the support vessels.	
Record Keeping	
• Consultation records. • NTM.	• Operational reports. • Incident reports.

7.3. IMPACT 3 – Routine Emissions – Light

7.3.1. Hazard

Light emissions will occur from the MODU and support vessels due to:

- Vessel navigation lighting will be maintained while vessels are on location for maritime safety purposes;
- MODU deck lighting will be maintained for the safety of personnel working on deck;
- Flaring from the MODU (if DST is undertaken); and
- Underwater light from ROV activities.

7.3.2. 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.

7.3.3. 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).

Based on a MODU deck height of 20 m above the sea, the MODU (and therefore light) would be visible from 16 km away (calculated based on average human height, not birds in the air or turtles at the sea surface). For vessels, this distance would be slightly less. Although there are no bird BIAs or turtle nesting beaches within 20 km of the drilling location, the 20-km radius light EMBA has been adopted as a very conservative EMBA for light emissions in line with DoEE (2020).

Light-sensitive receptors that occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Turtles;
- Pelagic fish; and
- Seabirds.

7.3.4. Evaluation of environmental impacts

The lighting levels associated with the MODU and support vessels are not considered to be significantly different from other commercial shipping activity in the impacts EMBA (see vessel types in Section 5.7.7), 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 operational area is located 80 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 MODU and support 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 operational area and its long distance from shorelines means that the impact of lighting on hatchling dispersal will be negligible (e.g., the nearest nesting beaches are at Cape Domett for green turtles, 87 km to the south of the operational area).

The light EMBA overlaps the following turtle BIAs (Figure 7.2):

- Green turtle – foraging;
- Flatback turtle – inter-nesting; 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 7.4.

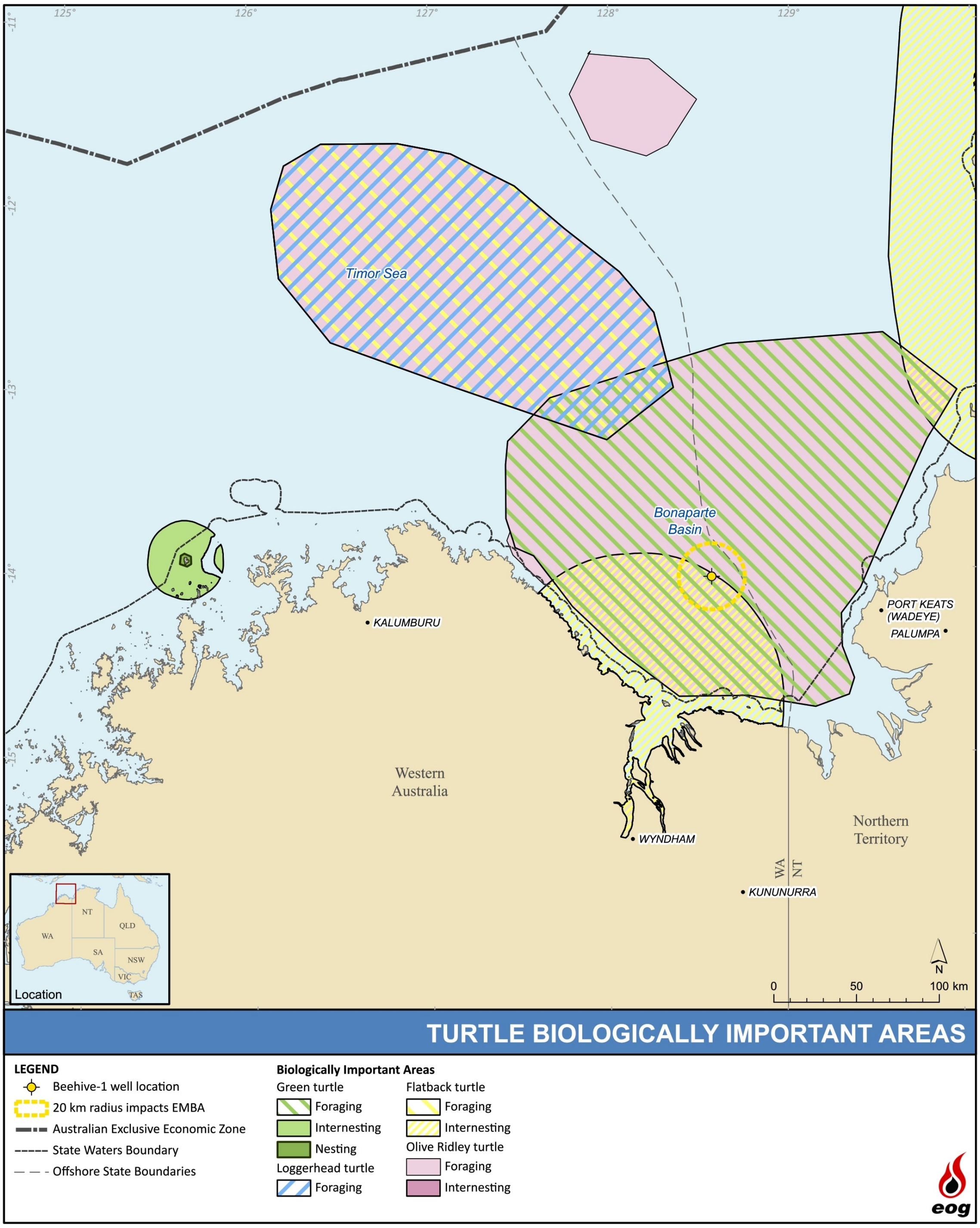


Figure 7.2. Turtle BIAs in the light EMBA

Table 7.4. 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 7.7 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.
Target 3.2: Threat mitigation strategies are supported by high quality information.	The activity will not have any impacts on this recovery target.

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 MODU and support vessels 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 MODU and support vessels, 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 7.3). 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

Management of the JBG AMP is covered by the North Marine Parks Network Management Plan 2018 (DNP, 2018). This plan identifies light emissions associated with habitat modification and marine pollution as a pressure on the AMP network. The light EMBA does not intersect any AMPs (it is located 16 km from the boundary of the JBG AMP) or other marine protected areas (see Figure 7.3).

Community

The distance of the closest point of the operational area from the nearest shoreline (80 km) and nearest town (Wadeye, 83 km) means that MODU and support vessel lighting in the activity area will not be visible from land. Visual impacts to these communities from lighting will not occur.

National Light Pollution Guidelines for Wildlife

Table 7.5 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 7.7).

Table 7.6 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 7.7).

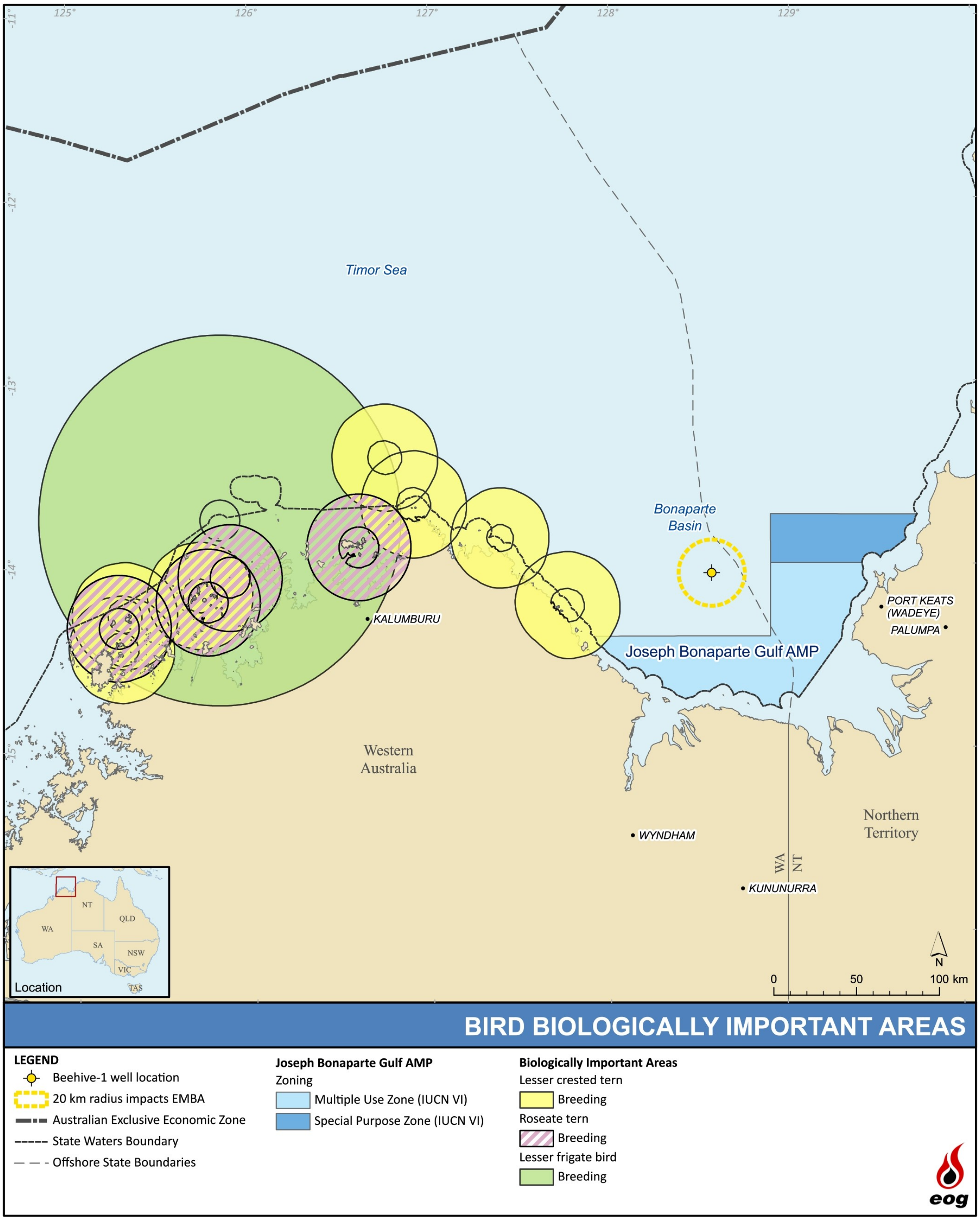


Figure 7.3. Seabird BIAs closest to the light EMBA

Table 7.5. 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 7.7 (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 80 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	Drilling 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 7.7).
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 7.7).
Use flashing/intermittent lights instead of fixed beam.	No	Drilling 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 7.7).
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 7.7).
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 7.7)
Night fishing should only occur with minimum deck lighting.	N/A	Not applicable - fishing is not permitted from the MODU or support 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 MODU or support vessel.
Ensure lighting enables recording of any incidental catch, including by electronic monitoring systems.	N/A	Not applicable - fishing is not permitted from the MODU or support vessel.
Avoid shining light directly onto longlines and/or illuminating baits in the water.	N/A	Not applicable - fishing is not permitted from the MODU or support 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 MODU and support vessels are 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 themselves to other vessels, reduce the risk of at-sea collision and provide for the safety of crews. Most seabirds in the region are migratory, with no breeding areas (i.e., islands) within 80 km of the activity area. See Table 7.7 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.	No	The activity may involve flaring, but the flare is not able to be shielded. Beehive-1 is located a long distance from seabird rookeries, so this management option is not required.
Minimise flaring on offshore oil and gas production facilities.	Yes	The activity may involve flaring, and this will be kept to the shortest time practicable.
In facilities requiring intermittent night-time inspections, turn on lights only during the time operators are moving around the facility.	N/A	The MODU and support vessels are equipped with lighting required under legislation to identify themselves to other vessels, reduce the risk of at-sea collision and provide for the safety of crews.
Ensure industrial site/plant operators use head torches.	No	Drilling 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 7.7 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 operational area and seabird rookeries, grounding of birds is unlikely to occur and thus a rescue program is not necessary.

Table 7.6. 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 7.7 (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 80 km away on the southern coast of the JBG. As such, the MODU and support 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 80 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	Drilling 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 7.7).
Use curfews to manage lighting.	No	Drilling 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 7.7).
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 7.7).
Use flashing/intermittent lights instead of fixed beam.	No	Drilling 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 7.7).
Use motion sensors to turn on lights only when needed.	No	Drilling 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 7.7).
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 7.7).

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 7.7 (adopted control measures and associated EPS).
Reduce unnecessary lighting at sea.	Yes	Achievable management actions are identified in this table and in Table 7.7 (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 MODU or support vessels.
Avoid lights containing short wavelength violet/blue light.	No	The MODU and support vessels are equipped with lighting required under legislation to identify themselves 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 80 km of the activity area. See Table 7.7 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.	No	The activity may involve flaring, but the flare is not able to be shielded. Beehive-1 is located a long distance from seabird rookeries, so this management option is not required.
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	Drilling 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 7.7).
Industrial site/plant operators to use head torches.	No	Drilling 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

Management option	Achievable?	Justification
		as is practicable and in accordance with maritime requirements and personnel safety. See Table 7.7 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 80 km away on the southern coast of the JBG. As such, the MODU and support 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 80 km away on the southern coast of the JBG. As such, the MODU and support vessel lighting will not be visible from the beach.

7.3.5. Impact Assessment

Table 7.7 presents the impact assessment for light emissions.

Table 7.7. Impact assessment for light emissions

Summary			
Summary of impacts	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).		
Extent of impacts	Localised for most marine fauna, and up to 15 km for turtle hatchlings and 20 km for seabirds.		
Duration of impacts	Temporary – short-term (duration of activity).		
Level of certainty of impacts	HIGH – the impacts of light glow 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	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.		
Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Exclude night-time operations.	Eliminate	No	**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. The high costs associated with extending the activity are grossly disproportionate to the benefits. Lighting is required by law for navigational and safety purposes.
Do not flare.	Eliminate	No	**EB:** Eliminates impact of artificial light on sensitive species (e.g., seabirds and turtles). **C:** in a success case, not being able to test the well using DST (which involves flaring) compromises the objectives of the drilling

			program and would it make it extremely difficult to predict future steps. **Ev:** The high costs associated with not being able to evaluate the well sufficiently are grossly disproportionate to the benefits of temporary additional light.
Keep MODU and support vessel external lighting to levels required for navigation, and safety of deck operations **(IMP-03:EPS-01)**.	Engineering	Yes	**EB:** This keeps light to the minimum required to meet legislated navigation requirements whilst reducing the likelihood of impacts to fauna from MODU and support vessel lighting. **C:** No additional activity costs. MODU and support 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 MODUs and vessels. 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.
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 lighting to working areas only on the MODU and support vessels **(IMP-03:EPS-02)**.	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	Administrative	Yes	**EB:** Provides mechanism to inspect the implementation of control measures and their associated environmental benefits.

with lighting standards **(IMP-03:EPS-03)**.			**C:** Cost of time only. **Ev:** Good practice and well established in the industry. Environmental benefits can be achieved with minimal cost.
Lower blinds on non-essential portholes and windows at night **(IMP-03:EPS-04)**.	Administrative	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.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
External lighting conforms to that required by maritime safety standards.	**(IMP-03:EPS-01)** External 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-03:EPS-02)** 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-03:EPS-03) Lighting is periodically inspected to ensure it complies with lighting standards and relevant control measures.	
	(IMP-03:EPS-04) Blinds will be lowered on all non-essential portholes and windows at night.	Completed environmental checklists and photos verify that blinds are drawn each night.
	(IMP-03:EPS-05) Well flaring is limited to the minimum time required to safety undertake the DST.	DDRs record the duration of flaring.
	(IMP-03:EPS-06) All crew are informed of the artificial lighting control measures during the environmental awareness induction.	Induction presentation includes requirements to minimise artificial lighting.
		Induction attendance list verify crew are aware of these measures.

Impact Consequence (residual)
Negligible

The consequence of light emissions is assessed as negligible because:

- The activity is short-term;
- 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.

<table>
<tr><th colspan="3">Statement of ALARP</th></tr>
<tr><td colspan="3">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="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 9 describes 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>External context</td><td>Relevant persons</td><td>There have been no objections or claims made by relevant persons regarding light emissions.</td></tr>
<tr><td>Legislative context</td><td colspan="2">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).</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 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 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-03:EPS-02, -03, -04).</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 lighting for offshore activities.</td></tr>
<tr><td>Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)</td><td>There is no specific guidance regarding lighting emissions.
Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.</td></tr>
<tr><td>Environmental, Health and Safety Guidelines for Offshore Oil and Gas</td><td>The EPS listed in this table are in accordance with these guidelines with regard to:</td></tr>
</table>

	Development (World Bank Group, 2015)	• 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-03:EPS-01)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore drilling operations: • To reduce the impact of light to ALARP and an acceptable level. • To reduce the risk of collision with other vessels in accordance with maritime standards and to an acceptable level.
	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 MODU and support vessels: • Maintain a dark zone between the rookery and the light sources. • Aim lights downwards and direct them away from nesting areas **(IMP-03:EPS-02)**. • Prevent indoor light reaching outdoor environment **(IMP-03:EPS-04)**. • Reduce unnecessary outdoor, deck lighting on all vessels in known seabird foraging areas at sea **(IMP-03:EPS-02)**. An assessment of the activity against the management actions of these guidelines is included in Table 7.5 for seabirds and Table 7.6 for turtles.
Environmental context	MNES	
	AMPs	This hazard will not reach any AMPs.
	Ramsar wetlands	This hazard will not reach any Ramsar wetlands.
	TECs	This hazard 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	This hazard will not reach any KEFs.
	NIWs	This hazard will not reach any NIWs.
	State marine parks	This hazard will not reach any state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Table 7.6 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 and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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	
• Periodic lighting inspections.	
Record Keeping	
• Vessel class certification. • Completed environmental inspections checklists. • Photos.	• Induction presentation. • Induction attendance sheet.

7.4. IMPACT 4 – Routine Emissions – Atmospheric

7.4.1. Hazard

The use of fuel to power the MODU and support vessels 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 from the MODU and support vessels:

- Combustion of MDO from engines, generators, cranes and other fixed and mobile equipment;
- Flaring;
- Painting and paint storage, resulting in the release of fugitive volatile organic compounds (VOCs) as vapours;
- Release of ozone-depleting substances (ODS) from refrigerants (R134a, R407C and R410A) used in the centralised air-conditioning system during maintenance activities; and
- 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.

Atmospheric emissions from fuel combustion from the helicopter will also be generated, but are considered negligible given the jurisdiction for the helicopter is a 500-m radius from the MODU.

For a drilling campaign undertaken in Bass Strait using a jack-up MODU in late 2019 and early 2020, the average daily diesel consumption was 14,500 litres. This would result in the generation of about 39 tonnes of carbon dioxide equivalent (CO_2-e) per day (equivalent to the emissions from 10 average Australian vehicles driven an average number of kilometres for a year). From the MODU, combustion emissions will be expelled from exhaust stacks about 22-25 m above deck level to ensure adequate aerial dispersion.

During the same drilling campaign, the two support vessels consumed an average of 6,400 litres of diesel per day. This would result in the generation of about 17 tonnes of CO_2-e each day (equivalent to the emissions from 4 average Australian vehicles driven an average number of kilometres for a year).

7.4.2. 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).

7.4.3. EMBA

The EMBA for atmospheric emissions associated is the local air shed, likely to be within hundreds of meters of the MODU and support vessels, both horizontally and vertically.

Sensitive receptors that may occur within this EMBA, either as residents or migrants, are seabirds. The health of the workforce on the MODU and support vessels, with regard to atmospheric emissions, is considered and assessed in other health and safety project documents.

7.4.4. 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 MODU and support vessels.

Particulate matter released from the MODU and support 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 MODU and support 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 MODU and support vessels. The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Air emissions will be similar to other MODUs and vessels operating in the region for both petroleum and non-petroleum activities.

7.4.5. Impact Assessment

Table 7.8 presents the impact assessment for atmospheric emissions.

Table 7.8. Impact assessment from atmospheric emissions

Summary		
Summary of Impacts	Decrease in air quality due to gaseous emissions and particulates from MDO combustion and contribution to the incremental build-up of GHG in the atmosphere (influencing climate change).	
Extent of 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 MODU or support 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:** MODU and support vessels are 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-04: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 MODU and support vessel contract costs. This is a legislative requirement. **Ev:** Environmental benefits can be achieved with little additional cost.
Implementation of a PMS for combustion equipment **(IMP-04:EPS-02)**.	Engineering	Yes	**EB:** Reduces the volume of emissions through improved equipment efficiency. **C:** Negligible; maintenance is part of routine MODU and support vessel operations. **Ev:** Benefits of ensuring efficient MODU and support vessel combustion processes outweigh the negligible costs.
IAPP certification **(IMP-04:EPS-03)**.	Engineering	Yes	**EB:** Reduces the volume of emissions. **C:** Negligible; certification and re-certification costs are factored into routine MODU and support vessel operations. **Ev:** Benefits of ensuring MODU and support vessels comply with emissions reduction standards outweighs the negligible cost.
SEEMP **(IMP-04:EPS-04)**.	Engineering	Yes	**EB:** Improved energy efficiency reduces the volume of emissions. **C:** Negligible; certification and re-certification costs are factored into routine MODU and support vessel operations. **Ev:** Benefits of ensuring MODU and support vessels comply with emissions reduction standards outweighs the negligible cost.
ODS procedure **(IMP-04: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 MODU and vessel operations. **Ev:** Benefits of ensuring MODU and support vessels comply with ODS reduction standards outweighs the negligible cost.
Waste incineration managed in accordance MARPOL and Marine Orders **(IMP-04: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 MODU and support vessel operations. **Ev:** Benefits of ensuring MODU and support vessels comply with MARPOL requirements outweighs the negligible cost.

Support vessels have the option to anchor rather than burning fuel to remain on station **(IMP-04:EPS-09)**.	Engineering	Yes	**EB:** Reduced fuel consumption results in fewer emissions to air. **C:** None. **Ev:** Benefits of allowing the support vessels to anchor in an area of seabed free of seabed sensitivities saves considerable fuel and therefore minimises emissions to air.
Use a high-efficiency well effluent burner head **(IMP-04:EPS-10)**.	Engineering	Yes	**EB:** Maximises combustion through proper atomisation of oil droplets, which eliminates or significantly reduces smoke and oil fallout. **C:** High-efficiency well effluent burners are an industry standard, so there is little additional cost in specifying this type of burner. **Ev:** Good practice and well established in the industry. Environmental benefits can be achieved with minimal additional cost.
Monitor fuel use **(IMP-04:EPS-12)**.	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 MODU and 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 Ships) requirements.	**(IMP-04: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-04:EPS-02) All combustion equipment is maintained in accordance with the PMS (or equivalent).	PMS records verify that combustion equipment is maintained to schedule.
	(IMP-04: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-04: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-04: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-04: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-04:EPS-07) Incineration is only conducted when the MODU and support vessels are >12 nm from the shore.	Incineration records include geographic coordinates to verify incineration took place >12 nm of the shore.
	(IMP-04: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.
Support vessels anchor in preference to burning fuel to remain on station.	**(IMP-04:EPS-09)** Anchoring occurs in preference to burning fuel when the vessels are required to maintain station.	DDRs note when the support vessels are on anchor.
The duration of and emissions from flaring are kept to ALARP.	**(IMP-04:EPS-10)** A high-efficiency well effluent burner head is used during flaring.	DDR verifies the use of a high-efficiency well effluent burner head for flaring.
	(IMP-04:EPS-11) Well flaring is limited to the minimum time required to safety undertake the DST.	DDRs record the duration of flaring.
Fuel use will be measured, recorded and reported.	**(IMP-04:EPS-12)** 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 DDRs.

Impact Consequence (residual)

Negligible

The consequence of atmospheric emissions is assessed as negligible because:

- The activity is of a temporary nature;
- The activity is located far offshore 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.

<table>
<tr><td>EMS compliance</td><td colspan="2">Chapter 9 describes 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>External context</td><td>Relevant persons</td><td>There have been no objections or claims from relevant person regarding air emissions.</td></tr>
<tr><td>Legislative context</td><td colspan="2">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).</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 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-04: EPS-04).
  ○ Selection of low sulphur diesel (IMP-04: EPS-01).
  ○ Regular plant maintenance (IMP-04: EPS-02).
  ○ Regular maintenance and emission control devices on vehicles and machinery (IMP-04: EPS-02).</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>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 MODU and vessels.</td></tr>
<tr><td>Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)</td><td>No guidance provided regarding the management of atmospheric emissions.
Section 2.4.4 specifies that equipment used for monitoring discharges or emissions should be correctly calibrated and operated, and that sampling and analysis procedures are based on sound field practices.</td></tr>
</table>

	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-04: EPS-01)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore drilling operations: • To reduce the impact of air emissions to ALARP and an acceptable level. • To reduce GHG emissions to ALARP and an acceptable level (All **IMP-07 EPS**).
Environmental context	MNES	
	AMPs	This hazard will not directly affect nearby AMPs.
	Ramsar wetlands	This hazard will not directly affect any Ramsar wetlands.
	TECs	This hazard will not directly affect any TECs.
	Nationally threatened and migratory species	This hazard will not directly affect threated or migratory species.
	Other matters	
	KEFs	This hazard will not directly affect any KEFs.
	NIWs	This hazard will not directly affect any NIWs.
	State marine parks	This hazard will 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. The Draft Wildlife Conservation Plan for Seabirds (DoEE, 2019) lists climate variability and change as a threat, though none of the seabirds known to occur in the impacts EMBA are listed as being of high risk from exposure to climate change. The Wildlife Conservation Plan for Migratory Shorebirds (DoE, 2015) lists climate variability and change as a threat, though coastal habitat loss and habitat modification are the key threats.
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 and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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	
• PMS records. • Fuel use records. • Bunkering receipts. • Waste manifests (for incineration).	• ODS record books. • Oil record books. • Garbage record books. • Activity-specific discharges and emissions register.

7.5. IMPACT 5 – Routine Emissions – Underwater Sound

7.5.1. Hazard

The following activities will generate underwater sound:

- MODU operations – sound generated by engines, onboard machinery and drilling equipment (principally the mechanical operation of the drill string);
- Placement and installation of the MODU;
- Support vessel operations – engine noise transmitted through the hull, propeller cavitation or DP;
- Helicopter operations – movements within the PSZ;
- Flaring; and
- Acoustic downhole profiling operations – VSP.

7.5.2. Known and Potential Environmental Impacts

The effects of underwater sound 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.

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).

Drilling

Fixed platforms such as jack-up MODUs have lower radiated sound levels than floating platforms (NCE, 2007) because they do not use thrusters or propellers to maintain station. Equipment operating onboard these facilities can contribute to marine environment sound however, airborne and structure-borne (vibration) pathways are considered more significant on floating platforms where equipment can be located below the water line (NCE, 2007).

Underwater noise produced from platforms standing on metal jack-up supports is relatively low given the small surface areas available for sound transmission and also given the location of machinery above the waterline. It is therefore expected that the dominant pathway for sound generation is structure-borne (i.e., vibration from machinery passing through the legs) (NCE, 2007).

Support Vessels

There will be several support vessel trips per week between the MODU and the supply base, with one support vessel 'on station' close to the MODU at all times. The support vessels 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 sized vessel normally operating in the area (such as vessels supporting the nearby Blacktip operations).

The sound levels and frequency characteristics of underwater sound produced by vessels are related to vessel size and speed. When idle or moving at slow speed within the PSZ, vessels generally emit low-level noise. The typical sound levels generated by vessels are:

- Tugboats, crew boats, supply ships and many research vessels in the 50-100 m size class – 165-180 dB re 1µPa range (Gotz *et al*., 2009);
- Vessels up to 20 m size class – 151-156 dB re 1µPa (Richardson *et al*., 1995);
- Trawlers – peak at around 175 dB re 1µPa (Gotz *et al*., 2009); and
- Large ships – levels exceeding 190 dB re 1µPa (Gotz *et al*., 2009).

Noise from vessels acts to increase the sound in the water column above ambient noise levels. For example, noise emissions from idling vessels are low, however noise from thrusters and strong thrusts from the main engines have been recorded at levels of up to 182 dB re 1µPa at 1 m (McCauley, 1998). Under this mode of operation, McCauley (1998) measured underwater broadband noise of approximately 137 dB re 1µPa at 405 m. Levels of 120 dB re 1 µPa extended for a distance of approximately 3-5 km from the source, depending on water depth, seabed composition and other factors.

Under normal operating conditions when the vessel is idling or moving between sites, vessel noise would be detectable over only a short distance. For example, Woodside (2003) found that vessel noise levels rarely (<1% of the time) exceeded a threshold of 120 dB re 1 µPa (i.e., less than ambient underwater sound intensity in the 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.

Helicopters

There will be several return helicopter flights each week to transport personnel and equipment to the MODU during drilling operations (see Section 2.6.3).

Sound emitted from helicopter operations is typically below 500 Hz (Richardson *et al*., 1985). Sound travelling from a source in the air (e.g., helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface. The received sound level underwater depends on the altitude of the sound source and lateral distance from the receiver, receiver depth, water depth, and other variables.

The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles above 13° from the vertical much of the sound is reflected and does not penetrate into the water (Richardson et al., 1995; NRC, 2003). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver. This 'zone of ensonification' can be enlarged in rough seas and can also be enlarged in shallow waters (Richardson et al., 1995).

Most air traffic supporting offshore installations involves turbine helicopters flying along straight lines. Usually, a helicopter can be heard in air well before and after the brief period it passes overhead and is heard underwater. Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. The peak received level diminishes with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude. Richardson et al (1995) reports figures for a Bell 214 helicopter (considered to be one of the loudest) being audible in air for four minutes before it passed over underwater hydrophones but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth.

VSP

The VSP program for Beehive-1 includes the use of four airguns with a total sound source volume of 600 cui, performing acoustic pulses for a duration of 8 hours (see Section 2.7.4). VSP involves placing a number of receivers in the well bore and transmitting impulsive sound energy to them from a sound source hung over the MODU just below the sea surface. VSP uses highly directional sound energy that is focussed towards the seabed, but it also ensonifies the surrounding water column.

Each discharge of the sound source generates a short, discrete, low frequency sound impulse, which are much lower than those generated during large-scale 2D or 3D marine seismic surveys. The underwater sound generated by VSP is loudest directly under the source and rapidly decreases with distance from the source.

Based on VSP modelling undertaken by Jasco Applied Sciences (McPherson *et al.*, 2018) for the Gular-1 appraisal well undertaken in a water depth of 26 m for a 600 cui airgun array, it is expected that the sound source is expected to generate a peak sound pressure level (SPL) of 239 dB re 1 µPa pk @ 1 m and per-pulse sound exposure level (SEL) up to 215 dB re 1 µPa^2.s @ 1 m.

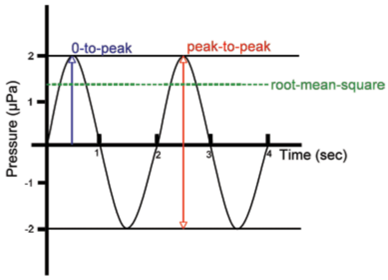
Modelling of VSP undertaken by Chevron Australia and reported in Chevron (2010) using 3 x 250 cui air guns at a source depth of 5 m recorded an amplitude spectrum peak of 190 dB re 1 µPa @ 1 m from the source. The results reported also demonstrated that the received source level did not exceed 160 dB re 1 µPa^2.s at a distance of 500 m from the source and 170 dB re 1 µPa^2.s at 100 m from the source.

Terminology

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. Table 7.9 defines the acoustic terms used throughout this section.

Table 7.9. 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 µPa^{2}m^2 (pressure level) or dB re 1 µPa^{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.

Term	Definition
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 µPa^2·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 in the PK graph. **Unit:** dB re 1 µPa. 
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.

Term	Definition
	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.
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).

Term	Definition
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).

7.5.3. EMBA

The EMBA for underwater sound is unlikely to be beyond several hundred metres at most from the sound source, dependent on the species and associated thresholds, as outlined in this chapter.

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);
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

The focus of this EIA is on EPBC-listed species that are sensitive to underwater sound, these being pelagic fish, marine mammals (whales) and marine reptiles (turtles).

7.5.4. Evaluation of Environmental Impacts

MODU noise

The MODU will generate noise from the operation of on-board machinery, including diesel engines, mud pump, ventilation fans (and associated exhaust) and electrical generators, and also (during drilling) from the drill string and bit. In general, fixed platforms such as jack-up MODUs transmit less noise underwater than a semi-submersible platform or a drill vessel due to the smaller surface area in contact with the water column.

Gales (1982) cited in NCE (2007), reports that underwater sound measured from platforms did not exhibit markedly different characteristics from those engaged in production, and that none of the measured sound could be directly related to the mechanical action of the drill bits. It is therefore believed that most sound associated with drilling is created by the operation of the MODU itself (and sound radiated through the MODU structure).

In the same study (Gales, 1982; cited in Richardson *et al.,* 1995) it was identified that platform noise was so weak that it was nearly undetectable even when alongside the platform during sea states ≥ 3. At the near-field measurement locations (ranges 9–61 m), the received sound levels were 119-127 dB re 1µPa (Richardson *et al.,* 1995).

Studies performed on the Spartan 151 jack-up MODU in Alaska's Cook Inlet in shallow waters (18-37 m water depth) verified the underwater acoustic levels as a function of range from the MODU (Marine Acoustics, 2011). Primary sources of MODU-based acoustic energy were identified as originating from the diesel engines, mud pump, ventilation fans and electrical generators. The study identified maximum sound levels were periodic (impulsive <1 second) with received levels at approximately 127 dB re 1µPa to a maximum range of 1.2–1.4km in the frequency range 8.9-44.7 Hz. Levels in the infrasonic band (i.e., frequencies <20 Hz) between 8.9–11.2 Hz and 11.2–14.1 Hz infrequently exceeded 120 dB re 1µPa at ranges less than 1.7 km and never more than 1 second at a time.

On this basis, emissions predominantly below 120 dB re 1µPa with non-continuous (less than 1 second) levels exceeding this to a range of approximately 1.4 km in the frequency band 8.9 Hz to 44.7 Hz (infrasonic and low frequency) as measured in that study is expected to be indicative of the low frequency sound levels emitted by the jack-up MODU during drilling activities.

In addition, an acoustic monitoring program commissioned by Santos conducted during an exploratory drilling program in 2003, indicated that the drilling operation was not audible between 8 and 28 km from the MODU (McCauley, 2004), with most sound above 120 dB SPL RMS confined within a 2 km to 4 km radius of the MODU.

Sound generation and frequency bands from the operation and drilling activities associated with the MODU would be expected to be similar to the sound levels described above. This sound level is lower than the recorded ambient sound in the activity area (that varies from a minimum of 148 dB re 1µPa2.s SEL to a maximum of 163 dB re 1µPa2.s SEL, see Section 5.2.2 under Ambient Ocean Sound) and is therefore likely to have a negligible impact on marine fauna.

Vessel noise

The MODU will be supported by two support vessels that typically emit low levels of sound from propeller cavitation (the dominant sound source), thrusters, hydrodynamic flow around the hull and from onboard machinery (Popper *et al*., 2014). Support vessels will likely use DP to maintain position, and cavitation from the thrust propellers while in DP mode can be a significant source of underwater sound, however the source will cycle on-off and not be present for most of the time.

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.

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 'ambient ocean sound' in Section 5.2.2).

Helicopter noise

Several helicopter flights each week will transport personnel and equipment to the MODU during drilling operations (see Section 2.5.3). Sound emitted from helicopter operations is typically below 500 Hz (Richardson *et al.,* 1985).

Sound travelling from a source in the air (e.g., helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface. The received sound level underwater depends on the altitude of the sound source and lateral distance from the receiver, receiver depth, water depth, and other variables.

The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles above 13 from the vertical much of the sound is reflected and does not penetrate into the water (Richardson *et al*., 1995; NRC, 2003). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver. This 'zone of ensonification' can be enlarged in rough seas and can also be enlarged in shallow waters (Richardson *et al*., 1995).

Most air traffic supporting offshore installations involves turbine helicopters flying along straight lines. Usually, a helicopter can be heard in air well before and after the brief period it passes overhead and is heard underwater. Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. The peak received level diminishes with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude.

Richardson et al (1995) reports figures for a Bell 214 helicopter (considered to be one of the loudest) being audible in air for four minutes before it passed over underwater hydrophones but detectable underwater for only 38 seconds (at 3 m depth) and 11 seconds (at 18 m depth). This means that as a conservative case, helicopter sound may be audible underwater for up to two minutes per flight per to and from the MODU. This provides an indication of the low level of received noise that may be expected from a helicopter.

Given the short time of audibility underwater (0.14% of a day) and low frequency of helicopter flights, impacts from helicopter sound to sound-sensitive marine fauna are assessed as negligible.

VSP

Noise emissions from VSP operations on marine fauna is considered to be low given its short duration (12 to 24 hours) and small air-gun array (600 cui array) as compared to conventional seismic survey arrays (typically 2,500 to 3,500 cui) that operate continuously for weeks or months.

Biological Impacts

The impacts of impulsive and non-impulsive noise in the operational area are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (https://info.nopsema.gov.au/activities/468/show_public), which was accepted by NOPSEMA in March 2022. The impacts of MODU and support vessel operations are expected to be similar to these.

For VSP operations, the impact assessment provided here is based on VSP modelling undertaken by Jasco Applied Sciences (McPherson *et al*., 2018) for the Gular-1 appraisal well undertaken in a water depth of 26 m for a 600 cui airgun array. A summary of the results for the VSP modelling is presented in Table 7.10.

Table 7.10. Summary of the maximum horizontal distances to noise effect criteria from VSP operations for per-pulse (PK) modelled sites in the water column and at the seabed

<table>
<tr><th rowspan="2">Fauna group</th><th rowspan="2">Behavioural</th><th colspan="3">Injury</th><th rowspan="2">Mortality/ potential mortality</th></tr>
<tr><th>TTS</th><th>PTS</th><th>Recoverable injury</th></tr>
<tr><td colspan="6">Water column</td></tr>
<tr><td>Plankton</td><td>-</td><td>-</td><td>-</td><td>-</td><td>84 m</td></tr>
<tr><td>Fish (with no swim bladders, including sharks)</td><td>(N) High
(I) Moderate
(F) Low</td><td>922 m</td><td>-</td><td>30 m</td><td>30 m</td></tr>
<tr><td>Fish (with swim bladders)</td><td>(N) High
(I) High
(F) Moderate</td><td>922 m</td><td>-</td><td>84 m</td><td>84 m</td></tr>
<tr><td>Fish eggs and larvae</td><td>(N) Moderate
(I) Low
(F) Low</td><td>922 m</td><td>-</td><td>84 m</td><td>84 m</td></tr>
<tr><td>Low-frequency cetaceans (LFC)</td><td rowspan="3">2,900 m</td><td>20 m</td><td>*</td><td>-</td><td>-</td></tr>
<tr><td>Mid-frequency cetaceans (MFC)</td><td>*</td><td>*</td><td>-</td><td>-</td></tr>
<tr><td>High-frequency cetaceans (HFC)</td><td>350 m</td><td>200 m</td><td>-</td><td>-</td></tr>
<tr><td>Turtles</td><td>1,856 m</td><td>N/A</td><td>N/A</td><td>-</td><td>84 m</td></tr>
<tr><td colspan="6">Seabed</td></tr>
<tr><td>Sponges and corals</td><td>-</td><td>-</td><td>-</td><td>-</td><td>*</td></tr>
<tr><td>Molluscs</td><td>-</td><td>-</td><td>-</td><td>304 m</td><td>-</td></tr>
<tr><td>Crustaceans</td><td>-</td><td>-</td><td>-</td><td>304 m</td><td>-</td></tr>
<tr><td colspan="3">* *Threshold not reached.*
- *No exposure criterion is available to model.*
N/A Not assessed.</td><td colspan="3">N (near) = tens of metres.
I (intermediate) = hundreds of metres.
F (far) = thousands of metres.</td></tr>
</table>

The following impact assessment is based on species-specific 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

Plankton (described in Section 5.4.3) 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.

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. The estimated distance for mortality of plankton (84 m) from VSP modelling also indicates a very localized area of impact.

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

Impacts to Fish and Sharks

Fish species known to occur within the impacts EMBA are listed and described in Section 5.4.4. 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).

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).

Based on the VSP modelling results in Table 7.10, it is expected that any impacts to fish and sharks from VSP will be highly localised and have no lasting effect, with the main impact being temporary behavioural changes (avoidance) for those individuals that are close to the VSP array at the time of operations. Impacts to species with BIAs in the operational area (see Section 5.4.4), such as the northern river shark (adults/juveniles may occur), dwarf sawfish (adults known to occur), largetooth sawfish (adults known to occur), green sawfish (adults known to occur) are expected to be the same. Underwater sound is not listed as a threat for these species (see Table 5.7 in Section 5.4.4). As such, the impact consequence from VSP operations are assessed as minor.

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 VSP. 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.

The activity will not have a 'significant' impact on endangered or vulnerable fish species (see Section 5.4.4) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), as outlined in Table 7.11.

Table 7.11. 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 drilling 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 VSP array and the short duration of VSP operations. 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 sound 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 drilling activities will not 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 drilling 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 drilling activities will not disrupt the breeding cycle of a population. There is no overlap between underwater noise emissions and fish breeding sites.
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 drilling 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).

Impacts to Cetaceans

The impacts of underwater sound on cetaceans are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (https://info.nopsema.gov.au/activities/468/show_public), which was accepted by NOPSEMA in March 2022.

This VSP modelling results presented in Table 7.10 indicate that mortality to cetaceans from VSP operations is not predicted. The maximum distance at which the NMFS (2018) marine mammal behavioural response criterion of 160 dB re 1µPa could be exceeded was modelled as 2,900 m (2.9 km). TTS and PTS are predicted to only affect HFC (species such as porpoises, that are not known to occur in the impacts EMBA), and even then to only a few hundred metres from the sound source. Given that threatened and other whale species are not likely to occur in the impacts EMBA at the time of drilling (see Figure 5.17), the impacts of VSP on whales are expected to have a negligible impact consequence. Dolphins are classified as MFC, and the VSP modelling results in Table 7.10 indicate that impacts will be limited to behavioural impacts (e.g., avoidance) within a 2,900 m radius of the sound source. Given the short-term nature of VSP, the impacts will be limited to short-term avoidance.

The proposed drilling activity will not have a 'significant' impact on threatened cetacean species (see Section 5.4.5) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013) as outlined in Table 7.12.

Table 7.12. 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 drilling 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 drilling 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 drilling 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 drilling 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 drilling 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 habitat to the extent that the species is likely to decline.	Underwater sound generated from drilling 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.
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).

<u>Impacts to Turtles</u>

Turtle BIAs overlapped by the impacts EMBA include that for the green turtle (foraging), flatback turtle (inter-nesting) and olive-ridley turtle (foraging) (see Section 5.4.6).

The impacts of underwater sound on turtles are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (https://info.nopsema.gov.au/activities/468/show_public), which was accepted by NOPSEMA in March 2022.

This VSP modelling results presented in Table 7.10 indicate that mortality or potential mortality to turtles from VSP operations is only likely within 84 m of the sound source. 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 (Table 7.13).

Table 7.13. 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

Distance from the source

Near = tens of metres.

Intermediate = within hundreds of metres.

Far = thousands of metres.

In the worst-case, recoverable injury and TTS for any turtles present near the VSP operations could occur within tens of metres (per Table 7.13). Behavioural changes, such as avoidance and diving, may occur for individuals within tens of metres of the sound source. This will not result in short- or long-term population impacts to turtles. The impact consequence level is assessed as negligible.

Impacts to Crustaceans

Although there are no threatened crustacean species in the impacts EMBA, crustaceans are assessed here given the presence of the commercially important NPF (see Section 5.7.1). Crustaceans such as banana and tiger prawns that are present in the impacts EMBA are described in Section 5.4.1.

The impacts of underwater sound on crustaceans are assessed in Section 7.1.4 of the Beehive-1 PDSA EP (https://info.nopsema.gov.au/activities/468/show_public), which was accepted by NOPSEMA in March 2022.

There are no established criteria to model for the effects of underwater sound on crustaceans, so comparisons can only be made to results from acoustic studies. This VSP modelling results presented in Table 7.10 indicate that the distance to effects for recoverable injury (based on a PK-PK of 202 dB re 1µPa from Payne et al (2008)) is 304 m (noting there are no comparison criteria for behaviour, TTS, PTS or mortality).

Based on a Q1 start for the drilling activity, VSP operations may overlap with the spawning period for grooved tiger prawn and blue endeavour prawn, along with migration of juvenile banana prawns (see Figure 5.12 in Section 5.4.1).

Impacts to crustaceans (prawns) will have a negligible impact consequence at both an individual level and local population level based on the following:

- The sound will be temporary (several hours) and localised;
- The activity is 80 km from inshore habitats favoured as nursery grounds for juveniles and therefore will not be impacted by underwater sound generated from VSP; and
- Lethal effects to crustaceans have not been observed (Christian *et al.*, 2003; Parry and Gason 2006; Payne *et al.*, 2007; Day *et al.,* 2016a).

Impacts to Avifauna

There are no threatened seabird species or seabird BIAs in the impacts EMBA.

In the event that individual birds or flocks are present in the impacts EMBA area during VSP operations, an indirect impact may occur if sound pulses 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 birds either positively or negatively, is not known. As described in the previously, the effects to fish from VSP will be very localised and short-term, and it is not likely that measurable impacts to predatory seabirds will be therefore occur.

Seabird species that may forage in the activity area (see Section 5.4.7) all have considerable foraging habitat present throughout JBG, will all listed as migratory. The short distance to behavioural effects for fish (tens to hundreds of metres for behavioural impacts) means that any temporary dispersal of fish due to VSP would not result in any significant decrease in availability of prey species that is of biological significance for seabird populations.

There are no thresholds or assessment criteria for noise impacts to birds. As most seabirds spend very little time under the water surface, and when they do it is for several seconds at a time, impacts to seabirds are predicted to be negligible. The operational area does not contain spatially limiting food sources, with JBG providing abundant foraging grounds.

7.5.5. Impact Assessment

Table 7.14 presents the impact assessment of underwater sound generated from the activity on biological receptors.

Table 7.14. Impact assessment for noise emissions on biological receptors

Summary		
Summary of impacts	Physiological or pathological impacts to local populations of marine fauna and avifauna from noise emissions generated during the drilling activity.	
Extent of Impact	Ten of metres and/or up to several hundred metres (due to VSP operations) depending on the source of sound.	
Duration of Impact	Very short-term (several minutes for helicopters) to the duration of drilling (support vessel movements, drilling sound).	
Level of certainty of impacts	Moderate to high.	
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 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.	
Impact consequence (inherent)		

Receptor	Consequence rating
Plankton	Negligible
Fish – with swim bladders	Negligible
Fish – without swim bladders	Negligible
Marine mammals	Negligible
Turtles	Negligible
Marine invertebrates (crustaceans)	Negligible
Avifauna	Negligible

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
EPBC Policy Statement 2.1 – Part A (Standard management procedures) for VSP operations **(IMP-05: EPS-01, -03 & -04)**	Engineering & administrative	Yes	**EB:** Improved ability to spot and identify marine fauna at risk of impact from underwater sound generated by VSP equipment. **C:** Little additional cost – time to induct VSP and deck crew and ensure compliance. **Ev:** Standard management procedures in Part A of the policy statement must be followed by all vessels conducting 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, as is the case in the JBG.
EPBC Policy Statement 2.1 – Part A (Standard management procedures) – soft-start procedures for VSP.	Engineering	No	**EB:** Improved ability to avoid or minimise impacts of underwater sound to marine fauna. **C:** Cost associated with the extra time to undertake VSP, likely to be several hours. This would be in the order of $100,000 for the MODU time alone. **Ev:** The airguns used for VSP have a much lower sound source volume (600 cui) compared to traditional seismic surveys (up to 3,500 cui) that the Policy Statement 2.1 has been prepared for. Sound will also be generated by the support vessels, acting as a ‘warning’ to sound-sensitive species. This, the short duration of VSP and with the low likelihood of whales being in the activity area at the time of drilling means the high cost of implementing this control is disproportionate to the low risk.

Environmental awareness induction **(IMP-05: EPS-02)**.	Administrative	Yes	**EB:** Ensures VSP and deck crew are aware of their obligations regarding implementation of EPBC Policy Statement 2.1 when conducting VSP operations, thereby minimising impacts to megafauna. **C:** Minimal additional cost to prepare and present induction. **Ev:** Presenting inductions to ensure VSP and deck crew are aware of their obligations is an industry standard. The environmental benefits outweigh the minor costs.
EPBC Policy Statement 2.1 – Part B (Additional management measures) – use of a Marine Mammal Observer (MMO) during VSP operations)	Administrative	No	**EB:** Improved ability to spot and identify marine fauna at risk of impact from underwater sound generated by activity equipment. **C:** About $20-30,000 to contract two MMOs (back-to-back operations, based on day rate, travel and accommodation) for the duration of VSP operations plus standby time. **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, so the use of an MMO is not considered necessary. Crew on the MODU can implement EPBC Policy Statement 2.1 with support of constant bridge observations from crew on the support vessels.
Undertake site-specific acoustic modelling and develop a noise management plan as per the Approved Conservation Advice for *Megaptera noveangliae* (humpback whale).	Administrative	No	**EB:** Increase the knowledge of potential impacts and potential reduction in impacts to whales. **C:** Several thousand dollars to undertake site-specific acoustic modelling and prepare the management plan. **Ev:** There is no environmental benefit with this control measure as there are no humpback whale BIAs in or near the activity area and the timing of the activity is outside the humpback whale migration period on the North West Shelf.
Vessels and helicopters will comply with EPBC Regulations 2000 – Part 8 Division 8.1 **(IMP-05: EPS-03)**.	Administrative	Yes	**EB:** Reduces the risk of physical and behavioural impacts to cetaceans from vessels and helicopters. **C:** Operational costs to adhere to marine fauna interaction restrictions, such as vessel speed and direction, are based on legislated requirements. **Ev:** Standard management procedures in Regulations 8.07 must be followed.

MODU machinery and support vessel engines and thrusters/DP are well maintained **(IMP-05: EPS-05)**.	Engineering	Yes	**EB:** Efficient engines, thrusters and other rotating equipment are likely to result in lower sound and vibration, thereby minimising impacts to sound-sensitive marine fauna. **C:** Maintenance costs can be significant. **Ev:** Planned maintenance is necessary to maintain MODUs and support vessels in sea-worthy condition. EOG would not hire a MODU or vessel that is not sea-worthy, so there are no alternative to implementing this control measure.

Environmental Controls and Performance Measurement		
Performance outcome	Performance standard (control)	Measurement criteria
VSP and pre-drilling geophysical operations		
No displacement or injury to threatened marine fauna from drilling or pre-drilling activities	**(IMP-05:EPS-01)** Geophysical and VSP team members, with the support of dedicated MODU deck crew and support vessel bridge crew, will implement parts of Part A of EPBC Policy Statement 2.1 during VSP and any pre-drill geophysical activities. Specifically:	
	A.3.1: Pre Start-Up Visual Observations • Pre-start visual observations out to 3 km for 30 minutes. • If a whale or turtle is observed during the pre-start observations, delay soft start for 30 minutes. • If no whales or turtles are observed, activate acoustic equipment.	Daily operations reports verify procedure was followed as required.
	A.3.4: Operations procedure • If a whale or turtle is observed within the shutdown zone of the source (500 m), the airguns will be shut down. • VSP can recommence after the whale or turtle 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 VSP 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-05: EPS-02) Environmental awareness induction will be provided to MODU, geophysical, VSP and support vessel crew prior to start of the activity. This includes: • Providing the policy statement to the Vessel Masters and Drilling Supervisor. • Providing photos/pictures of the different megafauna expected in the area at the time of the activity, including in the form of posters for display. • Instructions on the pre-start, shut-down and re-start requirements (as listed in **IMP-05:EPS-01**). • Instructions on distance estimation, including the specification that marine binoculars with reticles are used. • Instructions on how to detect marine megafauna based on observations on the water surface and surrounds. • Instructions on data to be recorded for marine megafauna sightings, including time of observation, type and number of species observed and estimated location coordinates.	Induction presentation and signed attendance sheet.
	(IMP-05: EPS-03) Support vessel and helicopter activities will be undertaken in accordance with EPBC Regulations 2000 – Part 8, Division 8.1. Specifically: • Vessels will not knowingly travel faster than 6 knots within 300 m of a whale or 150 m of a dolphin; • Vessels will not knowingly get closer than 100 m of a whale or 50 m of a dolphin; • If a cetacean approaches, the vessel within the above zones, the vessel will avoid rapid changes in engine speed or direction; • Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on.	Flight reports verify in the event of a cetacean sighting, that caution zone and interaction management actions were implemented.
Cetacean sightings are reported to the DAWE.	**(IMP-05:EPS-04)** *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.

<table>
<tr><td colspan="4">MODU and support vessel operations</td></tr>
<tr><td>MODU engines and support vessel engines and thrusters/DP are well maintained.</td><td colspan="2">(IMP-05: EPS-05) Engines and thrusters are maintained in accordance with manufacturer's instructions via the Planned Maintenance System (PMS) to ensure they are operating efficiently.</td><td>PMS records verify that engines and thrusters are maintained to schedule.</td></tr>
</table>

Impact consequence (residual)	
Receptor	Consequence rating
Plankton	Negligible
Fish – with swim bladders	Negligible
Fish – without swim bladders	Negligible
Marine mammals	Negligible
Turtles	Negligible
Marine invertebrates (crustaceans)	Negligible
Avifauna	Negligible

The consequence of underwater sound emissions is assessed as negligible because:

- Underwater sound emissions are localised and temporary;
- BIAs for cetaceans (as one of the more sound-sensitive fauna groups) do not occur in the impacts EMBA;
- The activity avoids temporal overlap with whales that may migrate through the region; 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.

<table>
<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>Management system compliance</td><td colspan="2">Chapter 9 describes 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 negligible, which is considered acceptable.</td></tr>
<tr><td>Engagement</td><td>Relevant persons</td><td>No objections or claims have been raised by relevant persons regarding noise emissions during the activity.</td></tr>
<tr><td>Legislative context</td><td colspan="2">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.</td></tr>
</table>

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.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	There is no guidance specific regarding underwater sound.
	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-05: EPS-01)**.
	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives: • Reduce the impact on cetaceans and other marine life to ALARP and an acceptable level **(IMP-05: EPS-01, -02 & -03)**. • To reduce the impacts to benthic communities to ALARP and an acceptable level.
	Underwater sound-specific	
	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-05: EPS-01 & -03)**.
	EPBC Regulations 2000 – Part 8, Division 8.1	The standard management procedures in Part 8, Division 8.1, Regulation 8.07 have been adopted **(IMP-05: EPS-04)**.
	MNES	

Environmental context	AMPs	This hazard will not reach levels above ambient sound at AMPs.
	Ramsar wetlands	This hazard will not reach levels above ambient sound at any wetlands.
	TECs	This hazard will not reach levels above ambient sound at TECs.
	Nationally threatened and migratory species	This hazard will not reach levels above ambient sound for threatened and migratory species.
	Other matters	
	KEFs	This hazard will not reach levels above ambient sound at KEFs.
	NIWs	This hazard will not reach levels above ambient sound at NIWs.
	State marine parks	This hazard 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 the Sawfish and River Sharks (DoE, 2015c) does not list anthropogenic sound as a threat to this species. The Conservation Advice of the Whale Shark (TSSC, 2015d) 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).	

Statement of acceptability	EOG considers the impacts from underwater sound to be acceptable because: • It will adhere to the company's Safety and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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 reports. • VSP operations reports. • Transmittal of sighting records to DAWE. • Induction presentation and attendance sheets. • PMS records.	

7.6. IMPACT 6 – Discharge of Drill Cuttings and Muds

7.6.1. Hazard

Cuttings (and adhered fluids) are discharged directly to the seabed during riserless drilling and discharged from the MODU to the sea surface while drilling with the riser connected.

Cuttings and adhered muds disposed from the MODU form a turbid plume, within which the larger particles (90-95%) fall to the seabed close to the discharge point, while the finer particles form an upper plume before dispersing, with a dilution factor of at least 10,000 within 100 m of the discharge point (Hinwood *et al.*, 1994).

Drill cuttings from upper well sections generally accumulate in an approximate 80 x 80 m area around the well, commonly an ellipsoid shape according to tide and current behaviour (Hinwood *et al.*, 1994). When cuttings from the lower sections of the well are discharged, the larger sediment particles settle rapidly to the seabed, generally with 90% of the discharge volume falling within 100 m of the discharge point (Hinwood *et al.*, 1994).

The physical deposition of these cuttings, combined with the properties of the adhered fluids, may have an impact on flora and fauna and benthic habitat, depending on the discharge volumes, exposure levels and the sensitivity of the species themselves.

While drilling the deeper sections of the well, WBM will be circulated and continuously recycled to the surface. The WBM is circulated to surface to separate cuttings from the fluid and in turn allows the mud to be pumped back down into the well. Cuttings are separated from the WBM using shale shakers and hydro-cyclones to remove as much WBM for reuse as possible. The cuttings with residual mud are intermittently discharged from the MODU from a discharge hose above sea level. Periodically, different solids control devices within the mud treatment system may also discharge to sea. The mud treatment system is continuously monitored for operability by the derrickman and drilling fluid properties assessed at least twice daily by the Drilling Supervisors and Drilling Fluids Engineer to optimise separation efficiency.

A bulk discharge of waste WBM will occur at the end of drilling the well, which is expected to last no longer than 4 hours.

At the completion of drilling, the well will be either P&A or TA (see Section 2.8), with either completion brine or WBM left in the wellbore. This means that the drilling fluid in the MODU tanks will be discharged, as the mud is formulated specific to each well section.

Drill Cuttings and Fluid Solids Discharge Modelling

EOG commissioned RPS to undertake dispersion modelling of drill cuttings and muds based on the well design described in Section 2.7.

Table 7.15 summarises the estimated volume of drill cuttings and unrecoverable mud solids for each well interval and the end-of-well mud discharge.

Table 7.15. Estimated volume of drill cuttings and unrecoverable mud solids for each well interval

Bore diameter (inches)	Well interval	Cuttings	Mud solids		Discharge duration (days)
		Volume discharged (m^3)[1]	Type	Volume discharged (m^3)[2,3]	
36”	Conductor hole	80.4	Seawater & sweeps	19.5	0.2
26”	Surface hole	360.1	Gel/polymer WBM	75.0	1.2
17½”	Intermediate hole	322.9	Potassium chloride (KCl) WBM	81.3	2.4
12¼”	Production hole	172.3	High performance WBM	32.7	5.7
8½”	Production liner	29.7		8.8	3.1
	Mud solids discharged at sea surface at well completion			53.9	0.2
	Total	**965.4**		**271.2**	**12.8**

[1] Hole washout included 20% over-gauge for hole sizes > 12.1/4", 5% for hole sizes 12.1/4" and lower.[2] Seawater is not included in the estimated drilling fluid volume discharged for conductor hole. [3] Solids determined as 10% of total mud system.

Modelling Methodology

The following information is taken from the RPS modelling report (2022).

MUDMAP is a three-dimensional plume model used to aid in assessing the potential environmental effects from operational discharges such as drill cuttings, drilling fluids and produced water. The model has been applied to hundreds of assessments in over 35 countries, including Australia.

The model itself is an enhancement of the Offshore Operators Committee (OOC) model and calculates the fates of discharges through three distinct stages, as defined by laboratory and field studies:

- Stage 1, Convective descent – free fall of the combined mass of fluids and cuttings;
- Stage 2, Dynamic collapse stage – the collapse of the combined mass as it meets the seabed (or water surface); and
- Stage 3, Dispersion stage – the transport and dispersion of discharged fluids and particles by the local currents. For cuttings and drilling mud particles that have higher density than seawater, this phase also calculates sinking and settlement to the seabed.

Each stage plays an integral role on different time and distance scales.

Settling under currents is selective for particle size, with the larger particles (rock chips to sand) tending to settle quickly, forming a pile that aligns with the predominant water current axis. Smaller particles (especially silts and clays) will remain suspended for longer periods and will therefore be dispersed more widely by the ambient current conditions. Dispersion of the finer discharged material tend to be enhanced with increased current speeds and water depth and with greater variation in current direction over time and depth.

Along with the advanced analyses tools, MUDMAP can simulate six classes of material (or 36 subcategories), each with unique density and particle-size distribution. During the dispersion stage, the model particles are transported in three dimensions according to the current data and horizontal and vertical mixing coefficients at each time step according to the governing equations.

MUDMAP has been extensively validated and applied for discharge operations in Australian coastal waters. The input data used to setup the dispersion model included:

- Volume and discharge duration of the cuttings and unrecovered muds;
- Particle size distributions and associated settling velocities of discharged cuttings and unrecoverable muds;
- Bulk density of the discharged cuttings and unrecoverable muds;
- Temperature and salinity profile of the receiving waters;
- The orientation of the discharge pipe;
- The height/depth of the discharge point relative to mean sea level; and
- Depth-varying current data to represent local physical forcing.

Table 7.16 provides a summary of the discharge configuration and the estimated volume of cuttings and muds used as input into the discharge model. Each simulation represented the sequential completion of each discharge operation with the sequence and rate of discharges set to represent the proposed drilling and discharge plan. Simulations were run for a longer period than the discharge duration to allow finer sediments to settle out of suspension or to disperse.

Table 7.16. Input data used for the drill cuttings and dispersion modelling

Parameter/description	Values/configuration
Volume of cuttings discharged near the seabed	80.4 m^3
Volume of mud solids discharged near the seabed	19.5 m^3
Volume of cuttings discharged near the sea surface	885 m^3
Volume of mud solids discharged near the sea surface	251.7 m^3
Total volume of cuttings discharged	965.4 m^3
Total volume of mud solids discharged	271.2 m^3
Density of drill cuttings	2,600 kg/m^3
Density of drilling mud solids	4,200 kg/m^3
Duration of discharge [simulation discharge]	12.8 days [17.3 days]
Depth of near – seabed discharge	2 m above seabed
Depth of near – sea surface discharge	0 m (sea surface)
Water depth	40 m
Orientation of discharge pipe	Vertically downwards
Stochastic modelling approach and conditions	Randomly selected start simulation dates between January–December (2010–2019). 25 simulations per quarter (Q1: January–March, Q2: April–June, Q3: July–September and Q4: November–December).

As the well will be drilled using a conventional drilling approach, the particle sizes for cuttings and drilling muds were represented by literature data for conventional drilling (Table 7.17). It is important to note that grain size has a greater influence on the rate of settling than density (Neff, 2005), and grain sizes are expected to vary between 0.016 mm and 6 mm in diameter. The model was set up with four main particle classes to represent large, medium and light cuttings, and drilling fluid solids (i.e., mud particles). The fall velocities for the various size classes were derived from empirical data provided by Dyer (1986).

A stochastic modelling approach was following with one hundred simulations modelled per well (or 25 per quarter per well). Each discharge simulation for the respective well had the same information but different commencement times, and thus, prevailing current conditions were different. This approach ensured that the cuttings and muds experienced a wide range of current conditions (speeds and directions). The results from all 100 simulations per well, were integrated to identify the overall area of exposure on the seabed and in water. The outputs are presented as contours relative to the maximum predicted bottom thickness of deposited material on the seabed or total suspended solids (TSS) concentrations.

Table 7.17. Discharged grain sizes, settling velocities and percentage distributions for the cuttings and drilling muds, based on conventional hole drilling using sea water and sweeps and WBM

Class	Grain size (mm)	Settling velocity (cm/s)	Well section consisting of cuttings & drilling fluids (composition %)	Class proportion (composition %)
Large cuttings	6	53.62	8.6	40.3
	5	49.46	8.6	
	2	28.55	8.6	
	1	12.73	5.8	
	0.5	7.5	5.8	
	0.45	6.6	2.9	
Medium cuttings	0.4	6	2.9	16.9
	0.35	5	2.8	
	0.3	4	2.8	
	0.25	3.1	2.8	
	0.2	2.3	2.8	
	0.15	1.6	2.8	
Light cuttings	0.1	0.8	2.8	14.3
	0.05	0.22	2.8	
	0.04	0.15	2.9	
	0.03	0.08	2.9	
	0.02	0.04	2.9	
Drilling muds solids	0.063	0.34	0.4	28.5
	0.05	0.22	1.6	
	0.035	0.11	3.7	
	0.026	0.06	6	
	0.02	0.038	7.4	
	0.016	0.026	9.4	
		Total composition (%)	**100**	**100**

Settling velocities per grain size sourced from Dyer (1986).

Reporting Thresholds

The following information is taken from RPS (2022).

The MUDMAP model can predict sediment concentrations and thickness to very low levels that may not be practical or ecologically significant; therefore, thresholds were carefully selected for reporting the model-predicted outcomes.

Based on available literature, thresholds of 1-10 mm and above 10 mm were used to define low and high exposure levels for this study, respectively (Table 7.18). In addition, Trannum et al (2009) reports a significant decrease in species count, abundance of individuals, Shannon-Wiener diversity, and biomass of marine animals with increasing depth of deposited cuttings (3-24 mm). Furthermore, a study by Kjeilen-Eilertsen et al (2004) reports that depositional thicknesses greater than 9.6 mm are likely to cause smothering impacts on benthic ecosystems, including corals. A study by Smit et al (2008) established that a thickness threshold of greater than 6.5 mm would be needed before potential harm to benthic macrofauna occur.

As a conservative measure, a thickness of 0.05 mm was adopted as a minimum reporting threshold for modelling (Table 7.18). Assuming newly settled cuttings and drilling muds will be less compact due to incorporation of water between grains of sediment deposits, a bulking factor of 2.5 was applied to predicted bottom thicknesses to account for porosity.

The minimum reporting threshold for TSS concentrations used for this study is 5 mg/L. Nelson et al (2016) reports <10 mg/L as a minimal or no effect, whilst concentrations above 10 mg/L have a sublethal effect to pelagic biota. Furthermore, IOGP (2016) cite that very high concentrations (>1,830 mg/L) of TSS has been shown to result in mortality of pelagic biota. Hence, a threshold range of 10-1,830 mg/L and greater than 1,830 mg/L were used to define low and high exposure, respectively (see Table 7.18).

Table 7.18. Reporting thresholds for sediment thickness and TSS concentrations for the drill cuttings and muds discharge modelling

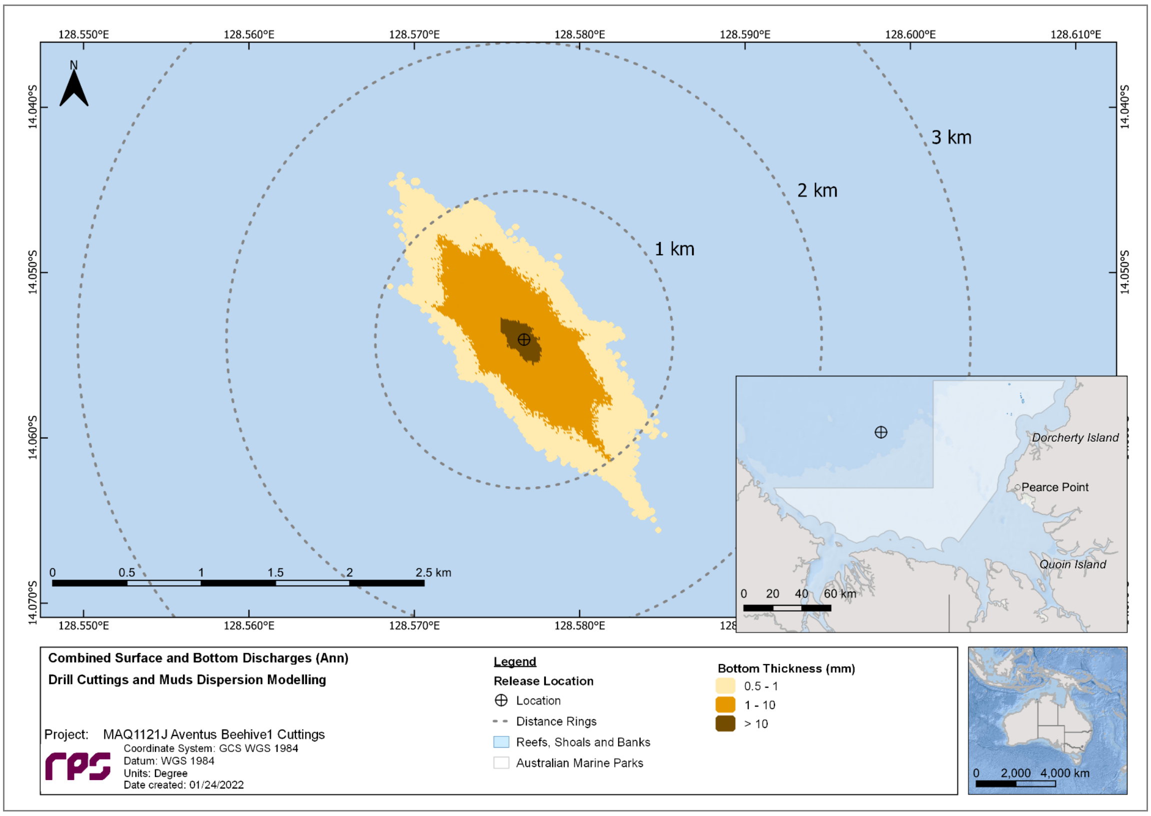
Reporting criteria	Total sediment thickness (mm)	TSS concentration (mg/L)
Minimum reporting threshold	0.05	5
Low exposure	1 – 10	10 – 1,830
High exposure	> 10	> 1,830

Stochastic Modelling Results – Sediment Thickness

Figure 7.4 illustrates the predicted coverage and sediment thickness from the combined near-seabed and sea surface drill cuttings and unrecoverable muds discharges from all 100 simulations. Table 7.19 presents the same results.

The total area of coverage on the seafloor above the minimum reporting threshold is 1.45 km^2, which was predicted to occur up to a maximum distance of 1.55 km from the release location (i.e., drill rig). In comparison, the area of coverage based on the low (1-10 mm) and high (>10 mm) exposure thresholds was 0.70 km^2 and 0.05 km^2, respectively. The maximum distance from the release location to the low and high exposure thresholds was 1.0 km and 0.21 km, respectively.

Table 7.20 provides a summary of the stochastic dispersion modelling assessment for each of the year’s four quarters, presenting the predicted maximum bottom thickness, total area of coverage and the maximum distance (and direction from the platform) to the minimum threshold. The maximum distance from the platform above the minimum threshold ranged from 1.23 km (Q4) to 1.55 km (Q3). The maximum distance from the well to the low (1–10 mm) and high (>10 mm) exposure thresholds ranged between 0.81 km (Q1) to 1.00 km (Q3) and 0.17 km (Q4) to 0.21 km (Q2), respectively. Given the orientation of the currents, the furthest extents of exposure occurred in a northwest or southeast direction.



Source: RPS (2022).

Figure 7.4. Predicted maximum thickness at each grid cell from all 100 simulations used to define the area of greatest extent from the discharge of drill cuttings and unrecoverable muds for all quarters

Table 7.19. Predicted annual area of coverage and maximum distance as a function of sediment thickness

Sediment reporting thickness (mm)	Reporting criteria	Collective assessment of all combined simulations		
		Area of coverage of cuttings and muds ≥0.05 mm thickness (km^2)	Percentage of modelled area covered by sediment	Maximum distance from the release location (km)
0.05 – 0.1	Minimum reporting threshold	0.70	48.3	1.55
1 – 10	Low exposure	0.70	48.3	1.00
> 10	High exposure	0.05	3.4	0.21
	Total	**1.45**	**100**	

Results are based on the collective assessment of all 100 individual simulations (near-seabed and surface discharges).

Maximum sediment thicknesses (or height of sediment mounds) ranged between 866 mm (Q3) and 1,036 mm (Q4) at the immediate vicinity (<10 m) of the well location. The maximum distance of deposited material from the release location above the minimum threshold ranged from 1.23 km (Q4) to 1.55 km (Q3), whist the total area of coverage ranged between 0.97 km^2 (Q2) and 1.28 km^2 (Q1).

Table 7.20 Predicted maximum sediment thickness, area of coverage and maximum distance to the minimum reporting threshold from combined near-seabed and sea surface drilling on a quarterly basis

Drilling start period	Maximum stochastic bottom thickness (mm)	Total stochastic area of coverage (km^2) ≥0.05 mm predicted bottom thickness (minimum threshold)	Maximum distance (km) from the release location to ≥0.05 mm thickness (minimum threshold)	Maximum distance (km) from the release location to ≥1 mm thickness (low exposure)	Maximum distance (km) from the release location ≥10 mm predicted bottom thickness (high exposure
Q1	966	1.28	1.29	0.81	0.18
Q2	871	0.97	1.38	0.90	0.21
Q3	866	1.03	1.55	1.00	0.18
Q4	1,036	1.06	1.23	0.85	0.17

Results are based on 25 simulations, each with a 12.8 day discharge period.

The modelling results demonstrated that the settlement of the cuttings and drilling muds occurred predominantly along a northwest–southeast axis, coinciding with the dominant current directions at the release location. Given the similarity in the seasonal current speeds and directions, there was no discernible differences to the predicted areas of exposure. However, the modelling results indicate that the maximum bottom thicknesses and area of coverage(s) of the exposure thresholds is directly attributable to the height of discharge. When the cuttings and muds were discharged from the surface, the sediments travelled further spread over a larger area forming a thinner pile on the seabed. Whilst the cuttings and muds discharged near-the seabed settled bottom discharges were unable to travel as far, this resulted in settling closer to the well location and a larger localised mound.

Stochastic Modelling Results – TSS Concentrations

Figure 7.5 illustrates the maximum instantaneous TSS concentrations at each grid cell from all 100 individual simulations (near-seabed and sea surface discharges) used to define the area of greatest extent from the discharge of drilling muds (at the completion of drilling) on an annualised basis.

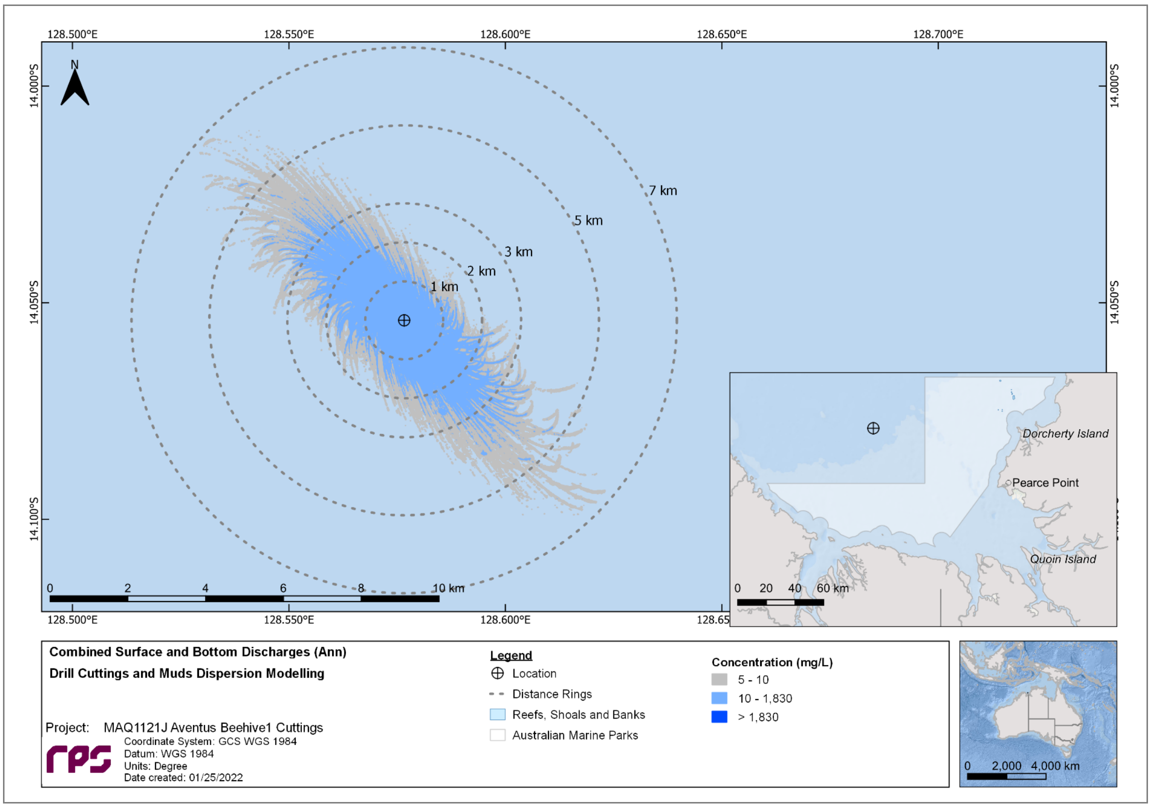
The total area of coverage above the minimum reporting threshold was 22.6 km^2, which was predicted to occur up to a maximum distance of 6.95 km from the drilling site. In comparison, the area of coverage based on the low (10-1,830 mg/L) exposure thresholds was 12.2 km^2. The maximum distance from the drilling site to the low exposure thresholds was 6.38 km (Table 7.21). The area of coverage based on the high (>1,830 mg/L) exposure threshold was predicted to occur within 30 m from the release location.

Table 7.22 presents the maximum instantaneous TSS concentrations resulting from the near-bottom and sea surface discharges (including waste muds discharges) and distances for each threshold and the area of coverage based on the minimum threshold for quarters one to four.

Table 7.21. Predicted area of coverage and maximum distance as a function of instantaneous TSS concentration

Maximum instantaneous TSS concentration (mg/L)	Reporting criteria	Collective assessment of all combined simulations		
		Area of coverage of maximum instantaneous TSS concentrations (km^2)	Percentage of area covered (%)	Maximum distance from release location (km)
5 – 10	Minimum reporting threshold	10.40	46.0	6.95
10 – 1,830	Low exposure	12.20	54.0	6.38
> 1,830	High exposure	<0.01	<0.01	0.03
	Total	**22.6**	**100**	

Results are based on the collective assessment all 100 individual simulations (i.e. 100 combined near-seabed and surface discharges).



Source: RPS (2022).

Figure 7.5. Predicted maximum instantaneous TSS concentrations in each grid cell from all 100 simulations (near-seabed and sea surface discharges) used to define the area of greatest extent from the discharge of muds on an annualised basis

Table 7.22. Predicted maximum instantaneous TSS concentrations resulting from the near-bottom and sea surface discharges and area of coverage and maximum distances based on the minimum reporting threshold at the end of drilling on a quarterly basis

Drilling start period	Maximum instantaneous TSS concentration (mg/L)		Total stochastic area of coverage (km^2), 5 mg/L TSS concentration (minimum threshold)	Maximum distance (km) from the release location ≥5 mg/L TSS concentration (minimum threshold)	Maximum distance (km) from the release location ≥10 mg/L TSS concentration (low threshold)	Maximum distance (km) from the release location to ≥1,830 mg/L TSS concentration (high exposure)
	Near-bottom discharge	Sea surface discharge				
Q1	13,274	1,578	14.50	6.95	4.96	0.03
Q2	8,376	778	13.61	6.69	6.38	0.02
Q3	13,190	1,021	15.09	6.69	5.38	0.02
Q4	8,213	792	14.05	6.66	4.13	0.02

Results are based on 25 combined simulations per quarter, each with a 12.8 day discharge period.

The maximum instantaneous concentrations occurring in the lower and upper water column as a result of the near-bottom and surface discharges, were 13,274 mg/L (Q1) and 1,578 mg/L (Q1), respectively. In all instances the concentrations were very localised and occurred within a maximum distance of 30 m from the release location. The maximum distance from the release location for TSS concentrations, equal to or above the minimum 5 mg/L threshold was 6.95 km (Q1). The maximum distance to the low (10–1,830 mg/L) exposure threshold was 6.38 km (Q3) and within 30 m for the high exposure threshold (>1,830 mg/L) to be triggered (see Table 7.22).

The TSS concentrations occurred predominantly along a northwest–southeast axis, coinciding with the dominant current directions at the release location.

7.6.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of the discharge of drill cuttings and fluids discharges are:

- Localised and temporary increase in total suspended solids (TSS) (i.e., turbidity) of the water column;
- Smothering of benthic habitat and fauna;
- Alteration of benthic substrate;
- Potential toxicity impacts to fauna; and
- Reduction of visual amenity from turbidity plumes.

7.6.3. EMBA

The EMBA for drill cuttings and unrecovered muds discharges is up to up to 1.55 km from the well for sediment deposition and 6.95 km in a in a northwest to southeast direction from the well for TSS, as outlined in Section 7.6.1.

Receptors that are known to occur or may occur within this EMBA are:

- Plankton;
- Benthic habitat and fauna; and
- Pelagic marine fauna.

7.6.4. Evaluation of Environmental Impacts

Increased Turbidity of the Water Column

During riserless drilling, the larger particles of the drill cuttings will settle in the immediate vicinity of the well, with smaller particles spreading further from the source aided by ocean currents. Once the riser is installed, drill cuttings are discharged just below the sea surface resulting in dissipation of the cuttings over a larger area. Hinwood et al (1994) and Neff (2005) note that within 100 m of the discharge point, a drilling cuttings and fluid plume will have diluted by a factor of at least 10,000, while Neff (2005) states that in well-mixed oceans waters (noting the activity area is considered a moderate-energy environment except when influenced by tropical cyclones), drilling mud is diluted by more than 100-fold within 10 m of the discharge.

When WBM and WBM-coated cuttings are discharged to the ocean, the larger particles, representing about 90% of the mass of the mud solids, form a plume that settles quickly to the bottom (or until the plume entrains enough seawater to reach neutral buoyancy).

About 10% of the mass of the mud solids form another plume in the upper water column that drifts with prevailing currents away from the platform and is diluted rapidly in the receiving waters (Neff, 2005; 2010). Neff (2005) states that although the total volumes of WBM and cuttings discharged to the ocean during drilling a well are large, the impacts in the water column environment are minimal, because discharges of small amounts of materials are intermittent. Drilling mud solids do not increase to high concentrations in the water column and affect only small parcels of water.

Periodic, minor increases in the turbidity and suspended particulate material concentrations in the upper water column during cuttings and mud discharges are unlikely to have an environmentally significant effect on phytoplankton, zooplankton and pelagic animal communities in the vicinity of the drill site (Neff, 2005).

Water column turbidity increases as a result from the suspended solids, with a subsequent minor decrease in available light in the water column, which may temporarily reduce primary production. Impacts to fauna may include obstructions to respiratory processes and other physiological processes as well as behavioural changes due to a reduction in visibility and available oxygen (due to reduction in primary production).

The impacts from cuttings discharge are expected to be restricted to a small area around the drilling site. The quantity of material discharged is extremely small compared with the water volume in which the material is dispersing, thus water quality is expected to quickly return to background levels close to the source of the discharge once the discharge ceases.

There are no known water column sensitivities (e.g., shoals, banks, reefs) located within the area of impact, so impacts to site-dependent species are not predicted. TSS concentrations above the minimum reporting threshold are not predicted to reach the Joseph Bonaparte Gulf AMP (located 35 km east of the drill site). As such, the consequence of this impact is considered negligible.

Smothering of Benthic Habitat and Fauna

The modelling results indicate that the volume of drill cuttings and muds discharged over the course of the campaign is 965.4 m^3 and 271.2 m^3, respectively, over a total of 12.8 days of discharge (which occurs intermittently, not consecutively).

In high energy environments, drill cuttings and muds do not tend to accumulate on the seabed because they are redistributed by bottom currents soon after deposition (Neff, 2010). This is expected to be the case in the impacts EMBA because it is strongly influenced by large tidal ranges that contribute to the vertical mixing of surface layers and sediments (see Section 5.2.3).

Once particulate material has settled onto the seabed it requires energy to re-suspend similar to existing sediments present on the seabed. Re-suspension volumes are a function of the surface area available to re-distributing currents, tides and storm events (i.e., induced wave stress). Redistribution is expected in areas of shallow water (<50 m) and strong seabed currents (Breuer *et al.,* 2003). Because the activity area has a water depth of 40 m, the surface layer of deposited sediment is expected to re-suspend during strong currents (e.g., during storms), however the magnitude of re-suspension is expected to be of a similar order to re-suspension of existing seabed sediments and should not result in a material impact to benthic habitats/fauna.

The main disturbance to the seabed is smothering and burial of sessile benthic and epibenthic fauna (Hinwood *et al*., 1994). Studies undertaken on faunal counts/diversity have shown no significant effects of drill cuttings as a function of thickness with respect to settling communities (i.e., recolonization) (Setvik, 2010). This is consistent with the findings of Daan & Muldur (1996) that identified no adverse impacts on benthic communities from WBM cuttings one year after deposition, even as close as 25 m from a former discharge site. Field and laboratory studies support that benthic fauna are not significantly harmed from WBM if the exposure is of short duration and the cuttings are rapidly diluted. Impacts of WBM are generally limited to within 100 m of the discharge point and recovery is well within one year (Setvik, 2010). Studies indicate that benthic infauna and epifauna recover relatively quickly, with substantial recovery within 3-10 years (Jones *et al*., 2012).

There are no areas of seabed sensitivity likely to be impacted by cuttings deposition, with areas of low and high exposure limited to soft substrate seabed. The modelling results predict that drill cuttings will not reach the Joseph Bonaparte Gulf AMP.

Impacts to the dominant seabed habitat of infaunal plains (flat, soft substrate with occasional rocky outcrops supporting sponge gardens) and barren sand banks (supporting limited biota) (see Section 5.4.1) within the operational area and impacts EMBA area will be temporary, with rapid re-colonisation of benthic infauna within the deposited cuttings soon after the cessation of drilling. Infaunal communities (dominated by polychaetes and other crustaceans) and epifauna (i.e., prawns) potentially occur in and around the activity area will not be impacted by sedimentation due to the very small area of exposure (0.05 km^2) to high sedimentation deposits (>10 mm).

On the basis of the modelling results, it is possible that smothering of benthic habitat (1-10 mm) may occur in an area of 0.70 km^2 extending a maximum distance of 1.0 km from the drilling site. For sediment thickness >10 mm (that may cause harm to benthic macrofauna), the area of impact is limited to 0.05 km^2 extending a maximum distance of 210 m from the around the drill site.

Taking into account that the Beehive-1 exploration well location is located entirely within the 'shelf' geomorphic feature of the JBG, typically characterised by extensive sediment plains and high sediment deposition and influenced by strong tidal movement, the impact of smothering of benthic habitat is expected to be short term (months up to a year). Species re-settlement within one year of the drilling campaign would be expected as per quoted studies of cuttings distribution offshore Australia. This impact area is miniscule compared with the available benthic habitat available throughout the JBG.

The Carbonate bank and terrace system of the Sahul Shelf KEF (described in Appendix 5) is located 26 km west of the drill site and therefore outside the impact area.

For these reasons, the impact consequence of smothering of benthic habitat is negligible.

Impacts to Fisheries

There is little commercial fishing in the impacts EMBA. The only fishery that may operate in or immediately around the activity area is the Commonwealth-managed NPF (see Section 5.7.1). Fish species known to occur in the region are common and widely distributed and there is no spatially limiting habitat for the fin fish and benthic species known to occur in the impacts EMBA.

The modelling indicates cuttings and mud plumes will not impact a significant area of muddy and sandy substrates of coastal waters and estuaries (habitat for banana and tiger prawns) given the very small area of exposure (0.05 km^2) to high sedimentation (>10 mm). In addition, there are no known sensitive benthic ecosystems in the activity area such as shoals, banks, reefs, seagrass meadows or mangroves (relevant to juvenile prawns) in or around the impacts EMBA.

The temporary nature of the drilling mud plumes, the rapid settling of cuttings and exclusion of fishing activities within the 500-m PSZ around the MODU means that there will be few if any impacts to the NPF from cuttings and muds discharges. Therefore, the impact to the NPF is considered to be negligible.

Alteration of Benthic Substrate

Modelling indicates that the maximum height of a sediment mound forming around the well is predicted to range between 0.866 m and 1.036 m. These sediment mounds are predicted to be limited to within the immediate vicinity (i.e., 10 m) of the drilling location. This will alter the nature of the seabed in this localised area for up to a year.

A cuttings mound will result in complete smothering of benthic fauna, though the mounds themselves (if they don’t become quickly redistributed with ocean currents) will provide new habitat for benthic fauna to colonise. The cuttings mound may be readily and rapidly reworked into existing seabed sediments by natural process including movement through bottom currents and infauna burrowing.

Potential Toxicity Impacts to Marine Fauna

The chemical composition of the drilling muds adhered to the deposited cuttings has the potential to result in toxicity impacts to marine fauna.

The non-toxic nature of the WBM means that acute or chronic toxicity impacts to fauna, especially immobile benthic fauna smothered by the cuttings, are highly unlikely. The lack of toxicity and low bioaccumulation potential of the drilling muds means that the effects of the discharges are highly localised and are not expected to spread through the food web (Neff, 2010).

There are few reports that deal specifically with the mineralogical toxicity or heavy metal content of cuttings, which is thought to be because of the inherent chemical stability of the rock substrate encountered during drilling.

Neff (2010) identifies that field and laboratory studies performed in temperate and cold water environments have shown that any metals present in drill cuttings are not bio-accumulated by marine organisms, primarily because they exist as extremely insoluble inclusions in cuttings minerals. Many field surveys investigating the concentrations of metals and hydrocarbons in tissues of marine animals in the vicinity of offshore WBM and cuttings discharges have shown that metals and hydrocarbon concentrations in tissues of marine animals near drilling platforms are similar to concentrations in tissues of the same or similar species well away from and out of the influence of the drilling platforms (Neff, 2010).

Based on this information, the bioavailability of metals within cuttings generated from drilling activities is low and thus the impacts to marine biota are insignificant.

7.6.5. Impact Assessment

Table 7.23 presents the impact assessment for discharge of drill cuttings and muds.

Table 7.23. Impact assessment for discharge of drill cuttings and muds

<table>
<tr><th colspan="4">Summary</th></tr>
<tr><td>Summary of impacts</td><td colspan="3">Increased water column turbidity and smothering of benthic habitat.</td></tr>
<tr><td>Extent of impacts</td><td colspan="3">Localised (up to several kilometres), in the direction of the dominant water currents (northwest to southeast direction).</td></tr>
<tr><td>Duration of impacts</td><td colspan="3">Temporary (days for TSS plumes, months for deposited cuttings).</td></tr>
<tr><td>Level of certainty of impacts</td><td colspan="3">HIGH – the impacts of drill cuttings and fluids discharges are well studied and 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">Discharges of drill cuttings and muds are managed to reduce volume and toxicity impacts to biodiversity or ecological integrity.</td></tr>
</table>

<table>
<tr><th colspan="2">Impact Consequence (inherent)</th></tr>
<tr><td>Receptor</td><td>Consequence</td></tr>
<tr><td>Water column</td><td>Negligible</td></tr>
<tr><td>Seabed habitats</td><td>Negligible</td></tr>
</table>

<table>
<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>Recover drill cuttings from the seabed</td><td>Elimination</td><td>No</td><td>EB: Eliminates potential for benthic habitat smothering from cuttings deposition on the seabed.
C: Significant additional cost (potentially hundreds of thousands of dollars)
Ev: Additional cost and longer MODU time on location required to implement this control is</td></tr>
</table>

			not commensurate with the negligible consequences associated with the discharge of drill cuttings.
Cuttings reinjection	Elimination	No	**EB:** Avoids all impacts associated with the discharge of cuttings and muds overboard by reinjecting them down the well annulus. **C:** This would compromise the integrity of the well and is not justified for a single well program. An additional injection well would need to be drilled to implement this control measure, which would cost millions of dollars and add to the routine impacts and risks associated with drilling. **Ev:** Costs are considered grossly disproportionate given the negligible impact consequences of overboard discharges at this location.
Onshore cuttings disposal ('skip and ship')	Elimination	No	**EB:** Avoids all impacts associated with the discharge of cuttings and muds overboard. **C:** Significant storage space is required on the MODU before cuttings and muds can be pumped to a vessel. There are limited facilities at the Port of Darwin or Port of Broome to handle this waste in the necessary volumes. There are the usual impacts and risks associated with numerous vessel movements between the MODU and shore bases. It would cost millions of dollars to implement this control measure. **Ev:** Costs are considered grossly disproportionate given the negligible impact consequences of overboard discharges at this location.
Do not use drilling muds	Elimination	No	**EB:** Elimination of impacts associated with TSS and smothering of benthic habitats. **C:** Drilling muds are required to enable the hole to be drilled. Mud prevents the wellbore from collapsing and enables the well objectives to be met. **Ev:** Costs to the program outweighs the benefits.
Use a centrifuge and dryer	Engineering	No	**EB:** Reduces the volume of drilling fluids from cuttings more than the use of shakers alone. This is typically only used when drilling with synthetic-based mud (SBM). **C:** Centrifuges and driers are prone to mechanical failure. Most MODUs do not have this as part of their standard fit out, so there would be significant cost to mobilise this equipment to the MODU.

			Ev: Costs to the program outweighs the benefits, especially because SBM is not being used for Beehive-1.
Use WBM fluids for drilling rather than synthetic-based muds **(IMP-06: EPS-01, -02)**	Engineering	Yes	**EB:** Eliminates ecotoxicity impacts to benthic fauna. **C:** Minor cost in selection of WBM rather than synthetic-based muds. **Ev:** Environmental benefit outweighs the cost to implement the measure.
Fluids Program **(IMP-06: EPS-03, -04, -05)**	Administrative	Yes	**EB:** Ensures drill fluids are managed in accordance with well-established industry processes. **C:** No additional cost. **Ev:** The environmental benefits outweigh the costs to implement the measure.
Minimum mud release duration **(IMP-06: EPS-06)**	Administrative	Yes	**EB:** Extends the release duration for muds, thereby reducing concentration of muds in the water column. **C:** No additional cost. **Ev:** The environmental benefits outweigh the costs to implement 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-06: EPS-01)** The contractor ensures that only PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated base fluids and additives are used 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-06: EPS-02) Where for technical reasons an additive is required that has not been registered with CEFAS (and therefore does not have a rating), AGR will apply the CHARM, or in the case of non-CHARMable products, the OCNS process (https://www.cefas.co.uk/cefas-data-hub/offshore-chemicalnotification-scheme/hazardassessment-process/) to calculate the CHARM rating or OCNS grouping. Only additives with a hazard quotient of <30 (silver/gold ranking) or an OCNS grouping of D/E will be used.	MoC documentation verifies that, for products not registered with CEFAS, the CHARM and/or OCNS process has been applied and that only additives with a hazard quotient of <30 or an OCNS grouping of D/E are used.
Mud operations are managed to ensure cuttings discharges are	**(IMP-06: EPS-03)** In accordance with the Fluid Program, the shaker screens are used during drilling to maximise fluid separation from cuttings prior to overboard disposal.	Daily Mud Report indicates shaker screens are used.

optimised to minimise adhered muds.	**(IMP-06: EPS-04)** Operation of the separation treatment system is monitored on a full-time basis by the Derrickman/Shaker-Hand to ensure system performance.	Performance of the system is logged by the Mud Engineer in Daily Fluids Reports.
	(IMP-06: EPS-05) Drilling fluid testing is performed by the Mud Engineer working under the supervision of the Drilling Supervisor at least twice per day.	Mud Engineer verifies through Daily Fluids Report that fluids properties have been tested and system optimisation activities actioned.

Impact Consequence (residual)	
Receptor	Consequence
Water column	Negligible
Seabed habitats	Negligible

The impact of drill cuttings and mud discharges is assessed as negligible because:

- The activity will be of a short duration;
- The area of impact on the seabed is extremely small;
- There is an absence of site-attached fauna in the water column and absence of sensitive benthic habitats in the impacts EMBA;
- The impacts EMBA is distant from the Carbonate bank and terrace system of the Sahul Shelf KEF;
- The seabed is widely represented in the region and pre-impact conditions will be rapidly re-established.

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 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 9 describes the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual impact consequence is negligible, which is considered acceptable.	
External context	Relevant persons	No concerns regarding discharge of drill cuttings and muds have been raised with EOG.
Legislative context	The EPS outlined in this table align with the requirements of: • OPGGS Act 2006 (Cth). ○ Section 460(2) – a person carrying on activities in an offshore area under the permit must carry on those activities in a manner that does not interfere with….the conservation of the resources of the sea and seabed…..to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.	
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 developed for this hazard are in line with the management measures listed for drilling wastes (cuttings and muds) in Section 4.5.8 of the guidelines, which include: • Select drilling fluid components to include the least ecotoxic options available that are suitable for the project **(IMP-06: EPS-01, -02)**. • Solids control equipment available onboard the drill rig to reduce the amount of residual drill fluids on cuttings prior to discharge **(IMP-06: EPS-03, -04, -05)**.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	The EPS developed for this hazard reflect the BAT in Section 17.2 of the guidance document, being: • Ensure engineering design for handling of drill cuttings/muds accounts for the minimisation of potential for environmental impact and exposure to hazardous materials in the event of a planned discharge or unplanned release **(IMP-06: EPS-01, -02)**. • For geographical areas where no previous environmental baseline survey has been performed, carry out an environmental baseline survey prior to drilling **(IMP-06: EPS-07)**. • Ensure that the handling of drill cuttings and drilling muds is addressed as part of management measures detailed in an EIA **(IMP-06: All EPS)**. • Where it is planned to discharge drill cuttings into the marine environment, perform analysis as part of a specialist technical study **(specialist study conducted)**. • Implement additional approaches as considered necessary to manage risks for specific operations, including but not limited to avoiding the use of oil-based muds, avoid cuttings and mud discharges in sensitive environments, discharge to achieve maximum dispersion of solids on the seabed **(IMP-06: EPS-01)**.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	No specific environmental guidance regarding cuttings and mud management (Section 3.3.2). One of the key objectives is to describe the details of the mud treatment equipment/systems that discharge to the environment, which has been outlined in this section.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • 51 - The selection of a drilling fluid should be made after evaluating its technical suitability and environmental impact. The use of fluids that contain diesel as the principal component of the drilling mud liquid phase is not good practice for offshore drilling programs and should be avoided **(IMP-06: EPS-01, -02)**.

		• 56 - Feasible alternatives for the disposal of spent WBM and cuttings from well sections drilled with either WBM or non-aqueous drilling fluids (e.g., SBM) should be evaluated. Options include injection into a dedicated disposal well offshore, injection into the annular space of a well, and containment and transfer to shore for treatment and disposal. When no alternative options are available, residual WBM might be discharged to sea at the end of a drilling program, provided that the overall EIA conducted for the site has considered this scenario, demonstrating the environmental acceptability of this practice. • 57 - When discharge to sea is the only alternative, a drilled cuttings and fluid disposal plan should be prepared, taking into account cuttings and fluid dispersion, chemical use, environmental risk and necessary monitoring. Discharge of cuttings to sea from wells drilled with non-aqueous drilling fluids should be avoided. If discharge is necessary, cuttings should be treated before discharge **(IMP-06: EPS-01, -02, -03, -04)**.
	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives for drilling: • 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 discharge of drill cuttings and muds to be acceptable because: • It will adhere to the company's Safety and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • Relevant legislation and industry best practice will be complied with; • Discharge of drill cuttings and muds will not have long-term or significant impacts on MNES; • The management of drill cuttings and mud discharges 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 drill cuttings and mud discharges 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	
• Mud chemical inventory. • Mud volumes discharged overboard. • Separation treatment system monitoring.	
Record Keeping	
• Daily drilling reports (DDRs). • Daily mud report (including chemical inventory). • End-of-well fluids report.	• MoC documents. • Incident reports.

7.7. IMPACT 7 – Discharge of Cement

7.7.1. Hazard

Activities that use cement are:

- Drilling – cement is used on board the MODU to cement the drill casing in place (sealing the annulus); and
- P&A – cement is used for setting abandonment plugs.

Cement is usually mixed as required ('on-the-fly') and hence waste is minimal. See Table 2.7 for the discharge volumes expected while drilling Beehive-1.

Bulk dry cement remaining onboard the MODU at the completion of drilling will be left on the MODU for use by the next operator. Failing that, the cement will be mixed with seawater and discharged overboard as a slurry.

7.7.2. Known and Potential Environmental Impacts

Cement discharges, like drill cuttings, can impact the environment through:

- Localised and temporary increased turbidity of the water column;
- Smothering of benthic habitat and fauna;

- Alteration of benthic substrate;
- Potential toxicity impacts to fauna; and
- Reduction of visual amenity from turbidity plumes.

7.7.3. EMBA

The EMBA for cement discharges is likely to be within the immediate vicinity of the discharge points (e.g., tens of metres to several hundred metres).

Receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Benthic fauna;
- Benthic habitat (sand substrates);
- Demersal fish; and
- Pelagic fish.

7.7.4. Evaluation of Environmental Impacts

Water column turbidity

Similar to drill cuttings dispersion and settling (see Section 7.6.4), cement discharges from the MODU (i.e., cement hose and equipment flushing) will form a turbid surface plume, where the larger, coarser components of the cement will precipitate. This would be expected to settle on the seabed within a radius of 100-200 m from the MODU. The remaining finer components are rapidly dispersed by ocean currents, aiding dispersion and dilution, and minimising water column turbidity. Although turbidity can decrease the available oxygen and light at the water surface (thereby reducing planktonic photosynthetic activity), the brief discharge periods and small volumes discharges result in only localised and temporary impacts.

Smothering of benthic habitat and fauna/alteration of seabed substrate

The minor volumes of cement that will be discharged at the seabed during cementing of the top hole section will result in localised smothering of benthic habitat and fauna. The discharge of cement on sandy seabed habitat will not result in impacts to sensitive benthic communities and this seabed type is widely represented in the region. A small area of hardened cement around the drill site will provide a surface for colonisation by epifauna that is not readily available in or around the activity, so there will be no net loss of seabed habitat.

Given the mobile nature of the sandy seabed sediments (see Section 5.2.3), any unconsolidated cement on the seabed will rapidly shift and disperse. Should colonising benthic species be present, impacts to them and their habitats will therefore be insignificant.

Toxicity impacts to marine fauna

Cement is considered inert (with the key component Portland cement being mostly calcium silicates, and aluminate and aluminoferrite). Portland cement is classified as non-CHARMable ‘E’ PLONOR under the OCNS.

While the cementing program has not yet been finalised, cement additives will be of low toxicity (according to OSPAR rankings, in line with drill fluids). As such, these constituents of the cement will have negligible chronic or acute toxicity impacts to benthic fauna or other fauna exposed to the cement.

In summary, cement discharges are small in volume, inert, unlikely to result in permanent smothering of benthic impact and are generally restricted to a highly localised area around the drill site (other than cement fines that rapidly disperse through the water column).

7.7.5. Impact Assessment

Table 7.24 presents the impact assessment for cement discharges.

Table 7.24. Impact assessment for cement discharges

Summary			
Summary of impacts	Localised and temporary turbidity of the water column, smothering of benthic habitat, potential toxicity impacts to benthic fauna.		
Extent of impacts	Localised – tens to hundreds of metres from the discharge point in the direction of dominant water currents.		
Duration of impacts	Short-term – intermittently during drilling.		
Level of certainty of impacts	HIGH – the impacts associated with cement discharges 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 & 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	Cement discharges are limited to the necessary amount to safely complete the well.		
Impact Consequence (inherent)			
Negligible			
Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
No cement discharges	Eliminate	No	**EB:** Eliminates impacts to benthic communities and the water column. **C:** Cementing is essential to maintain well integrity and the well cannot be drilled without cement. This is not an option. **Ev:** Cement discharges are a necessary component of safely completing the well casing. Adopting this measure would pose significant risks to the project.
Skip-and-ship (take cement discharges to shore)	Eliminate	No	**EB:** No cement discharges to the marine environment. **C:** Very high cost associated with vessel movements between the MODU and port, and onshore disposal costs. Increased vessel

			movements result in increased fuel use and associated GHG emissions. **Ev:** Environmental benefit is outweighed by the significant cost to implement this measure, especially given the negligible impact.
Chemical selection process **(IMP-07: EPS-01, -02)**	Engineering	Yes	**EB:** Ensures only low-toxicity chemicals are used in the cement system. **C:** Minor cost. **Ev:** Environmental benefit outweighs the minor cost to implement this measure.
Cement program **(IMP-07: EPS-03, -04)**	Administrative	Yes	**EB:** Ensures cement jobs are conducted in accordance with procedures and processes in order to minimise losses. **C:** No additional cost. **Ev:** Environmental benefit outweighs the cost to implement this measure.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Only low toxicity cement additives will be used.	**(IMP-07: EPS-01)** The Cement Engineer ensures that only PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated cement additives are used to minimise ecotoxicity impacts to marine fauna.	The Cement Chemical Inventory verifies that all additives are PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated.
	(IMP-07: EPS-02) Where for technical reasons an additive is required that has not been registered with CEFAS (and therefore does not have a rating), AGR will apply the CHARM, or in the case of non-CHARMable products, the OCNS process (https://www.cefas.co.uk/cefas-data-hub/offshore-chemicalnotification-scheme/hazardassessment-process/) to calculate the CHARM rating or OCNS grouping. Only additives with a hazard quotient of <30 (silver/gold ranking) or an OCNS grouping of D/E will be used.	MoC documentation verifies that, for products not registered with CEFAS, the CHARM and/or OCNS process has been applied and that only additives with a hazard quotient of <30 or an OCNS grouping of D/E are used.
Cement losses to the seabed during top hole cementing operations are minimised.	**(IMP-07: EPS-03)** Once good cement returns are detected, the mixing and pumping of cement will cease, and displacement of the string with drilling fluid will begin.	The Cement Job Report notes details the pumping schedule.
Cement remaining at the completion of drilling is	**(IMP-07: EPS-04)** As far as is practicably reasonable, all remaining cement slurry will be used in the casing job.	Records are available to verify that, in order of preference:

<table>
<tr><td rowspan="2">managed so as to avoid or minimise its discharge overboard.</td><td colspan="2">Where cement cannot be transferred to the next operator at the completion of drilling, it will be mixed with seawater and discharged overboard.</td><td rowspan="2">Effort was made to transfer cement to the next operator, and if that was not possible, then;
Effort was made to minimise the inventory of cement on board, and if that was not possible then;
Any leftover cement slurry was used in well plugs.</td></tr>
<tr><td colspan="2">(IMP-07: EPS-05) Bulk dry cement will not be discharged overboard (unless in an emergency situation).</td></tr>
<tr><th colspan="4">Impact Consequence (residual)</th></tr>
<tr><th colspan="4">Negligible</th></tr>
<tr><td colspan="4">The impact of cement discharges is assessed as negligible because:
The discharges will be small in volume and intermittent; and
The area of impact extremely small;
There is an absence of known sensitive seabed features in the activity area (e.g., shoals, reefs); and
The sandy seabed is well represented in the region.</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 9 describes 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>External context</td><td>Relevant persons</td><td colspan="2">No concerns regarding discharge of cement have been raised with EOG (see Table 4.2).</td></tr>
<tr><td>Legislative context</td><td colspan="3">There are no legislative controls regarding offshore cement discharges.
In the absence of Australian regulations or guidelines, cement additive selection complies with the North Sea OCNS, which implements the OSPAR Convention.</td></tr>
<tr><td rowspan="3">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 cement management Section 4.5.8 of the guidelines, which include:
Volume of cement to be used for each well to be planned to minimise excess bulk at the end of campaign and volumes discharged into the ocean (IMP-07: EPS-04).</td></tr>
<tr><td colspan="2">Best Available Techniques Guidance Document on</td><td>No guidance is provided regarding cement management.</td></tr>
</table>

	Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	No guidance is provided regarding cement management.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	No guidance is provided regarding cement management.
	APPEA CoEP (2008)	The EPS developed for this activity meet the code's following objectives for offshore drilling: • To reduce the risk of release of material into the marine environment to ALARP and to an acceptable level. • To reduce the impacts to benthic communities to acceptable levels and to ALARP.
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 discharge of cement to be acceptable because: • It will adhere to the company's Safety and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • Relevant legislation and industry best practice will be complied with; • Discharge of cement will not have long-term or significant impacts on MNES;	

	• The management of cement discharges 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 cement discharges will ensure it is not inconsistent with the aims of relevant marine reserve management plans; and • The management of cement discharges will not be inconsistent with ESD principles.
Environmental Monitoring	
• Real-time ROV observations during conductor cementing operations. • Tracking of cement volumes and chemical additives.	
Record Keeping	
• Cement chemical inventory. • Cement job report (and DDRs). • MoC documents.	• End-of-well cement report. • ROV footage and/or report.

7.8. IMPACT 8 – Routine Discharges – Putrescible Waste

7.8.1. Hazard

The generation of food waste (putrescible waste) from the MODU and support vessel galleys 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 MODU that has regularly worked in Australian waters, the typical volume of macerated waste discharged overboard is about 50 grams per person. Based on an assumed maximum POB of:

- MODU – assumed maximum POB for 120, equating to a discharge of ~7 kg/day.
- Support vessels – assumed POB of 30 for two vessels, equating to a discharge of 1.5 kg/day.

This waste is likely to float for a short time and if not consumed by fauna (such as pelagic fish and seabirds) quickly at the sea surface, it will become water-logged and sink through the water column.

NERA (2018) estimates the volume of putrescible waste to be in the order of 1-2 kg (0.001-0.002 m^3) per person per day. While this is likely to be an over-estimate, based on the same POB numbers listed above, an estimated 150-300 kg (0.15 – 0.3 m^3) of putrescible waste may be generated and discharged overboard daily.

7.8.2. 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).

7.8.3. 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:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

7.8.4. 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, its physical and microbial breakdown, together with the absence of habitats nearby sensitive to increased nutrients, ensures that the impacts of such discharges are insignificant and therefore have a negligible impact consequence.

7.8.5. Impact Assessment

Table 7.25 presents the impact assessment for putrescible waste discharges.

Table 7.25. 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 impacts to 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 in a tropical environment. The discharge of macerated putrescible waste (and unmacerated putrescible waste when >12 nm from shore) is permitted by legislation. **Ev:** Cost of this control measure is grossly disproportionate to the negligible consequence.
GMP **(IMP-08: EPS-01)**.	Engineering	Yes	**EB:** Reduces probability of garbage being inappropriately discharged to sea, reducing potential impacts to fauna. **C:** Negligible; part of routine MODU and 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-08: EPS-02, -03, -04).**	Engineering	Yes	**EB:** Reduces probability of putrescible waste being inappropriately discharged to sea, reducing impacts to water quality and marine fauna. **C:** Negligible; part of routine MODU and 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 MODU and vessel crews **(IMP-08: EPS-05)**.	Administrative	Yes	**EB:** Reduced likelihood of inappropriate waste disposal to the sea. **C:** Negligible; part of routine MODU and vessel operations. **Ev:** Environmental benefits can be achieved with little additional cost.

Environmental Performance Objectives and Measurement		
EPO	EPS	Measurement criteria
Putrescible waste discharges meet MARPOL Annex V requirements.	**(IMP-08: 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.
	(IMP-08: EPS-02) A macerator is on board the MODU and vessels, functional, in use and set to macerate putrescible waste to a particle	PMS records verify that the macerator is functional and regularly maintained or replaced.

	size ≤25 mm using to ensure rapid breakdown upon discharge.	
	(IMP-08: EPS-03) Records of food waste disposal to be maintained in a Garbage Record Book.	A Garbage Record Book is in place and verifies waste discharge locations and volumes.
	(IMP-08: EPS-04) Only macerated putrescible waste (≤25 mm) is discharged overboard (noting that un-macerated putrescible waste is permitted to be discharged as the MODU and support vessels will be >12 nm from shore). Un-macerated putrescible waste is only discharged overboard in the event of macerator malfunction or other emergency.	
	(IMP-08: EPS-05) Waste management and housekeeping requirements are communicated to all MODU and vessel crews to ensure discharges are in accordance with MARPOL Annex V.	MODU and vessel induction includes waste management requirements.

Impact Consequence (residual)
Negligible
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.
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 9 describes the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual impact consequence is negligible, which is considered acceptable.	
External context	Relevant persons	No objections or claims have been made by relevant persons with regard to putrescible waste discharges.
Legislative context	The EPS align with the requirements of: • *Navigation Act* 2012 (Cth):	

<table>
<tr><td></td><td colspan="2">Chapter 4 (Prevention of Pollution).
AMSA Marine Order 95 (Marine Pollution Prevention - garbage).
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
Section 26F (which implements MARPOL Annex V).</td></tr>
<tr><td rowspan="6">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:
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-08: EPS-02 and -04).</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>The EPS listed in this table meet these guidelines for offshore activities with regard to:
Environmental monitoring (item 26). The BAT guidelines are met for the activity with regard to monitoring waste streams.</td></tr>
<tr><td>Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)</td><td>There is no specific guidance regarding putrescible waste discharges.
Section 2.3.6.2 (management of waste) of the guideline states that, among other things, waste management and disposal options should be evaluated.
Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.</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:
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-08: EPS-04).</td></tr>
<tr><td>APPEA CoEP (2008)</td><td>The EPS for this activity meet the code’s following objectives for offshore drilling operations:
To reduce the volume of wastes produced to ALARP and to an acceptable level.</td></tr>
<tr><td rowspan="5">Environmental context</td><td colspan="2">MNES</td></tr>
<tr><td>AMPs</td><td>This hazard will not impact the conservation values of nearby AMPs.</td></tr>
<tr><td>Ramsar wetlands</td><td>This hazard will not intersect any Ramsar wetlands.</td></tr>
<tr><td>TECs</td><td>This hazard will not intersect any TECs.</td></tr>
<tr><td>Nationally threatened and migratory species</td><td>This hazard will not have any significant impacts on threated or migratory species.</td></tr>
</table>

	Other matters	
	KEFs	This hazard will not intersect any KEFs.
	NIWs	This hazard will not intersect any NIWs.
	State marine parks	This hazard not intersect any state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	This hazard will 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 and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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.	

7.9. IMPACT 9 - Routine Discharges – Sewage and Grey Water

7.9.1. Hazard

The use of ablution, laundry and galley facilities by MODU and support 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.

Total volumes of sewage and grey water typically generated at offshore facilities range between 0.04 and 0.45 m^3 per person per day (NERA, 2017). Assuming a POB of 120 on the MODU and 30 on both support vessels (a total of 150 people), this equates to between 6 and 68 m^3 of sewage and grey water generated daily.

AMSA (2016) states that most large vessels generate 5-15 m^3 wastewater per day, the majority of which is grey water (wastewater from showers, laundry, galley and wash basins).

7.9.2. 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 MODU and support vessels; and
- An associated increase in scavenging behaviour of marine fauna and seabirds (at the sea surface or in the water column).

7.9.3. EMBA

The EMBA for sewage and grey water discharges associated with MODU and support 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:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

7.9.4. 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 the open oceanic waters of the JBG, 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.

7.9.5. Impact Assessment

Table 7.26 presents the impact assessment for the discharge of treated sewage and grey water.

Table 7.26 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 of transport to port for onshore disposal, associated increase in emissions (such as GHG) and increased health and safety risk involved with storing organic wastes onboard, particularly in a tropical environment. Discharges are permitted by legislation. **Ev:** Cost is grossly disproportionate to the negligible consequence associated with the discharges.
Sewage and grey water treatment and discharges are managed in accordance with MARPOL Annex IV **(IMP-09: EPS-01, -02, -03, -04)**	Engineering	Yes	**EB:** Reduces potential impacts of inappropriate discharge and ensures compliance with Marine Order 96 and MARPOL requirements as appropriate for vessel class. **C:** Cost of installing and maintaining STPs can be high, but are part of routine MODU and support vessel operations. **Ev:** Environmental benefits outweigh the costs.
Environmental Controls and Performance Measurement			
EPO	EPS	Measurement criteria	
Water pollution is avoided by treating sewage and grey	**(IMP-09: EPS-01)** The STPs meet MARPOL standards.	ISPP certificates are valid and verify the installation of MARPOL-approved STPs.	

<table>
<tr><td rowspan="3">water prior to discharge.</td><td colspan="2">(IMP-09: EPS-02) The STPs are maintained in accordance with the MODU and support vessels’ PMS.</td><td>PMS records confirm that the STPs are maintained to schedule.</td></tr>
<tr><td colspan="2">(IMP-09: EPS-03) All sewage and grey water is treated in the STPs prior to overboard discharge.</td><td>No reports of discharge being diverted around the STP in DDRs.</td></tr>
<tr><td colspan="2">(IMP-09: EPS-04) In accordance with Regulation 11 of MARPOL Annex IV (as enacted by Marine Order 96), sewage is comminuted, disinfected and discharged from the support vessels:
When they are >3 nm from the nearest shore.
At a moderate rate while proceeding en route at a speed not less than 4 knots.
In the event of a STP malfunction or other emergency, untreated sewage and grey water can be discharged (because they are >12 nm from shore when in the operational area).</td><td>Records verify that treated sewage is only discharged when the support vessel is >3 nm from shore and at a speed not less than 4 knots (unless the STP has malfunctioned or in an emergency).</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 treated sewage and grey water discharges is assessed as negligible because of:
The temporary and intermittent nature of the discharges;
The consistent movement of the support vessels;
Low discharge volumes;
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.</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 9 describes 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 regarding treated sewage and grey water discharges.</td></tr>
<tr><td>Legislative context</td><td colspan="3">The EPS align with the requirements of:
Navigation Act 2012 (Cth):</td></tr>
</table>

	○ 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-09: EPS-03)**. • Sewage units to be in compliance with MARPOL Annex V requirements **(IMP-09: 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.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	While Section 3.4.5 of the guideline states that the arrangements for sewage and grey water discharges are to be described, there is no specific guidance regarding sewage and grey water discharges. Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.
	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). Grey and black water should be treated in an appropriate on-site marine sanitary treatment unit in compliance with MARPOL **(IMP-09: EPS-01, -03)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore drilling operations: • To reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs	This hazard will not impact the conservation values of the JBG AMP.
	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 significant impacts on threated 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 treated sewage discharges to be acceptable because: • It will adhere to the company's Safety and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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. • DDRs		

7.10. IMPACT 10 - Routine Discharges – Cooling and Brine Water

7.10.1. Hazard

Seawater is used as a heat exchange medium for cooling machinery engines and other equipment on the MODU and support 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 MODU and support 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.

7.10.2. 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 fauna;
- 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.

7.10.3. EMBA

The EMBA for cooling water and brine discharges associated with MODU and 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) (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

7.10.4. 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.

7.10.5. Impact Assessment

Table 7.27 presents the impact assessment for the discharge of cooling and brine water.

Table 7.27. 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 MODU and vessel modifications to enable onboard storage. **Ev:** Cost outweighs the environmental benefit given the minor inherent consequence.
Low toxicity chemicals **(IMP-10: 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-10: EPS-02)**.	Engineering	Yes	**EB:** Minimises the likelihood of out-of-specification discharges. **C:** Negligible; part of routine MODU and support vessel operations. **E:** Environmental benefits can be achieved with negligible additional cost.
Freshwater generation volumes **(IMP-10: EPS-03)**.	Engineering	Yes	**EB:** Minimises the volume of brine discharges. **C:** Negligible; part of routine MODU and support vessel operations. **E:** Environmental benefits can be achieved with negligible additional cost.
PMS **(IMP-10: EPS-04)**.	Engineering	Yes	**EB:** Minimises the likelihood of out-of-specification discharges. **C:** Negligible; part of routine MODU and 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-10: 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.	Chemical inventories records verify that biocides and scale inhibitors are of low toxicity.

<table>
<tr><td></td><td>(IMP-10: EPS-02) Biocide dosing kept to a minimum in accordance with the equipment manufacturer’s specifications.</td><td>PMS data verifies minimum biocide dosage.</td></tr>
<tr><td rowspan="2">The RO plant and equipment that requires cooling by water is well maintained.</td><td>(IMP-10: EPS-03) Freshwater generation will be limited to volumes necessary for operational requirements.</td><td>Tank volumes verify minimum requirement for freshwater generation.</td></tr>
<tr><td>(IMP-10: EPS-04) Plant and equipment that requires cooling by water is maintained in good working order in accordance with the PMS.</td><td>PMS records verify that equipment that requires cooling is well maintained.</td></tr>
<tr><th colspan="3">Impact Consequence (residual)</th></tr>
<tr><th colspan="3">Negligible</th></tr>
<tr><td colspan="3">The consequence of cooling and brine water discharges is assessed as negligible because of the:
• Temporary nature of the activity;
• Support vessels 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 the open waters of the JBG; and
• Absence of sensitive habitats in the activity area.</td></tr>
<tr><th colspan="3">Demonstration of ALARP</th></tr>
<tr><td colspan="3">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="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 9 describes 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>External context</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>Legislative context</td><td colspan="2">There are no legislative controls regarding cooling and brine water discharges.</td></tr>
<tr><td rowspan="2">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:</td></tr>
</table>

		• Biocide dosing kept to a minimum in accordance with the equipment manufacturer's specifications **(IMP-10: EPS-02)**. • Freshwater generation to be limited to volumes necessary for operational requirements **(IMP-10: EPS-03)**.
	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 cooling and brine water discharges.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	There is no specific guidance regarding cooling and brine water discharges. Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.
	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-10: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.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore drilling operations: • To reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs	This hazard will not impact the conservation values of 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 significant impacts on threated 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 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 and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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.		

7.11. IMPACT 11 – Routine Discharges – Bilge Water and Deck Drainage

7.11.1. Hazard

Bilge tanks on the MODU and support 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.

MODU and support 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.

7.11.2. 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.

7.11.3. 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:

- Plankton;
- Pelagic fish;
- Marine mammals;
- Marine reptiles; and
- Seabirds.

7.11.4. 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 OWS malfunction and discharge 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.

7.11.5. Impact Assessment

Table 7.28 presents the impact assessment for the discharge of bilge water and deck drainage.

Table 7.28. 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 MODU and vessel operations.	
Level of certainty of impacts	HIGH – the impacts of oily water discharges to the ocean 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	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 the MODU and vessels. **Ev:** Cost to implement control measures outweighs the benefit given the negligible inherent consequence.
Oily water treatment system **(IMP-11: 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, but it is legislated requirement and part of routine MODU and support vessel operations. **Ev:** Benefits to the marine environment outweigh the costs.

Maintain bilge water systems **(IMP-11: 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 and part of routine MODU and support vessel operations. **Ev:** Benefits to the marine environment outweigh the costs.
Bunding of hydrocarbons and chemical storage areas **(IMP-11: EPS-07, -08)**	Engineering	Yes	**EB:** Reduces the likelihood that a spill will be discharged overboard. **C:** Minor equipment installation and maintenance costs. **Ev:** Environmental benefit outweighs the costs.
SMPEP **(IMP-11: EPS-05, -09, -10).**	Administrative	Yes	**EB:** Documented and 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-11: EPS-06).**	Administrative	Yes	**EB:** Avoids toxic water discharges. **C:** Minor additional cost of environmentally acceptable deck cleaning products. **Ev:** Environmental benefits outweigh 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-11: 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-11: EPS-02) The OWS is maintained in accordance with the PMS.	PMS records verify that the OWS is maintained to schedule.
	(IMP-11: EPS-03) The OWS is calibrated in accordance with the PMS to ensure the 15 ppm OIW limit is met.	PMS records verify that the OWS is calibrated to schedule.
	(IMP-11: 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 MODU and support vessel contractor.	**(IMP-11: EPS-05)** The MODU or vessel-specific SMPEPs are 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-11: 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-11: 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 they drain to the bilge tank.
	(IMP-11: 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-11: EPS-09)** The MODU and support 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 MODU and support vessel crews receive spill response training.
	(IMP-11: 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; • Support vessels will be constantly moving; • Discharges will be low volume and intermittent; • High energy offshore waters of the JBG will aid in dilution of discharges; and • EMBA 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		

<table>
<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 9 describes 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>External context</td><td>Relevant persons</td><td>There have been no objections or claims raised by relevant persons regarding bilge water discharges and deck drainage.</td></tr>
<tr><td>Legislative context</td><td colspan="2">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).</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 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 (deck drainage and bilge water) in Section 4.5.2 of the guidelines:
• MODU and 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-11: 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-11: EPS-07, -08).
• MODU and vessels to maintain an Oil Record Book (applicable to vessels >400 gross tonnes), including the discharge of dirty ballast or cleaning water (IMP-11: 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-11:EPS-01, -03).
• Contaminated deck drainage and bilge water to be contained and treated prior to discharge. If treatment is not possible, these waters should be contained and shipped to shore for disposal.
• Extracted hydrocarbons from OWS to be stored in suitable containers and transported to shore for treatment and/or disposal by a certified waste oil disposal contractor (IMP-11: EPS-04).</td></tr>
</table>

	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 drain water (item 24). The BAT are met for MODU and 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-11: EPS-09)**.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	While Section 3.2.3.2 (ballast and bilge systems for jack-ups) of the guideline states that bilges be kept clean, there is no specific guidance regarding discharges. Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.
	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 the MODU and vessels should be routed to the closed drain system or contained and treated before discharge to meet MARPOL requirements **(IMP-11: 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-11: EPS-07)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore drilling operations: • To reduce the risk of release of substances into the marine environment to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs	This hazard will not impact the conservation values of 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 significant impacts on threated or migratory species.
	Other matters	
	KEFs	This hazard will not intersect any KEFs.
	NIW	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 impact from bilge water discharges and deck drainage to be acceptable because: • It will adhere to the company's Safety and Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • 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.	

8. Environmental Risk Assessment – Unplanned Events

This chapter presents the environmental risk assessment (ERA) for the environmental 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 risks. The definitions for these terms as listed at the start of Chapter 7 apply here. A summary of the risk rankings for each hazard identified and assessed in this chapter is presented in Table 8.1.

Table 8.1. Summary of environmental risk rankings

Identifier	Hazard	Inherent	Residual
1	Accidental release of waste overboard	Low	Negligible
2	Vessel collision with megafauna	Low	Negligible
3	Introduction and establishment of IMS	High	Medium
4	Interference with other marine users	Medium	Low
5	Unplanned discharge of drilling muds, chemicals or hydrocarbons	Negligible	Negligible
6	MDO release	Negligible	Negligible
7	Loss of well containment		
	- Benthic fauna	High	Medium
	- Macroalgal and seagrass	High	Medium
	- Coral	High	Medium
	- Mangroves and saltmarsh	High	Medium
	- Sandy beaches	High	Medium
	- Rocky shores	Low	Low
	- Plankton	Low	Low
	- Fish	Low	Low
	- Marine mammals	High	Medium
	- Marine reptiles	High	Medium
	- Seabirds and shorebirds	High	Medium
	- Commercial fisheries	High	Medium
	- Protected areas	High	Medium
8	Hydrocarbon spill response activities		
	- Source control; relief well	Negligible	Negligible
	- Monitor and evaluate	Negligible	Negligible
	- Dispersant application	Low	Low
	- Nearshore containment and recovery	Negligible	Negligible

Identifier	Hazard	Inherent	Residual
	- Shoreline protection and deflection	Negligible	Negligible
	- Shoreline assessment and clean up	Low	Low
	- Oiled wildlife response	Low	Low
	- Waste management	Negligible	Negligible
	Faunal receptors - Fauna disturbance	Negligible	Negligible
	- Fauna injury	Negligible	Negligible
	- Fauna death	Negligible	Negligible

The following sections assess the environmental risks associated with the activity, and Figure 8.1 presents a simplified pictorial representation of these risks.

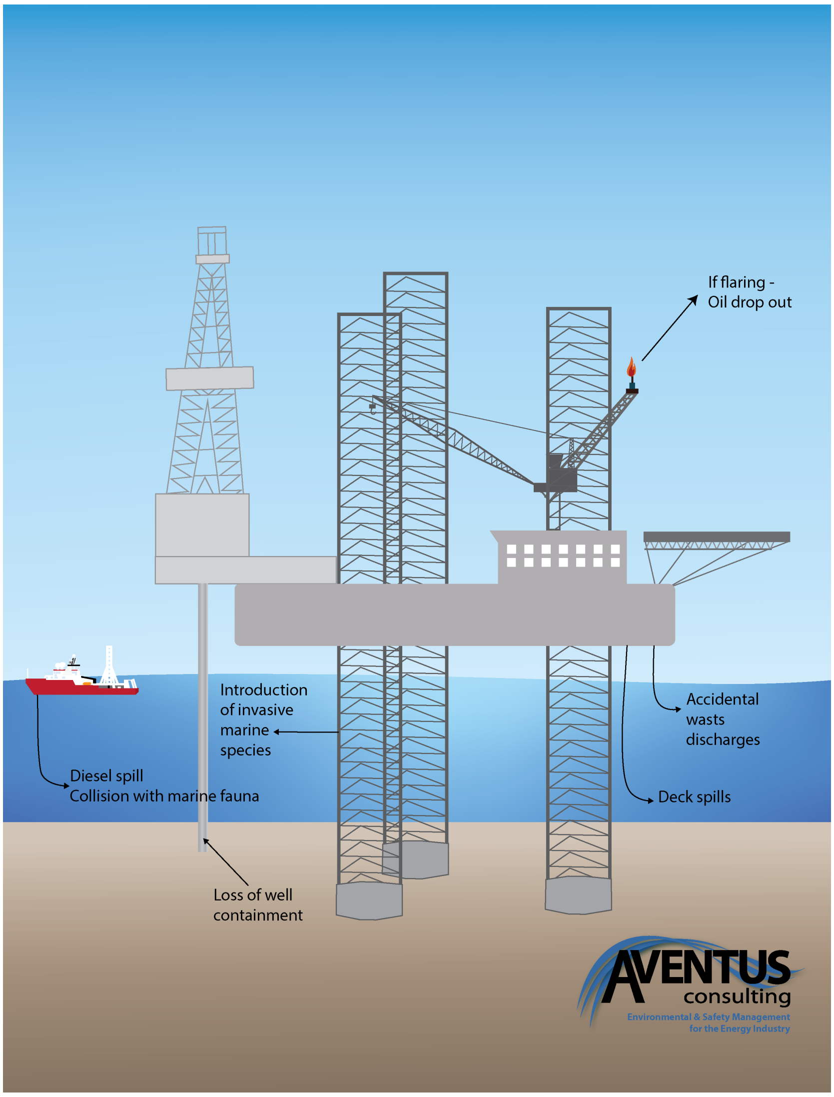


Figure 8.1. Simplified pictorial representation of the risks associated with the drilling activity

8.1 RISK 1 – Accidental Release of Waste Overboard

8.1.1. Hazard

The handling and storage of materials and waste on board the MODU and support vessels 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 MODU or support 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, reuse or recycling at licensed onshore facilities. However, accidental releases to sea are a possibility, especially in poor weather and 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.

8.1.2. Potential Environmental Risks

The risks of the release of hazardous and non-hazardous materials and waste to the ocean are:

- Marine pollution (litter 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.

8.1.3. 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 and settle on the seabed.

Receptors susceptible to waste that may occur within this EMBA, either as residents or migrants, are:

- Benthic fauna;
- Benthic habitat (sandy seabed);
- Pelagic fauna (fish, cetaceans and turtles); and
- Seabirds.

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 operational area or EMBA) are:

- The six turtle species (loggerhead, green, flatback, olive ridley, leatherback and hawksbill);
- Sawfish and river sharks;
- Seabirds (Australian noddy, shearwater); and
- Cetaceans (Australian snubfin dolphin, Australian humpback dolphin, PBW).

8.1.4. 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 turtles 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.

The following turtles may be at risk from waste at sea:

- Green turtle – foraging BIA is overlapped by the operational area. They generally feed in shallow waters far from the operational area, so their risk of ingesting waste (such as plastics) is low given their distance of their preferred habitats from Beehive-1.
- Flatback turtle – inter-nesting BIA is overlapped by the operational area. Their foraging BIA is about 90 km from the operational area, but because adults consume soft-bodied invertebrates, they may be at risk of ingesting plastic wastes floating in the ocean. This risk is low given the distance of the foraging BIA from the operational area.
- Olive ridley turtle – foraging BIA is overlapped by the operational area. Although this species forages primarily at the seabed, they also consume soft-bodied invertebrates and therefore may be at risk of ingesting plastic wastes floating in the ocean. This risk is moderate given the foraging BIA overlaps the operational area.

If dropped objects such as skip bins are not retrievable (e.g., by crane), these items may permanently smother small areas of seabed (tens of square metres), 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 corals) and become a focal area for sea life, so the net environmental impact is likely to be neutral. The benthic habitats in this EMBA are broadly similar to those elsewhere in the region (e.g., extensive sandy seabed, see Section 5.4.1), so impacts to small 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 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 small areas of seabed will not result in the long-term loss of benthic habitat or species diversity or abundance.

All hazardous waste will be safely transported offshore in suitable receptables and 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 8.2. Though the relevant management actions target the commercial fishing industry, the guiding principle of the management action has been applied to the activity.

Table 8.2. Assessment of the relevant management actions of the Approved Conservation Advice for the Humpback Whale

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 8.6 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.
Investigate alternative fishing techniques and technologies to reduce the risk of entanglement.	

TSSC (2015a).

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 (albeit low) to contribute to marine debris, an assessment of the management actions and objectives has been provided in Table 8.3.

Table 8.3. 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

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 8.6 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 8.6 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.
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.

Objective and associated management actions	Assessment
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.
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.

Objective and associated management actions	Assessment
Improve public communication about consumer waste and litter.	The activity will not have any impacts on this management action.

DoE (2018).

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 8.4.

Table 8.4. Assessment of the relevant interim recovery objectives and targets of the Recovery Plan for Marine Turtles 2017-2027 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 8.6 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.

DoEE (2017c).

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 8.5.

Table 8.5. Assessment of the relevant recovery objectives and relevant actions of the Sawfish and River Sharks Multispecies Recovery Plan 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 8.6 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 impede upon the migration of individual sawfish or river sharks.	The EPS listed in Table 8.6 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.
Action 5b. Determine the effect of river and estuarine barriers on the movements of sawfish	The activity will not have any impacts on this management action.

Objective or management action	Assessment
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.	
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 8.6 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 8.6 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 8.6 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.

DoE (2015c).

8.1.5. Risk Assessment

Table 8.6 presents the risk assessment for the accidental disposal of hazardous and non-hazardous materials and waste.

Table 8.6. Risk assessment for the accidental release of waste overboard

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.	
	Decision type	A - good industry practice required.

Risk 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	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 MODU and support vessels 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 additional routine vessel impacts and risks. **Ev:** Cost to implement is grossly disproportionate to the benefit given the low inherent risk rating.
MODU and 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 educate personnel. **Ev:** Benefits of ensuring responsible waste management outweighs the negligible cost.
Recover accidentally discharged solid 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:** Medium to high costs dependent on the duration of down-time to retrieve materials. **Ev:** Environmental benefit of recovering marine debris outweighs the costs.
Handling and storage procedures **(RSK-01: EPS-06, -12, -13, -14, -15).**	Administrative	Yes	**EB:** Reduces the likelihood that materials will be accidentally lost overboard. **C:** Negligible; it is a standard maritime requirement. Minor administrative cost to produce documents and educate personnel. **Ev:** Environmental benefit outweighs the negligible costs.

Dropped object prevention procedure **(RSK-01: EPS-07, -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.
PMS **(RSK-01: EPS-08)**	Engineering	Yes	**EB:** The maintenance of lifting equipment minimises the likelihood of dropped objects. **C:** Negligible; it is a standard maritime requirement. Minor administrative costs associated with maintaining the PMS. **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. • Correct segregation of solid and hazardous wastes.	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.
	(RSK-01: EPS-03) MODU and 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 manifest 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 MODU and 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) 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 MODU and 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 prevents bulk release.	**(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 lockers that drain to bilge tanks.
	(RSK-01: EPS-13) MODU and 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

<table>
<tr><td rowspan="3"></td><td colspan="2"></td><td>and in accordance with OEM requirements.</td></tr>
<tr><td colspan="2">(RSK-01: EPS-14) Where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.</td><td>Visual inspection verifies that where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.</td></tr>
<tr><td colspan="2">(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.</td><td>PTW records verify that crane transfers of bulk chemicals and hydrocarbons are undertaken in accordance with the procedure.</td></tr>
<tr><th colspan="4">Risk Assessment (residual)</th></tr>
<tr><th colspan="2">Likelihood</th><th>Consequence</th><th>Risk rating</th></tr>
<tr><td colspan="2">Rare</td><td>Minor</td><td>Negligible</td></tr>
<tr><td colspan="4">The risk of accidental discharge of waste to the ocean is assessed as negligible because:
• Volumes of waste generated will be small due to the nature of the activity; and
• Implementation of the control measures reduces the likelihood to accidental discharge of waste to the ocean to ALARP.</td></tr>
<tr><th colspan="4">Demonstration of ALARP</th></tr>
<tr><td colspan="4">A ‘negligible’ 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="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 9 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 risk is negligible, which is considered acceptable.</td></tr>
<tr><td>External context</td><td>Relevant persons</td><td colspan="2">No objections or claims have been raised by relevant persons regarding accidental release of wastes to the ocean.</td></tr>
<tr><td>Legislative context</td><td colspan="3">The EPS align with the requirements of:
• Navigation Act 2012 (Cth):
o Chapter 4 (Prevention of Pollution).
o Marine Orders Part 94 (Marine pollution prevention – packaged harmful substances).
o Marine Orders Part 95 (Marine pollution prevention – garbage).
• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
o Part III (Prevention of pollution by noxious substances).
o Part IIIA (Prevention of pollution by packaged harmful substances).
o Part IIIC (Prevention of pollution by garbage).</td></tr>
</table>

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 (**RSK-01: EPS-12, -14, -15**).
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	The EPS developed for this activity meet the following requirements. • Section 2.3.6.2 (management of waste) of the guideline states that regulatory requirements should be identified, waste tracking methods be developed and that waste minimisation opportunities should be identified. • Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared.
	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.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore drilling activities:

		• 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 MODU and 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 **(RSK-01: EPS-02, -06, -12, -14)**.
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 reach 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 8.2.

		• Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia's coasts and oceans (DoEE, 2018) - Table 8.3. • Recovery Plan for Marine Turtles 2017-2017 (DoEE, 2017c) - Table 8.4. • The Sawfish and River Shark Multispecies Recovery Plan (DoE, 2015c) - Table 8.5.
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 9) 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		
• Contractor pre-qualification reports. • GMPs. • Garbage Record Books. • Crew induction and attendance records.	• Inspection records/checklists. • Shore-based waste contract. • Incident reports.	

8.2 RISK 2 – Vessel Collision with Megafauna

8.2.1 Hazard

The movement of the drilling support vessels throughout the operational area on a 24-hr basis has the potential to result in collision with megafauna, this being marine mammals (whales, dolphins, dugong), whale sharks and turtles.

The MODU legs will not present a strike hazard to megafauna as they are stationary and readily detected and avoided by megafauna. In petroleum production provinces around Australia, marine mammals such as whales, dolphins and seals swim around platform jackets without any apparent risk of injury.

8.2.2 Potential Environmental Risks

The risks of vessel strike with megafauna are:

- Injury; and
- Death.

8.2.3 EMBA

The EMBA for vessel strike with megafauna is the immediate area around the support vessel.

8.2.4 Evaluation of Environmental Risks

Cetaceans

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 5.4.5).
- 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 5.4.5).
- 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 (see Section 5.4.6).

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 support vessels are operating within the operational area, they 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 'vessel disturbance in the form of collisions' to be a threat that may inhibit the recovery of the species. An assessment of the relevant management actions listed in the Conservation Management Plan against the activity is provided in Table 8.7.

Table 8.7. Assessment of relevant management actions of the Conservation Management Plan for the Blue Whale 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 8.13 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 8.13 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 and high priority research projects identified in this plan are achieved or underway.	The information presented throughout this section and the subsequent EIA presented in Table 8.13 is based on high 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 8.13 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 8.13. Therefore, the activity will be consistent with this action.

Management Action	Assessment
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 8.13. Therefore, the activity will be consistent with this action.

DoE (2015a).

The Approved Conservation Advices for the Sei Whale (TSSC, 2015b) and the Fin Whale (TSSC, 2015c) list vessel strike as a threat with a minor consequence rating. An assessment of the listed management actions with the activity is provided in Table 8.8.

Table 8.8. Assessment of relevant management actions of the Approved Conservation Advice for the Sei Whale and Fin Whale 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 8.13. Therefore, the activity will be consistent with this action.

TSSC (2015b;c).

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 8.9.

Table 8.9. Assessment of relevant management actions of the Approved Conservation Advice for the Humpback Whale 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 with an appropriate EPS developed in Table 8.13. 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 8.13. Therefore, the activity will be consistent with this action.

TSSC (2015a).

There is a CMP in place for the southern right whale, but given it is unlikely to occur in the activity area, an assessment of the activity against this plan is not presented.

Table 8.10 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 8.10. Assessment of the objectives and relevant management actions of the National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna 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 8.12 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 8.12 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.	

DoEE (2017a).

Turtles

The operational EMBA overlaps the following turtle BIAs (Figure 7.2):

- Green turtle – foraging;
- Flatback turtle – inter-nesting; and
- Olive Ridley turtle – foraging.

When these turtles are migrating through or foraging in the operational area , they may be at risk of colliding with support vessels when they surface to breathe and rest. However, only a small portion of their time is spent at the surface, as they typically spend more than 90% of their time underwater (Lutcavage and Lutz, 1997; Hochscheid *et al*., 2010).

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 8.11 presents an assessment of the relevant objectives and targets of the Recovery Plan for Marine Turtles in Australia with the activity.

Table 8.11. Assessment of the relevant interim recovery objectives and targets of the Recovery Plan for Marine Turtles 2017-2027 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 8.12 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.

DoEE (2017c).

Whale sharks

The whale shark may occur in the operational area and are known to seasonally aggregate in shallow tropical waters off the North West Cape in WA in March and April (DAWE, 2021b). Given there is little spatial overlap between this species' known migration routes, and unlikely to be a temporal overlap with the drilling window, vessel collisions with whale sharks and the support vessels has a low risk of occurring.

Nevertheless, whale sharks do spend considerable time close to the surface. Whale sharks tagged off the WA coast (Wilson *et al*., 2006; Gleiss *et al*., 2013) spent approximately 25% of their time less than 2 m from the sea surface, which increases their vulnerability to vessel strike (DoEE, 2017b).

The Approved Conservation Advice (TSSC, 2015a) notes that the threat to the recovery of the species includes strikes from vessels.

Table 8.12. Assessment of the relevant conservation actions of the Conservation Advice for whale sharks with the activity

Interim Objective or Target	Assessment
Minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations (Ningaloo Reef, Christmas Island and the Coral Sea) and along the northward migration route that follows the northern WA coastline along the 200 m isobath.	The activity is 300 km from the whale shark BIA, 1,700 km from known aggregation areas (Ningaloo Reef) and 450 km south the 200 m isobath. The EPS listed in Table 8.13 will reduce the likelihood of vessel strike with whale sharks to ALARP.
Assess the impacts of offshore installations and associated environmental changes (light spill, chronic noise, changed water temperature, localised nutrient levels) on whale sharks and mitigation options for these impacts.	The EIA presented in Chapter 7 of the EP indicates the emissions and discharges associated with this activity will have a negligible impact on marine fauna.

Interim Objective or Target	Assessment
Conduct further research into the impacts of boat strike on whale sharks to determine the significance of the threat. Consider possible mitigation actions (collision avoidance systems) if required.	The activity will have no impacts on this research priority

TSSC (2015).

8.2.5 Risk Assessment

Table 8.13 presents the risk assessment for vessel collision or entanglement with megafauna.

Table 8.13. Risk assessment for vessel collision with megafauna

Summary			
Summary of risks	Injury or death of megafauna.		
Extent of risks	Localised – limited to individuals coming into contact with a support vessel.		
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 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 support vessels.	Eliminate	No	**EB:** Eliminates the potential collision hazard. **C:** The activity could not proceed. **Ev:** The use of support vessels is the only way in which the activity can proceed. The cost of not using them 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 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 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.
Restrict support vessel speed to no greater than 6 knots in the activity area.	Administrative	No	**EB:** Reduces the risk of collision with megafauna. **C:** In the event of an emergency, the support vessels may need to travel at speeds >6 knots. There may be a human health or safety cost of not being able to do so. **Ev:** Preventing vessels from travelling at speed in the event of an emergency is not commensurate with the negligible risk rating for this hazard.
Dedicated marine fauna observer (MFO) onboard the support vessels.	Administrative	No	**EB:** Improves the ability to spot megafauna by allowing vessel Masters to focus on navigation duties, thereby reducing the risk of collision. **C:** Tens of thousands of dollars over the duration of the drilling program, increasing if sourcing MFOs and/or logistics issues means that MFOs cannot be sourced in time for the scheduled start date. **Ev:** The cost of dedicated MFOs on the support vessels is grossly disproportionate to the negligible residual risk associated with this hazard and in light of the low likelihood of high numbers of megafauna in the operational area.
Australian National Guidelines for Whale and Dolphin Watching (2017) (giving effect to the 'interacting with cetaceans and whale watching' in EPBC Regulations Part 8) **(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 vessel 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 present to crew. **E:** Environmental benefit outweighs cost.
Notification and reporting of collisions	Administrative	Yes	**EB:** Reduces risk of physical impacts to cetaceans from the activity vessels. **C:** No additional costs.

with megafauna **(RSK-02: EPS-03, -04).**			**Ev:** Environmental benefit can be achieved without costs.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
No collision 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. • Recording all interactions.	Daily operations reports note marine megafauna interactions.
	(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.
Vessel strike is reported to regulatory authorities.	**(RSK-02: EPS-03)** 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-04) Injured 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

<table>
<tr><td colspan="3">The risk of vessel strike 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
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’ 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 & Environmental Policy objectives are met.</td></tr>
<tr><td>EMS compliance</td><td colspan="2">Chapter 9 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>External context</td><td>Relevant persons</td><td>No objections or claims have been raised by relevant persons regarding vessel strike 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="3">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-01).</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>
</table>

	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	There is no specific guidance regarding minimising the risk of megafauna collisions. Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.
	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 drilling operations: • 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 **(RSK-02: EPS-01).**
	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 **(RSK-02: EPS-01)**.
Environmental context	MNES	
	AMPs	The risk of collisions with megafauna will not have any effect on nearby AMPs.
	Ramsar wetlands	The risk of collisions with megafauna will not have any effect on Ramsar wetlands.
	TECs	The risk of collisions with megafauna will not have any effect on TECs.
	Nationally threatened and migratory species	The low speed or stationary nature of the support vessels, along with the temporary nature of the activity, makes it unlikely that vessel strike with megafauna will occur. This section provides 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 will not have any effect on KEFs.
	NIWs	The risk of collisions with megafauna will not have any effect on NIWs.
	State marine parks	The risk of collisions with megafauna will not have any effect on state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Vessel collisions 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 with megafauna. This section provides 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 9) 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; • Collisions with megagauna will not have long-term or significant impacts on MNES;	

	• Control measures in place to prevent collisions with megafauna are not inconsistent with the aims of recovery plans/conservation plans/advice that are in force for EPBC Act-listed threatened and migratory species; • Control measures in place to prevent collisions with megafauna are not inconsistent with the aims of relevant marine reserve management plans; and • The control measures are not inconsistent with ESD principles.
Environmental Monitoring	
• Constant bridge watch on support vessels.	
Record Keeping	
• Vessel crew induction presentation and attendance records. • Megafauna sighting records. • Incident reports.	

8.3 RISK 3 – Introduction and Establishment of Invasive Marine Species

8.3.1 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 ballast water from the support vessels and MODU hull containing foreign species; and
- Translocation of foreign species through biofouling on support vessel hulls and niches (e.g., thruster tunnels, sea chests) and the MODU hull and legs.

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).

Ballast water is estimated to be 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.

The MODU

As a jack-up, the key IMS risks from the MODU come from the legs, as they are immersed in the water column for long periods, along with the spud cans that are immersed in seabed sediments. Ballast water is taken up from the jack-up MODU in the hull when it leaves a location (to assist with ballasting during the tow) and then discharged when it reaches a location.

The IMS risk for jack-up MODUs is lower when compared to semi-submersible MODUs because the legs are raised out of the water when towed between drilling locations, meaning that any biofouling generally dehydrates and dies (and may dislodge) between locations and is therefore less likely to survive in a new location once the MODU is jacked down.

Support Vessels

Support vessels 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.

8.3.2 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.

8.3.3 EMBA

The EMBA for IMS introduction is anywhere within the operational 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 JBG.

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.

8.3.4 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., operational 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). Because the eradication of IMS populations is innately extremely difficult, it is necessary that preventing their introduction (or failing this, early detection) is the key to managing this risk.

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.

Activity-specific risk assessment

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 in the region and the most likely port of call for the support vessels, the likelihood of IMS introduction from this port is therefore low.

The MODU to be used for drilling Beehive-1 will be one of two jack-up MODUs currently operating in northern Australian waters. These MODUs have been operating in Australian waters for several years and as such, the risk of introducing IMS is greatly reduced, as the MODU hull will have been flushed with water from the region several times prior to drilling Beehive-1. Similarly, any biofouling accumulated on its legs will be from the Northwest Marine Region and therefore present a lower risk of introducing IMS to the JBG compared to the MODU coming from non-Australian waters (because any fouling species or IMS present in ballast waters are likely to have come from the region and therefore present a lower risk of being invasive species).

The unconsolidated sandy sediments of the activity area and surrounds (see Section 5.2.3), combined with its water depth (40 m) and distance from shore (80 km), reduce the risk of IMS establishment because IMS generally require hard substrate to attach to in the photic zone. Colonisation and spread is more likely in shallow, highly disturbed nearshore waters (such as ports and marinas) than open waters further offshore (Geiling, 2014) where the rate of dilution and the degree of dispersal are high (Paulay *et al*,. 2002).

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) against the activity is provided in Table 8.14.

Table 8.14. Assessment of the objectives and management activities of the National Strategic Plan for Marine Pest Biosecurity (2018-2023) against the activity

Objectives and Activities	Assessment
Objective 1: Minimise the risk of marine pest introductions, establishment and spread	The adopted EPS listed in Table 8.15 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 8.15 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.
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.

Objectives and Activities	Assessment
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 recommendations for improved management.	The activity will not have any impact on this management activity.
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.

Objectives and Activities	Assessment
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.

8.3.5 Risk Assessment

Table 8.15 presents the risk assessment for the introduction of IMS.

Table 8.15. Risk assessment for the introduction of IMS

<table>
<tr><th colspan="4">Summary</th></tr>
<tr><td>Summary of risks</td><td colspan="3">Reduction in native marine species diversity and abundance, displacement of native marine species, socio-economic impacts on commercial fisheries and changes to conservation values of protected areas.</td></tr>
<tr><td>Extent of risk</td><td colspan="3">Localised (isolated locations if there is no spread) to widespread (if colonisation and spread occurs).</td></tr>
<tr><td>Duration of risk</td><td colspan="3">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).</td></tr>
<tr><td>Level of certainty of risk</td><td colspan="3">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.</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 introduction of IMS.</td></tr>
<tr><th colspan="4">Risk Assessment (inherent)</th></tr>
<tr><td colspan="2">Likelihood</td><td>Consequence</td><td>Risk rating</td></tr>
<tr><td colspan="2">Occasional</td><td>Moderate</td><td>Medium</td></tr>
</table>

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Use only locally/ regionally sourced support vessels.	Elimination	Likely	**EB:** Eliminates the potential for introduction of IMS from non-Australian waters. **C:** This is not standard industry practice. This is a significant limitation on the activity, as there are very few if any drilling support vessels permanently based in Australia, so vessels must be sourced opportunistically if they are in-country when required, or else internationally (e.g., southeast Asia). There is no cost to the project in adopting this approach. However, this cannot be guaranteed. **Ev:** There are significant schedule and capability implications for the activity by restricting the choice of vessels. On balance, the cost to implement this control is disproportionate to the risk if other controls are adopted.
Do not exchange or discharge ballast water in the operational area.	Elimination	No	**EB:** Eliminates the potential for introduction of IMS. **C:** It is not feasible to implement this from a structural integrity or safety perspective, as ballast water exchange is required to ensure the stability of vessels as they load and unload goods. **Ev:** The high risk to human safety outweighs any environmental benefits.
International Anti-fouling System (IAFS) Certificate **(RSK-03: EPS-02).**	Engineering	Yes	**EB:** Ensures that the MODU and support vessels have an anti-fouling coating and associated certificate to reduce the likelihood of transfer of IMS from their hulls to the activity area. **C:** Significant cost to the contractors to have the MODU and vessels inspected and anti-fouling paint applied (generally every 5 years). This is a legislated requirement. **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.
Cleaning of immersible equipment **(RSK-03: EPS-04).**	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-05, -06).**	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. This is a legislated requirement. **Ev:** Environmental benefit outweighs cost.
Incident reporting **(RSK-04: EPS-07).**	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)** The MODU and support vessels are managed in accordance with the *National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry* (CoA, 2008) to ensure they present a low biofouling risk. This means: • Biofouling risk assessment is conducted to ensure there is a low risk of IMS introduction. • 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 reports prior to mobilising to site confirms acceptability to enter the operational area.
	(RSK-03: EPS-02) The MODU and support vessels >400 gross tonnes carry a current IAFS Certificate that is complaint with Marine Order Part 98 (Anti-fouling Systems).	IAFS Certificates are available and current.
	(RSK-03: EPS-03) The MODU and support 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.	Biofouling Management Plans and Biofouling Record Books are available and current.

Immersible equipment does not introduce IMS to the activity area.	**(RSK-03: EPS-04)** Immersible equipment (e.g., VSP equipment, ROV) is cleaned (e.g., biofouling is removed) prior to initial use on the MODU.	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-05)** Vessels fulfil the requirements of the *Australian Ballast Water Management Requirements* (DAWR, 2020, v8). This includes requirements to:
	• Carry a valid Ballast Water Management Plan (BWMP).
	• Submit a Ballast Water Report (BWR) through the Maritime Arrivals Reporting System (MARS).
	    ○ If intending to discharge internationally-sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival.
	    ○ If intending to discharge Australian-sourced ballast water, seek a low-risk exemption through MARS.
	• Hold a Ballast Water Management Certificate (BWMC).
	• Ensure all ballast water exchange operations are recorded in a Ballast Water Record System (BWRS).
		BWMP is available and current.
		
		BWR (or exemption) is submitted prior to entry to the activity area.
		
		A valid BWMC is in place.
		
		An up-to-date BWRS is in place.
		
		An electronic Pre-Arrival Report (ePAR) is available and signed off by DAWR.

	(RSK-03: EPS-06) 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-07)** Non-compliant discharges of domestic ballast water are to be reported to the DAWR immediately (contact details in Section 9.7.2).	Incident report notes that contact was made with the DAWR regarding non-compliant ballast water discharges.

Risk Assessment (residual)		
Likelihood	Consequence	Risk rating
Remote	Moderate	Low

<table>
<tr><td colspan="3">The risk of the introduction and establishment of IMS is assessed as low because:
• The control measures adopted are effective in reducing the risk to ALARP.</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 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>OEMS compliance</td><td colspan="2">Chapter 9 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>External context</td><td>Relevant persons</td><td>No objections or claims have been raised by relevant persons regarding the introduction and establishment of IMS.</td></tr>
<tr><td>Legislative context</td><td colspan="2">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).
• Ballast Water Management Convention and Resolution 127 (53) (Marine Environmental Protection Committee of the IMO) 2005.
• Convention for the Control and Management of Ships’ Ballast Water and Sediments 2004 (IMO).</td></tr>
<tr><td rowspan="3">Industry practice</td><td colspan="2">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>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>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>
</table>

	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There are no guidelines regarding preventing the introduction of IMS.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore drilling operations: • 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 for this activity reflect the guidance regarding ballast water management in the DAWR guide.
	Offshore Installations – Biosecurity Guide (DAWE, 2020, v1.4)	The EPS for this activity reflect the guidance provided in the DAWE guide, which largely references other guidelines listed here.
	Anti-Fouling and In-Water Cleaning Guidelines (DoA/DoE, 2015).	The EPS for this activity 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.

<table>
<tr><td rowspan="7"></td><td>TECs</td><td>The risk of introducing IMS is highly unlikely to affect TECs.</td></tr>
<tr><td>Nationally threatened and migratory species</td><td>The threatened and migratory species within the spill EMBA are all highly mobile species. There are no EPBC Act-listed benthic species listed as occurring in the operational area; these are generally more susceptible to the effects of IMS than mobile fauna.</td></tr>
<tr><td colspan="2">Other matters</td></tr>
<tr><td>KEFs</td><td>The risk of introducing IMS is highly unlikely to affect KEFs.</td></tr>
<tr><td>NIWs</td><td>The risk of introducing IMS is highly unlikely to affect NIWs.</td></tr>
<tr><td>State marine parks</td><td>This hazard does not intersect any state marine parks.</td></tr>
<tr><td>Species Conservation Advice/
Recovery Plans/
Threat Abatement Plans</td><td>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).</td></tr>
<tr><td rowspan="3">ESD principles</td><td colspan="2">The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).</td></tr>
<tr><td>Is there a threat of serious or irreversible environmental damage?</td><td>Possibly, but the EPS aim to avoid this.</td></tr>
<tr><td>Is there scientific uncertainty as to the environmental damage?</td><td>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.</td></tr>
<tr><td>Statement of acceptability</td><td colspan="2">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 low;
• An Implementation Strategy (described in Chapter 9) 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;
• 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.</td></tr>
<tr><th colspan="3">Environmental Monitoring</th></tr>
<tr><td colspan="3">• None required.</td></tr>
</table>

Record Keeping	
• Vessel contractor pre-qualification reports. • Biofouling risk assessment. • Ballast water risk assessments. • BWMP. • BWR.	• BWMC. • BWRS. • IAFS Certificates. • DAWR-signed ePARs.

8.4 RISK 4 – Interference with Other Marine Users

8.4.1 Hazard

The presence of the MODU and support vessels may result in unplanned interference with other marine users and equipment, such as commercial fishing gear and merchant shipping.

8.4.2 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.

8.4.3 EMBA

The EMBA for interference with other marine users is anywhere within the operational area (wherever vessel movements occur), and more specifically the immediate area around the two intersecting vessels or equipment.

Receptors in the EMBA include:

- Commercial fishing vessels; and
- Merchant vessels.

8.4.4 Evaluation of Environmental Risks

Collision with other marine users

Interference from the MODU and support vessels undertaking the activity with other marine users is highly unlikely because:

- There is low shipping traffic in and around the activity area (see Section 5.7.7);
- The MODU will be highly visible from long distances;
- The support vessels are highly visible and move slowly around the MODU;
- Large vessels use sophisticated navigation aids;
- Navigational warnings and a PSZ will be in place; and
- Consultation has been undertaken with relevant persons prior to the activity.

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 (which is unlikely due to the generally low speed), an MDO spill may eventuate (the environmental consequences of which are addressed in Section 8.6).

Damage to or loss of fishing equipment

There is the remote possibility that fishing gear (e.g., NPF otter trawl nets) may get caught by the MODU legs if third-party commercial fishing vessels breach the 500-m radius PSZ with their gear deployed. This would likely result in the gear becoming detached from the fishing vessel and the loss of any associated catch. In addition to the cost of repairing or replacing this equipment, it could also result in the loss of income from caught fish during that fishing expedition. This is highly unlikely to occur because the size of the MODU ensures it is visible from long distances, meaning that fishers will not deploy trawl nets nearby.

The only fishery likely to be active in the activity area is the NPF. The NPF primarily operates from April to June and August to November. If the activity occurs mostly within Q1 2023, it will not overlap with the NPF fishing season. If there is some temporal overlap with the NPF fishing season, the overlap will be short-term and for the reasons outlined above, will be unlikely to result in damage to or loss of fishing equipment.

Interference from the support vessels with commercial fishing vessels is unlikely, for the same reasons stated above.

8.4.5 Risk Assessment

Table 8.16 presents the impact assessment for interference with other marine users.

Table 8.16. Risk assessment for interference with other marine users

Summary		
Summary of risks	Presence of MODU and support vessels, resulting in the risk of vessel-to-vessel collision, damage to or loss of fishing equipment and loss of commercial fish catches.	
Extent of risks	Highly localised (within the activity area).	
Duration of risks	Short-term (minutes for a third-party vessel detour) to long-term (vessel collision).	
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 interference with other marine users.	
Impact Consequence (inherent)		

Likelihood	Consequence	Risk rating
Occasional	Minor	Low

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
PSZ **(RSK-04: EPS-01)**.	Engineering	Yes	**EB:** Minimises collision risk with the MODU, support vessels and third-party equipment through increased awareness. **C:** Minimal cost to prepare and issue notices to marine users. **Ev:** Benefits to safety for all parties outweighs the minimal costs.
Navigation equipment and procedures **(RSK-04: EPS-03, -06, -08)**.	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 legislative requirement. **Ev:** The safety benefits of having navigation equipment and procedures outweighs the cost.
Relevant person notifications **(RSK-04: EPS-02, -09)**.	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.
Continuous bridge watch **(RSK-04: EPS-04)**.	Administrative	Yes	**EB:** Reduces the risk of collisions with other marine users or their equipment (e.g., marker buoys). **C:** No additional cost. It is routine maritime practice that the vessel master and mates maintain bridge watch at all times. **Ev:** Environmental benefits are achieved with no additional cost.
Crew qualifications. **(RSK-04: EPS-05)**.	Administrative	Yes	**EB:** Reduces the risk of vessel collision by ensuring crew possess appropriate qualifications to operate the vessels. **C:** Negligible; it is a standard maritime requirement that crew possess such qualifications. **Ev:** Environmental benefits can be achieved with negligible additional cost.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria

The EPS listed in 'displacement of other marine users' (see Section 7.4) 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)** The AHO will be notified of the activity no less than three weeks prior to the activity commencing to enable the promulgation of a Notice to Mariners that communicates the 500-m PSZ and 4.6 km (2.5 nm) cautionary area around the MODU for the duration of the activity.	NTM is issued via the AHO prior to the activity and includes details of the PSZ and cautionary area.
	(RSK-04: EPS-02) EOG notifies relevant persons ahead of the activity so that third-party marine users are aware of the MODU location and activity timing.	Stakeholder correspondence verifies that EOG contacted relevant persons about the timing and location of the activity.
	(RSK-04: EPS-03) The MODU and support vessels are readily identifiable to third-party vessels with lights, signals, AIS transponders and communication equipment.	Visual inspection and/or OVID/CMID 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-04) The support vessels monitor the PSZ and cautionary area at all times using safe continuous watch.	Daily drilling reports/vessel bridge logbooks verify constant monitoring of the PSZ and cautionary area.
	(RSK-04: EPS-05) The support vessel masters and deck officers have valid SCTW certificates in accordance with AMSA Marine Order 70 (seafarer certification) (or equivalent) to operate radio equipment to warn of potential third party spatial conflicts (e.g., International Convention on Standards of Training, Certification and Watch-keeping for Sea-farers [STCW95], GDMSS proficiency).	Appropriate qualifications are available.
	(RSK-04: EPS-06) The support vessel masters issue warnings (e.g., radio warning, flares, lights/horns) to third-party vessels approaching the PSZ in order to prevent a collision with the MODU.	Radio operations communications log verifies that warnings to third-party vessels approaching the PSZ have been issued when necessary.
	(RSK-04: EPS-07) All incidents of spatial conflict with other marine users will be reported in the EOG incident register.	The incident register is current.
Vessel-to-vessel collisions are managed in accordance with vessel-specific	**(RSK-04: EPS-08)** The support vessel masters will sound the general alarm, manoeuvre the vessel to minimise the effects of the collision with the MODU and implement all other measures as outlined in	Incident report verifies that the relevant safety procedure was implemented.

emergency procedures.	the vessel or structure collision procedure (or equivalent).	
	(RSK-04: EPS-09) 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 commercial shipping and fishing 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 'negligible' 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.	
EMS compliance	Chapter 9 outlines the EP implementation strategy to be employed for this activity.	
Risk matrix standard compliance	The residual risk is negligible, which is considered acceptable.	
External context	Relevant persons	No objections or claims have been raised by relevant persons regarding interference with other marine users.
Legislative context	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).	

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 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, -07)**. • 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 **(RSK-04: EPS-02, 04, -05)**. • 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 is no specific guidance regarding collision avoidance and navigational lighting.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	There is no specific guidance regarding collision avoidance and navigational lighting. Section 2.3.6.1 (environmental protection) states that location- and well-specific environmental protection plans should be prepared. The EP satisfies this requirement.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There is no specific guidance regarding collision avoidance and navigational lighting.
	APPEA CoEP (2008)	The EPS for this activity meets the code's following objectives for offshore drilling operations: • To reduce the impact on other marine resource users to ALARP and to an acceptable level **(RSK-04: All EPS)**. • To reduce risks to public safety to ALARP and an acceptable level **(RSK-04: All EPS)**.
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 affect 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 & Environmental Policy; • The residual consequence rating is negligible; • An Implementation Strategy (described in Chapter 9) 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 and radar monitoring.		
Record Keeping		
• Stakeholder communication records. • NTM. • PSZ gazettal. • Crew qualifications.	• Radio communication logs. • Crew qualifications. • Incident reports. • Daily drilling reports.	

8.5 RISK 5 – Unplanned Discharge of Drilling Fluids, Chemicals or Hydrocarbons

8.5.1 Hazard

The following activities have the potential to result in unplanned discharges of small volumes (typically no greater than 5-10 m^3) of drilling fluids, chemicals and hydrocarbons:

- MODU operations – crane transfers and bunkering operations;
- Support vessel operations – cane transfers and bunkering operations; and
- Aviation operations – refuelling of the helicopter on the MODU.

Crane transfers or bunkering operations between support vessels and the MODU may result in accidental discharges of various products overboard or to deck, such as:

- Drilling muds;
- Bulk drilling chemicals (e.g., barite, bentonite);
- Bulk chemicals (e.g., pipe dope, BOP hydraulic fluids);
- Hydraulic oil from the cranes' electric prime movers;
- Helicopter aviation fuel (avgas [aviation gasoline] or diesel [Jet-A1]); and
- Assorted pumps, winches, power packs and generators.

Spills overboard may be caused by:

- Hose or connection failure (due to equipment condition or failure of a support vessel to keep station);
- Failure to align valves correctly during transfer to tanks;
- Overfilling of tanks on MODU or support vessel;
- Overfilling of aviation fuel tank on fuel unit or bulk storage tank of the MODU;
- Overfilling of helicopter on the MODU helideck;
- Dropped objects from crane transfers; and
- Accidental or emergency disconnection of the riser.

Fluids stored in tanks (or pits) are pumped between tanks or to mixing equipment using transport pumps. The pipes through which they are pumped are under pressure. Possible causes of spills during these transfers include:

- Leaks due to the condition of pipes, connections, flanges and valves;
- Leaks from pump packers;
- Leaks from blocked mixing hoppers;
- Loss of storage tank integrity; and
- Failure to align valves correctly during transfer to tanks.

Jet A1 fuel used for helicopter refuelling has been excluded from spill modelling and this assessment as only small volumes will be stored on the MODU (~6 m^3), and spills of this fuel evaporate quickly due to the very high levels of light ends.

8.5.2 Potential Environmental Risks

The known and potential environmental risks of the unplanned discharge of small volumes of drilling muds, chemicals and hydrocarbons are:

- Temporary and localised reduction of water quality; and
- Acute toxicity to marine fauna through ingestion or absorption.

8.5.3 EMBA

The EMBA for the risk of discharge of drilling muds, chemicals and fuel is likely to range from tens to hundreds of metres depending on the product and volume spilled, so a precise EMBA cannot be calculated.

Receptors most at risk within this EMBA are:

- Water quality;
- Plankton;
- Pelagic fish;
- Marine mammals; and
- Marine reptiles.

8.5.4 Evaluation of Environmental Risks

The impact of the discharge of drilling muds is addressed in Section 7.6.2. The impacts of a small unplanned discharge of drilling muds will not vary significantly from the EIA presented in Section 7.6.5.

The risks associated with the discharge of chemicals in drilling muds is addressed in Section 7.6.4. The risks of an unplanned discharge of chemicals will not vary significantly, though the increased release volume means it will take longer to dilute and disperse through the water column.

The risks associated with the discharge of MDO is addressed in Section 8.6.2. The risks of a discharge of aviation fuel will be less than that resulting from a vessel collision due to the much smaller volumes involved, so the extent of spread will be less, and the high volatility of aviation fuel means a greater proportion of fuel will evaporate much faster than MDO.

In general, the small potential release volumes mean that such releases would be confined to a small area around the drill site and result in rapid dilution in the open ocean environment, meaning that the risk of toxic effects to marine fauna are low. The low commercial fishing activity and absence of fish BIAs and sensitive habitats in the operational area means the risks to the biological and socio-economic environments are low.

8.5.5 Risk Assessment

Table 8.17 presents the impact assessment for the unplanned discharge of small volumes of drilling muds, chemicals and hydrocarbons.

Table 8.17. Risk assessment for the unplanned discharge of drilling muds, chemicals and hydrocarbons

Summary	
Summary of risks	Temporary and localised reduction of water quality and acute toxicity to marine fauna through ingestion or absorption of small volumes of drilling muds, chemicals and hydrocarbons.

Extent of risks	Highly localised – small mixing zone around the MODU		
Duration of risks	Temporary and short-term (several minutes for small deck spills or longer for larger spill)		
Level of certainty of risks	HIGH – the impacts associated with drilling fluid, chemical and hydrocarbon spills at sea are well known and documented.		
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 drilling muds, chemicals and hydrocarbons.		

Impact Consequence (inherent)		
Likelihood	Consequence	Risk rating
Unlikely	Minor	Low

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
Pre-acceptance inspection of MODU **(RSK-05: EPS-01).**	Administrative	Yes	**EB:** Ensures the storage tanks, equipment and bunding are in good working condition prior to the activity commencing, thereby reducing the likelihood of drilling fluid, chemical and hydrocarbon spills. **C:** Negligible; it is a standard maritime requirement. Minor administrative cost to produce documents and educate personnel. **Ev:** Benefits outweighs the low costs.
Hydrocarbon and chemical storage **(RSK-05: EPS-02 & 03).**	Engineering	Yes	**EB:** Reduces the likelihood that hydrocarbon and chemical storage will be accidentally lost overboard. **C:** Negligible; it is a standard maritime requirement. Minor administrative cost to produce documents and educate personnel. **Ev:** Environmental benefit outweighs the negligible costs.
PTW system **(RSK-05: EPS-04)**.	Administrative	Yes	**EB:** Reduces the likelihood that hydrocarbon and chemical storage will be accidentally lost overboard by ensuring operations is undertaken via a PTW. **C:** Negligible; it is a standard maritime requirement. Minor administrative costs associated with maintaining the PTW.

			Ev: Environmental benefit outweighs the negligible costs.
PMS **(RSK-05: EPS-05)**.	Administrative	Yes	**EB:** The maintenance of MODU storage systems and associated fittings minimises the likelihood of chemical and hydrocarbon lost overboard. **C:** Negligible; it is a standard maritime requirement. Minor administrative costs associated with maintaining the PMS. **Ev:** Environmental benefit outweighs the negligible costs.
SMPEP **(RSK-05: EPS-06, 07, 08, 09 & 10)**.	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.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
A pre-acceptance inspection of the MODU takes place.	**(RSK-05: EPS-01)** EOG's pre-acceptance inspection of the MODU confirms that storage tanks, equipment, bunding and machinery spaces are free of defects.	MODU pre-acceptance inspection records verify good condition of all equipment.
Hydrocarbons and chemicals stored on the MODU are stored in a manner that prevents bulk release.	**(RSK-05: EPS-02)** All hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.	Visual inspection verifies that hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.
	(RSK-05: EPS-03) Where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.	Visual inspection verifies that where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.
The operation of the dump valve/s for the mud tanks will be managed under a Permit to Work (PTW) system.	**(RSK-05: EPS-04)** The mud dump valve/s are locked, with the keys remaining secure in a key locker. A PTW will be required to unlock the dump valve/s, which involves an assessment by the OIM regarding the need for a specific operation.	Visual inspection of key locker and dump valve/s verify its integrity.
		Daily Fluids Report allow for material balance assessment to determine discharge volume of weighted brine.
		PTW records verify that a PTW was prepared prior to unlocking the dump valve/s.

Planned maintenance will be undertaken on all MODU storage systems (bunds, hoppers), hose fittings and so forth.	**(RSK-05: EPS-05)** Planned maintenance is undertaken to the PMS schedule.	PMS records verify that maintenance work (and repairs where necessary) is undertaken.
The MODU management and crew are well prepared to respond to deck spills.	**(RSK-05: EPS-06)** The MODU OIM ensures that crew undertake spill response drills every three months in accordance with the SMPEP and drills and exercises matrix.	Records show that relevant crew have conducted quarterly spill response drills.
	(RSK-05: EPS-07) In accordance with the SMPEP, oil spill response kits are available in relevant locations around the MODU, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for MDO spills to deck record that the spill is cleaned up using SMPEP resources.
Reporting		
A bulk spill of chemicals or hydrocarbons at surface will be promptly reported internally and externally, and appropriately managed.	**(RSK-05: EPS-08)** The MODU OIM will report a bulk spill to the AGR Drilling Supervisor and lead the onboard response in line with the SMPEP.	Incident reports and logs confirm that internal notifications were made in a timely fashion.
A bulk spill of chemicals or hydrocarbons at surface will be promptly reported to external regulatory agencies.	**(RSK-05: EPS-09)** The Drilling Incident Management Team (DIMT) Incident Controller will report to AMSA and NOPSEMA within 2 hours of EOG becoming aware of the spill (see Section 9.7.2).	Incident reports and logs confirm that regulatory authorities were notified within 2 hours of EOG becoming aware of the spill.

Impact Consequence (residual)		
Likelihood	Consequence	Risk rating
Rare	Minor	Negligible

The risk of the unplanned discharge of bulk drilling muds, chemicals and hydrocarbons is assessed as negligible because:

- The volumes of chemicals and hydrocarbons on the MODU will be small;
- Helicopter refuelling is unlikely to take place on the MODU; and
- The control measures adopted significantly reduce the likelihood of an unplanned discharge of bulk drilling fluids, chemicals and hydrocarbons.

Demonstration of ALARP

A ‘negligible’ 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

<table>
<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 9 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>External context</td><td>Relevant persons</td><td>No objections or claims have been raised by relevant persons regarding accidental discharge of drilling fluids, chemicals and hydrocarbons.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The performance standards outlined in this EP align with the requirements of:
• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
    ○ Section 9 (Prohibition of discharge of oil or oily mixture to sea).</td></tr>
<tr><td rowspan="6">Industry practice</td><td colspan="2">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.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>As per the impact assessment table in Section 7.6 and Section 7.11.</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>As per the impact assessment table in Section 7.6 and Section 7.11.</td></tr>
<tr><td>Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)</td><td>As per the impact assessment table in Section 7.6 and Section 7.11.</td></tr>
<tr><td>Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)</td><td>As per the impact assessment table in Section 7.6 and Section 7.11.</td></tr>
<tr><td>APPEA CoEP (2008)</td><td>As per the impact assessment table in Section 7.6 and Section 7.11.</td></tr>
<tr><td rowspan="3">Environmental context</td><td>MNES</td><td></td></tr>
<tr><td>AMPs</td><td>This hazard will not affect nearby AMPs.</td></tr>
<tr><td>Ramsar wetlands</td><td>This hazard will not affect any Ramsar wetlands.</td></tr>
</table>

	TECs	This hazard will not affect any TECs.
	Nationally threatened and migratory species	This hazard is unlikely to have acute or chronic toxicity effects 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 unplanned small discharges of drilling fluids, chemicals and hydrocarbons 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 9) 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		
• Not applicable.		
Record Keeping		
• Pre-acceptance MODU inspection records. • Inspection records. • Drill records. • Daily fluids reports.	• PMS records. • PTWs and JSAs. • Incident reports.	

8.6 RISK 6 - Marine Diesel Oil Release

8.6.1 Hazard

A release of MDO may occur from the support vessels as a result of refuelling, a vessel-to-vessel collision or a support vessel colliding with the MODU legs.

The waters of the activity area and its surrounds are deep and bathymetry mapping indicates there are no sub-surface features (such as reefs or shoals) that present a risk of vessel grounding (see Figure 5.9), so this risk has been discounted for this risk assessment.

Only the vessel-to-vessel collision scenario has been taken forward to OSTM. The other scenarios are dismissed as having negligible risks or as non-credible, as discussed herein.

MODU refuelling

MODU refuelling is a closely supervised activity on board a MODU with strict controls on the transfer of fuel from support vessels to the MODU. The fuel transfer hoses are supplied by the MODU and generally have a capacity of 47 m^3 (based on a re-fuelling hose 10 cm in diameter and 60 m long). The fuel transfer pump for jack-up MODUs is typically capable of supplying up to 33 m^3/hr. AMSA's guidance (AMSA, 2015) of using the fuel transfer rate multiplied by 15 minutes of flow (for supervised operations) to estimate the volume of MDO for spill modelling significantly over-estimates how long it would take to shut down re-fuelling operations and it is more likely to be around 5 minutes maximum based on industry experience. Fifteen minutes of flow from the pumps represents a potential loss of 8.25 m^3 based on the maximum transfer pump rate. A spill of this volume in the operational area would rapidly evaporate and dilute with seawater, and would not reach shorelines, causing negligible environmental impacts (NOAA, 2006). Therefore, this spill size has not been assessed further.

Vessel collision

An errant vessel collision with the MODU is not a credible scenario for the loss of MDO from the MODU for the following reasons, and is therefore not modelled and assessed:

- A temporary PSZ will be gazetted around the MODU;
- One support vessel is present on location at all times to maintain guard and intercept any errant vessel;
- Jack-up MODU hulls are raised high above the water line (generally with an air gap of about 20 m), meaning that the tanks would not be pierced in the event of a collision with a large vessel.
- The MDO tanks are located inboard and double-skinned (with mud, pre-load and potable tanks typically located on the outer edge of the hull), further ensuring that piercing of the MDO tanks (and fuel loss) is even more unlikely.

8.6.2 Risk Assessment

In line with OPGGS(E) Regulation 31 and Section 2.6 of NOPSEMA's *Environment Plan content requirement guidance note* (September 2020), EOG refers the reader to Section 7.16 of its PDSA EP (996161-2022-Beehive#1_PDSA-EP-Rev2, available at https://info.nopsema.gov.au/activities/468/show_public) that provides the risk assessment for an MDO spill. The volume chosen for that spill scenario took into account the typical fuel tank sizes on drilling support vessels (as well as vessels used to undertaken geophysical and geotechnical investigations).

8.7 RISK 7 – Loss of Well Containment and Major Oil Spill

8.7.1 Hazard

A LoWC may occur if all barriers on the well fail, which could result in a large-scale oil spill.

As outlined in Section 2.10, the most credible release of light crude oil (with the analogue oil being Jabiru crude) is 72,572 bbl (11,538 m^3) per day over 77 days, tapering down over time for an average daily release of 64,270 bbl (10,218 m^3) per day.

History of large oil spills from offshore drilling campaigns

Since 1980, there have been approximately 59,000 offshore wells drilled world-wide (Bureau of Safety and Environmental Enforcement, 2017). In this time there have been three large spills during drilling, which are summarised in Table 8.18.

Table 8.18. Summary of large-scale oil spills resulting from offshore drilling

Well	When	Location	Spill duration	Volume spilled
Frade	2011	Brazil (Atlantic Ocean)	4 days	3,000 bbl (~476 m^3)
Macondo	2010	USA (Gulf of Mexico)	87 days	4.9 million bbl (780,000 m^3)
Montara	2009	Australia (Timor Sea)	74 days	~115,000 to 154,000 bbl

In Australia, there have been seven well blowouts since offshore drilling began in 1964 (APPEA, 2011), with all of these (except the Montara well blowout, see table above) resulting in spills of less than 2 bbl of oil (Volkman *et al*., 1994).

It is estimated that for wells with a BOP installed, including shear rams and following the two-barrier principle, the frequency of a blowout is 3.1 x 10^{-4} (0.00031, or 0.031%) per exploration well drilled (OGP, 2010 in DNV, 2011). This is based on data from the Gulf of Mexico, UK and Norway from 1980-2004. The risk is expected to be even lower for this project given the number of additional controls and mitigation measures developed around well control, based on learnings from the Macondo and Montara blowouts. These include:

- Additional shear rams on the BOP – three shear rams now use on BOPs. In addition, there are two variable pipe rams and one fixed diameter ram;
- Regular system and pressure testing of BOP is conducted; and
- Third-party verification of BOP testing and maintenance is conducted.

Most of the oil spills that have increased community concerns have been as a result of oil tanker or pipeline accidents involving the loss of crude oil very close to sensitive areas such as beaches, rather than offshore drilling. In these instances, large volumes of fresh (unweathered) oil have washed ashore and onto shorelines.

The risks associated with drilling exploration wells far offshore are low, not only because of the control measures in place during drilling, but because any released crude oil would undergo weeks (or months) of weathering at sea, during which time its toxicity reduces before reaching sensitive coastal areas.

In this section, the risk assessment is based on the absence of spill response measures and that the flow of oil has not stopped until day 77. Oil spill response actions that will take place in the event of a spill are discussed in Section 8.8.

8.7.2 Oil Spill Trajectory Modelling

This section details the OSTM undertaken for a LoWC from Beehive-1, including how the volume and duration of the spill was determined, the OSTM methodology and results.

To understand the risks posed by a LoWC, EOG commissioned RPS to undertake OSTM for a loss of 64,270 bbl (10,218 m^3) per day for 77 days for each of the three distinct seasons in the region:

- Summer – October to February;
- Transitional – March and September; and
- Winter – April to August.

The OSTM report is provided in **Appendix 6.**

The modelling and risk assessment assumes no application of dispersant. Additional modelling for dispersant application is currently in progress and is expected to show decreased oil loads on shorelines and on the sea surface. As such, the risk assessment presented in this section is based on worst-case data.

Determining worst credible discharge

Table 2.9 provides the predicted worst-case flow rates and volumes in the event of a LoWC. Losses are based on a well bore size of 8½” (216 mm) to a depth of 4,667 m and then 8½” to a mid-perforation depth of 4,887 m. The wellbore design is coupled to dynamic simulation model that includes the impact of 330 m of net pay (total depth of 5,107 m).

The flow rates and volumes have been calculated by EOG based on the following guidance:

- SPE Technical Report *Calculation of Worst-Case Discharge (WCD)* (SPE-174705-TR, 2016);
- NOPSEMA Information Paper *Source control planning and procedures* (N-04750-IP1979, June 2021); and
- NOPSEMA Guidance Note Oil Pollution Risk Management (N-04750-GN1488, July 2021).

Determining WCD duration

A preliminary RWP shows that the well can be killed 77 days (11 weeks) after the well blowout (see Section 2.10.2).

Modelling inputs

The modelling was undertaken using the crude oil properties outlined in Table 2.3. The boiling point ranges for the Jabiru analogue oil are presented in Table 8.19, and Table 8.20 presents the key physical properties of the oil.

Table 8.19. Boiling points and persistence of Jabiru crude

	Volatiles	Semi-volatiles	Low Volatiles	Residual Oil
Boiling Point (°C)	< 180	180-160	160-380	> 380
Carbon range	C_4 to C_{10}	C_{11} to C_{15}	C_{16} to C_{20}	$>C_{20}$
Jabiru crude	24.2%	20.9%	33.9%	21.0%
Evaporation times	Up to 12 hrs	Up to 24 hrs	Several days	Slow
Persistence	Non-persistent			Persistent

Table 8.20. Key physical characteristics of Jabiru crude

Characteristic	Details
Density (kg/m^3)	813.9 at 15°C
API	42.3
Dynamic viscosity (cP)	3.0 at 20°C
Pour point (°C)	18
Oil property category	Group II
Oil persistence classification	Light persistent oil

Modelling of the fate of oil was performed using the Spill Impact Mapping Analysis Program (SIMAP). SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases and has been used to predict the weathering and fate of oil spills during and after major incidents including Montara (Australia), Macondo (USA) Bohai Bay (China) oil spill and the pipeline oil spill July 2013 in the Gulf of Thailand. The SIMAP model calculates the transport, spreading, entrainment, evaporation and decay of surface hydrocarbon slicks as well as the entrained and dissolved oil components in the water column, whether spilled at surface or discharged subsea.

The movement and weathering of the spilled oil is calculated for specific oil types. Input specifications for oil mixtures include the density, viscosity, pour point, distillation curve (volume lost versus temperature) and the aromatic/aliphatic component ratios within given boiling point ranges.

SIMAP is a three-dimensional model that allows for various response actions to be modelled including oil removal from skimming, burning, or collection booms, and surface and subsurface dispersant application. The SIMAP oil spill model includes advanced weathering algorithms, specifically focused on unique oils that tend to form emulsions and/or tar balls. The weathering algorithms are based on five years of extensive research conducted in response to the Deepwater Horizon oil spill in the Gulf of Mexico.

Biodegradation is included in the oil spill model. In SIMAP, degradation is calculated for the surface slick, deposited oil on the shore, the entrained oil and dissolved constituents in the water column, and oil in the sediments. For surface oil, water column oil and sedimented oil, a first order degradation rate is specified. Biodegradation rates are relatively high for hydrocarbons in dissolved state or in dispersed small droplets.

Table 8.21 outlines the key OSTM inputs.

Table 8.21. Summary of the OSTM inputs

Parameter	Details
Oil Type	Jabiru crude
Total spill volume	4,948,790 bbl (~786,794 m^3)
Release rate	64,270 bbl (10,218 m^3) per day
Release type	Sea surface
Release duration	77 days
Simulation duration	98 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

Weathering

RPS conducted a series of model weather tests to illustrate the potential behaviour of the Jabiru crude oil when exposed to idealised and representative environmental conditions:

- A 1-hour release onto the water surface at a discharge rate of 25 m^3/hr under calm wind conditions (constant 5 knots), assuming low seasonal water temperature (25°C) and average air temperature (29°C). The slick was also subject to ambient tidal and drift currents.
- A 1-hour release onto the water surface at a discharge rate of 50 m^3/hr under variable wind conditions (1-12 knots), assuming low seasonal water temperature (25°C) and average air temperature (29°C). The slick was also subject to ambient tidal and drift currents.

The first case is indicative of cumulative weathering rates under calm conditions that would not generate entrainment, while the second case may represent conditions that could cause a minor degree of entrainment. Both scenarios provide examples of potential behaviour during periods of a spill event once the oil reaches the surface.

The mass balance forecast for the constant-wind case (Figure 8.2) shows that 45.3% of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation of the residual compounds will slow significantly, and they will then be subject to more gradual decay through biological and photochemical processes.
Under the variable-wind case (Figure 8.3), where the winds are of greater strength on average, entrainment of the crude oil into the water column is predicted to increase. Approximately 24 hours after the spill, 54.1% of the oil mass is forecast to have entrained and a further 42.8% 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).The increased level of entrainment in the variable-wind case will result in a higher percentage of biological and photochemical degradation, where the decay of the floating slicks and oil droplets in the water column occurs at an approximate rate of ~1.3% per day with an accumulated total of ~9.1% after 7 days, in comparison to a rate of ~0.3% per day and an accumulated total of ~2.4% after 7 days in the constant-wind case.

Table 8.22 summarises the mass balance for the calm wind and variable wind case at day 7. Given the proportion of entrained oil and the tendency for it to remain mixed in the water column, the remaining hydrocarbons will decay over several weeks.

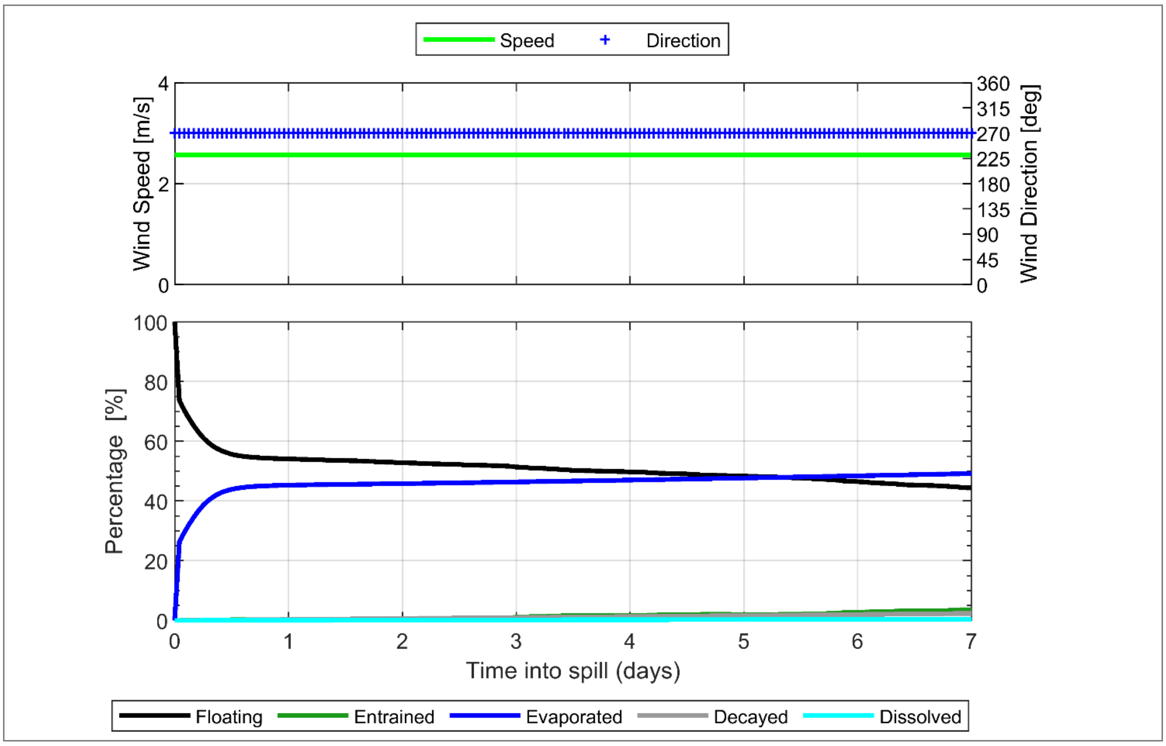


Figure 8.2. Proportional mass balance plot representing the weathering of crude oil spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 25°C water temperature and 29°C air temperature

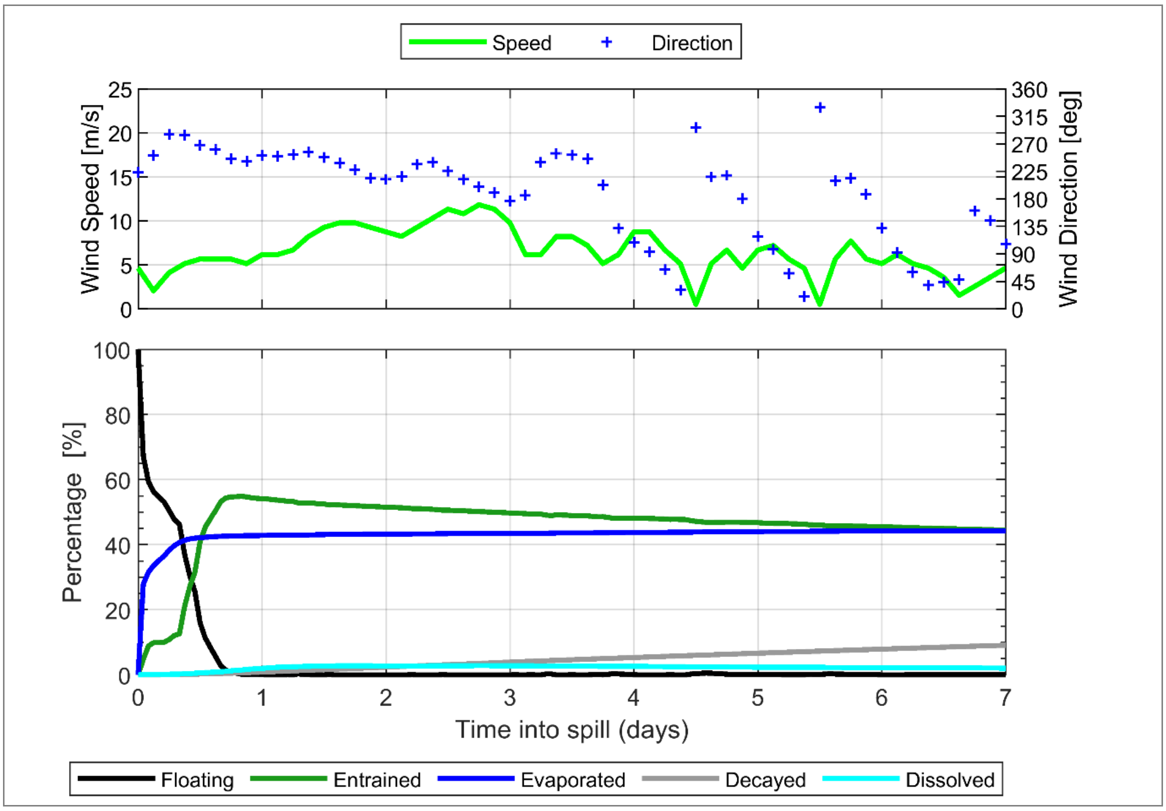


Figure 8.3. Proportional mass balance plot representing the weathering of crude oil spilled onto the water surface over 1 hour and subject to variable wind speeds (1-12 knots) at 25°C water temperature and 29°C air temperature

Table 8.22. Summary of the mass balance at day 7

Exposure metric	Calm wind conditions	Variable wind conditions
Surfac/floating oil (%)	44.4	0
Shoreline (%)	0	0
Entrained (%)	3.6	44.5
Evaporated (%)	49.2	44.2
Decay (%)	2.4	9.1

Results are based on a 25 m^3 surface release of crude oil over 1 hour, tracked for 7 days.

Exposure thresholds

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 socio-economic 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 8.21. The adopted exposure values are based primarily on the exposure values defined in NOPSEMA *Bulletin #1 Oil Spill Modelling* (April 2019), as listed in Table 5.2 of Chapter 5.

Modelling Results

This section presents the stochastic OSTM results. These are presented for the different hydrocarbon phases (surface, entrained, dissolved and shoreline) for each of the three modelling seasons (summer, winter and transition).

The results are calculated based on 100 simulations of a volume of 786,858 m^3 over 77 days and tracked for 98 days. Section 10.1 of **Appendix 6** presents the detailed tabulated results of the stochastic analysis, with the associated maps presented here:

- Surface/floating oil – Figures 8.4, 8.5 and 8.6, and zones of floating oil for the deterministic trajectory with the largest swept area above 1 g/m^2 in Figure 8.7;
- Shoreline oil - Figures 8.8, 8.9 and 8.10, and the deterministic trajectory with the largest volume of oil ashore in Figure 8.11;
- Dissolved hydrocarbons (0-10 m below the sea surface) – Figures 8.12, 8.13 and 8.14, and the deterministic trajectory with the largest area of dissolved hydrocarbons above 10 ppb in Figure 8.15; and
- Entrained hydrocarbons (0-10 m below the sea surface) – Figures 8.16, 8.17 and 8.18, and the deterministic trajectory with the largest area of entrained hydrocarbons above 10 ppb in Figure 8.19.

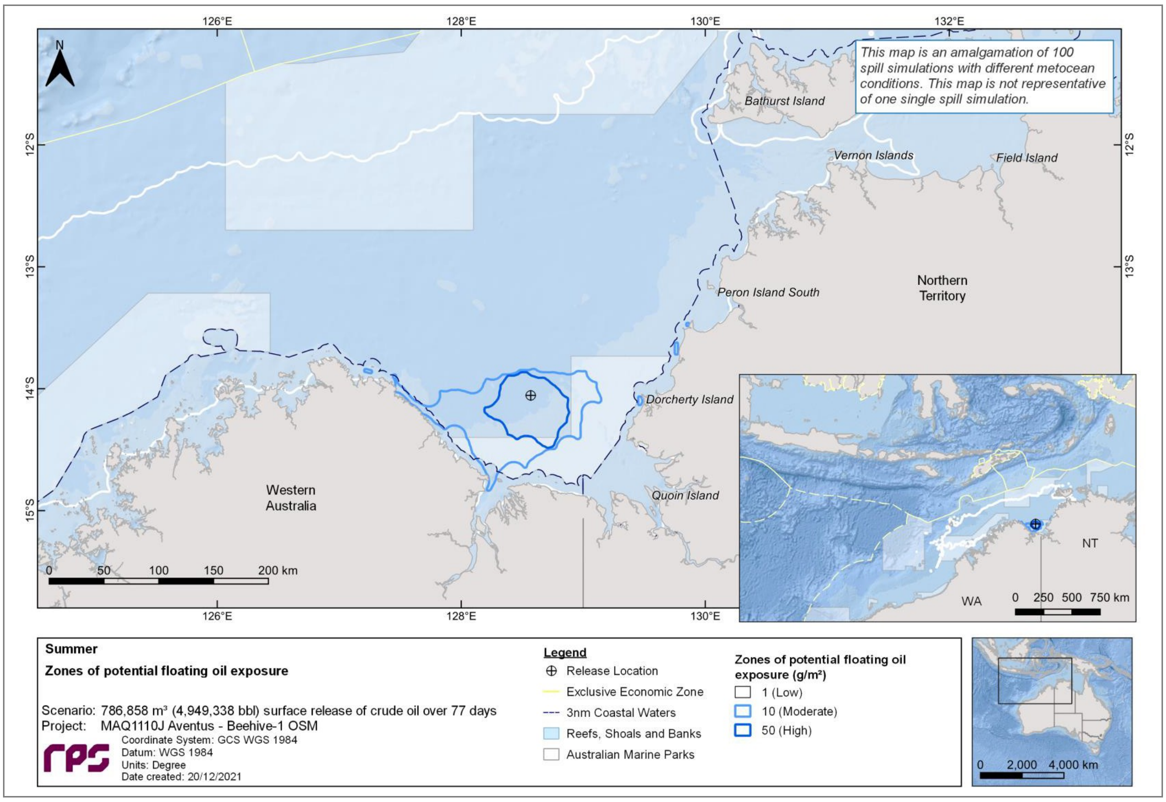


Figure 8.4. Zones of potential floating oil exposure during summer conditions

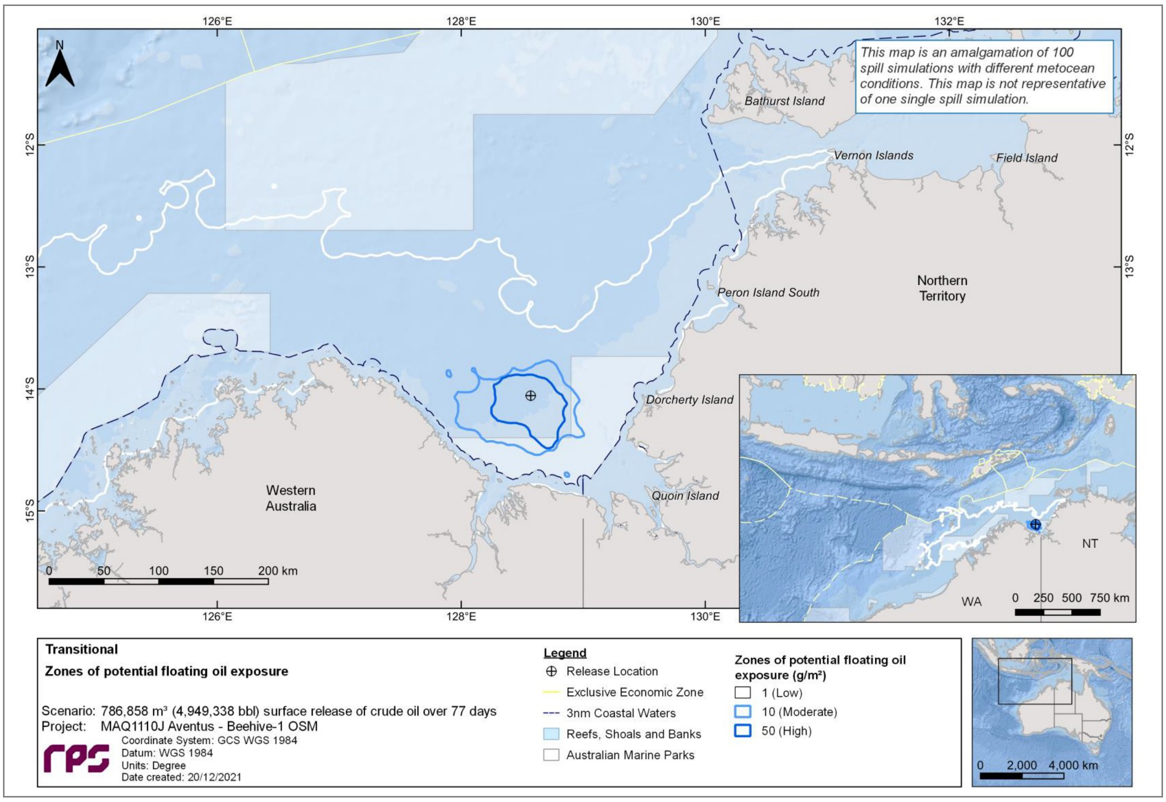


Figure 8.5. Zones of potential floating oil exposure during transitional conditions

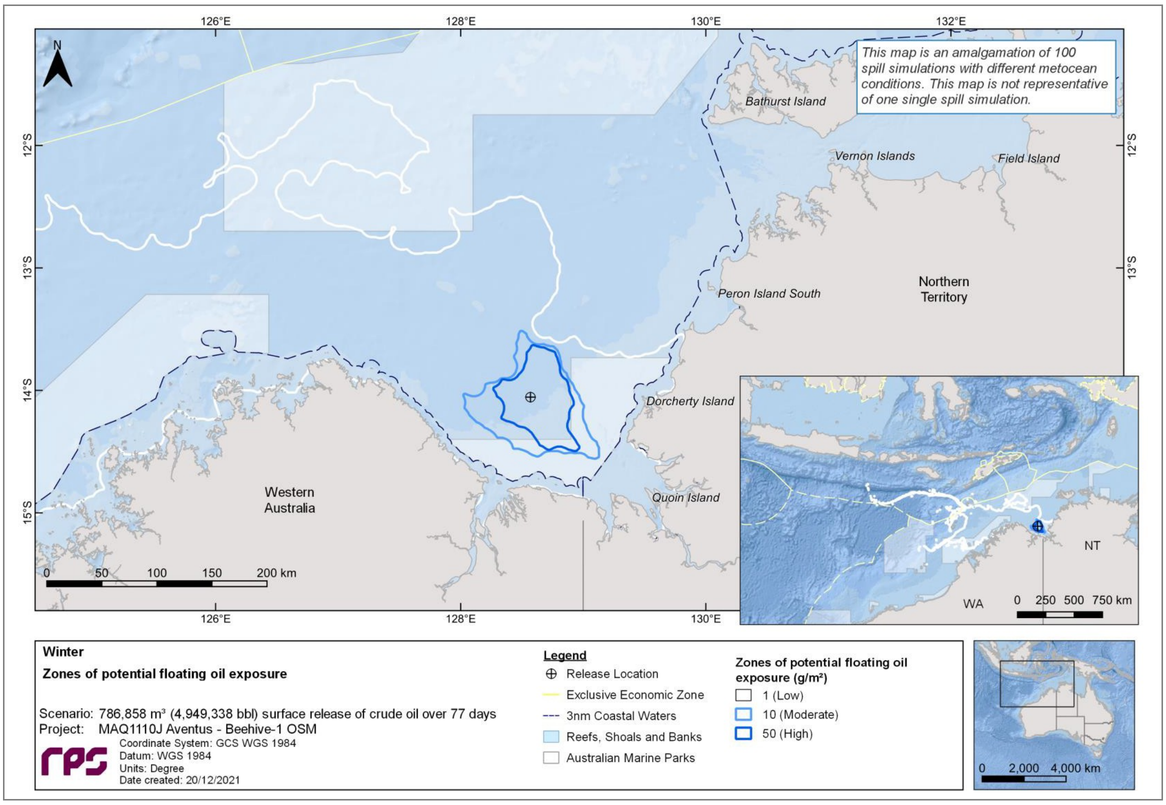


Figure 8.6. Zones of potential floating oil exposure during winter conditions

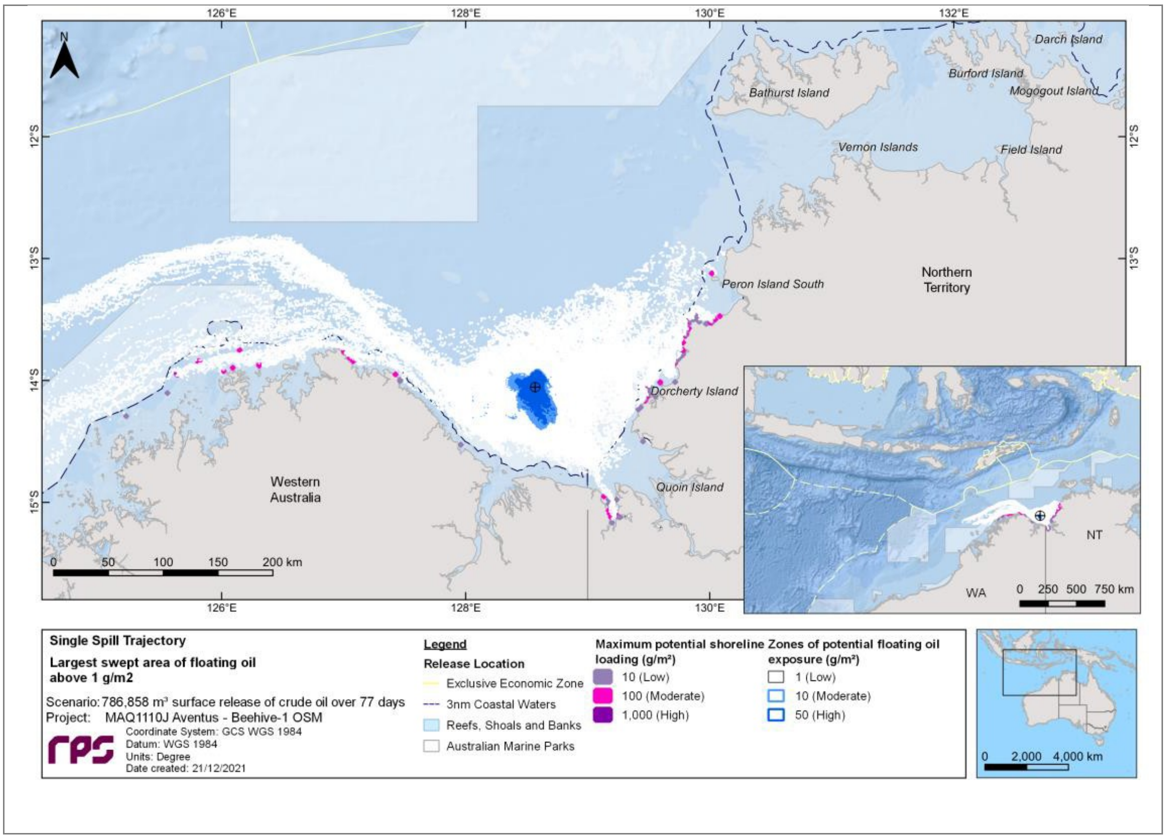


Figure 8.7. Zones of potential floating oil exposure and shoreline accumulation, for the trajectory with the largest swept area of floating oil above 1 g/m²

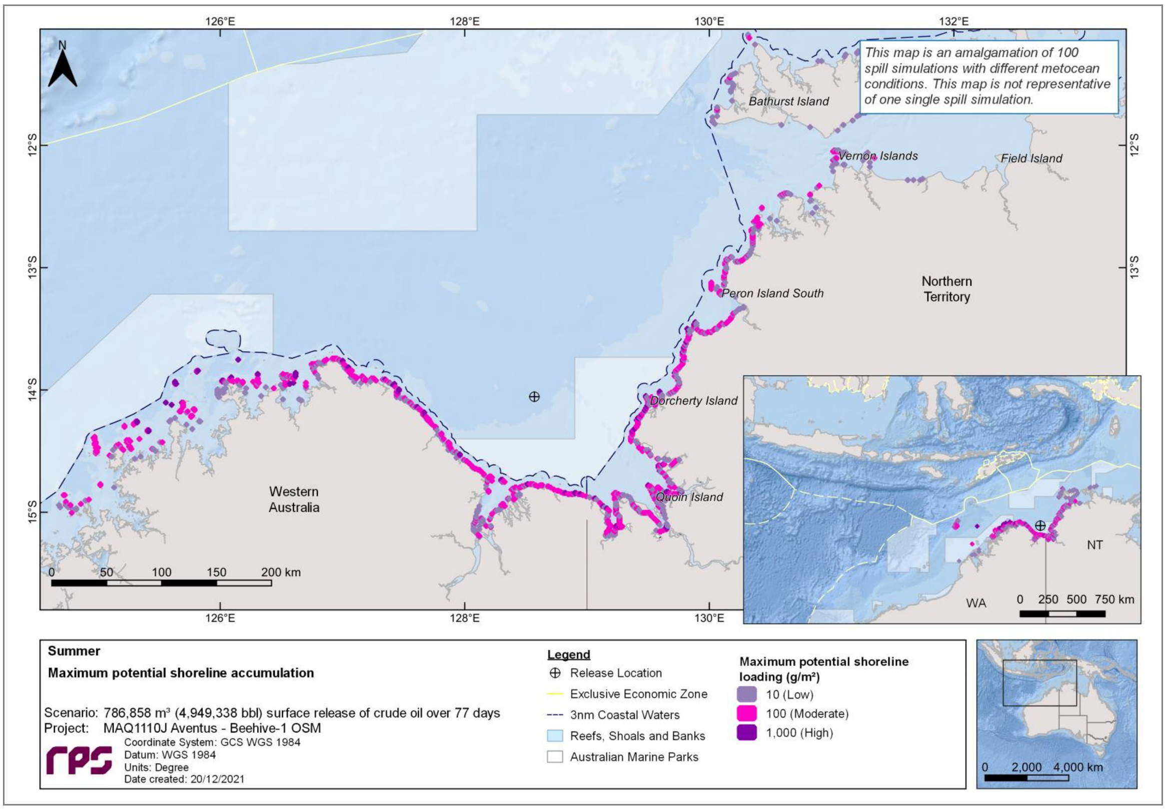


Figure 8.8. Maximum potential shoreline loading during summer conditions

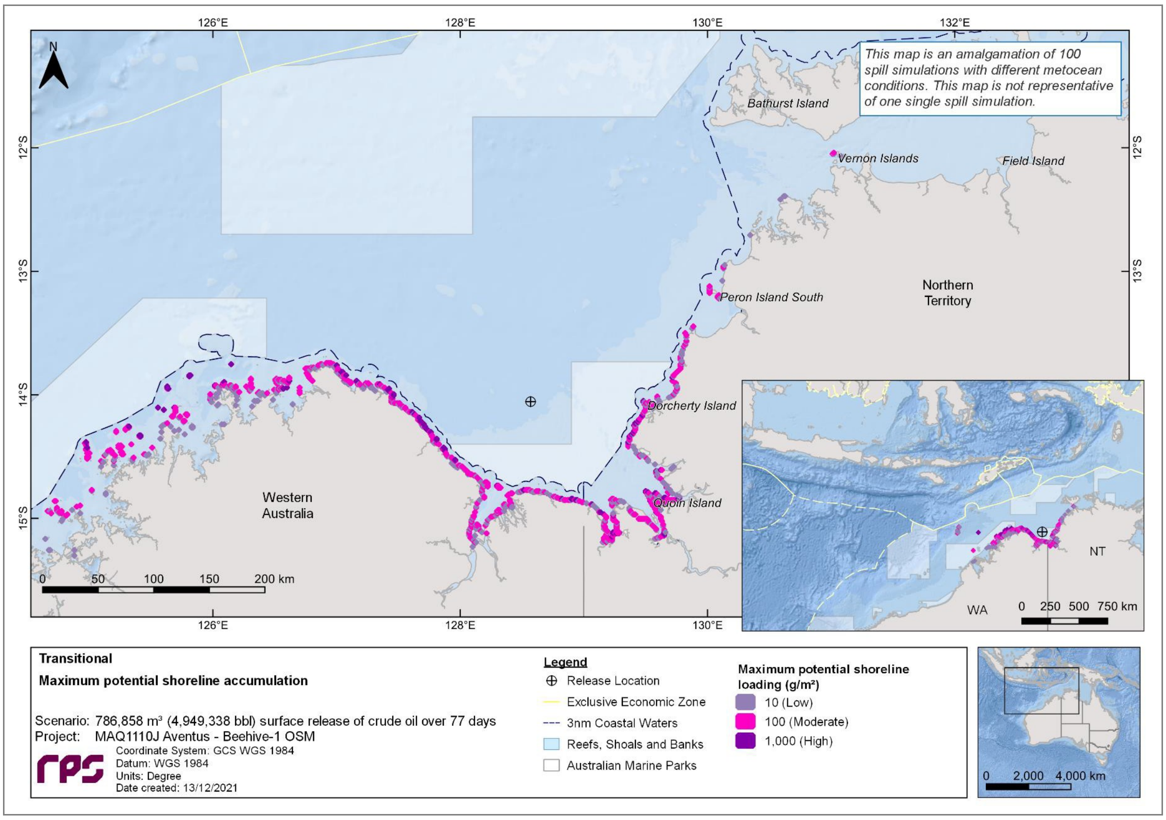


Figure 8.9. Maximum potential shoreline loading during transitional conditions

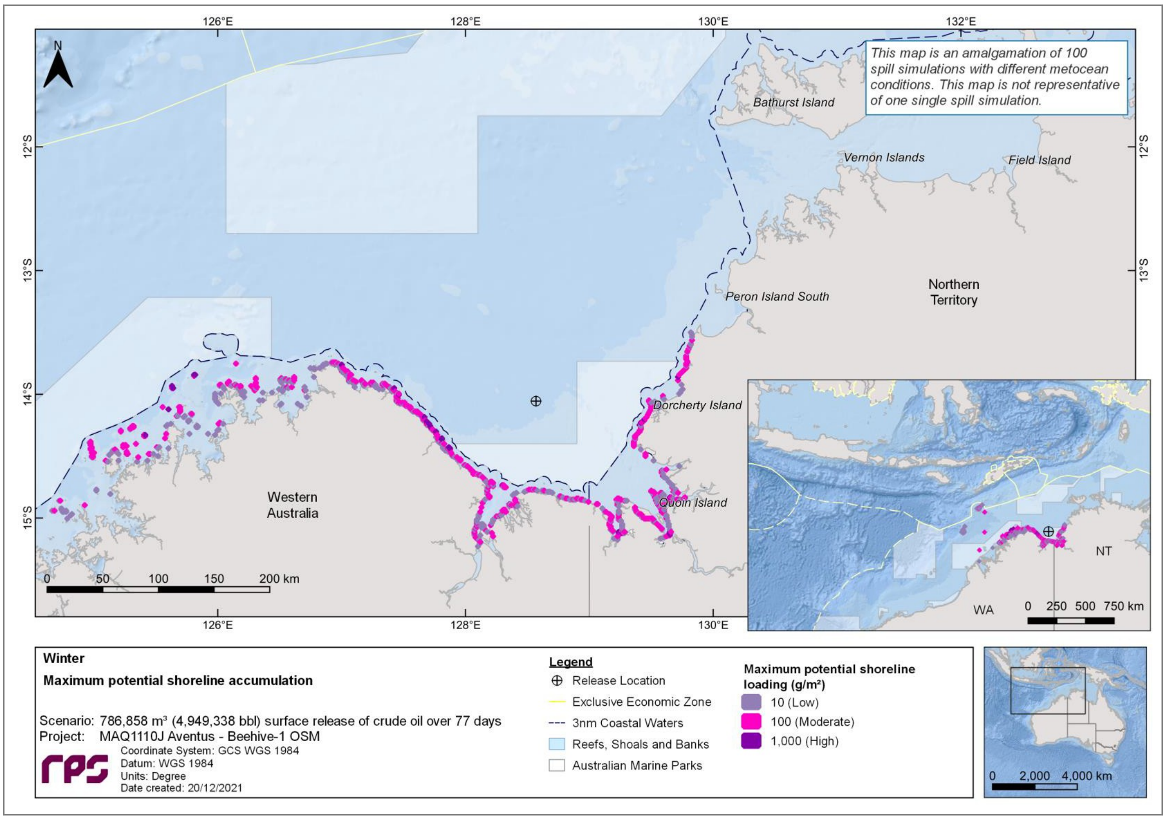


Figure 8.10. Maximum potential shoreline loading during winter conditions

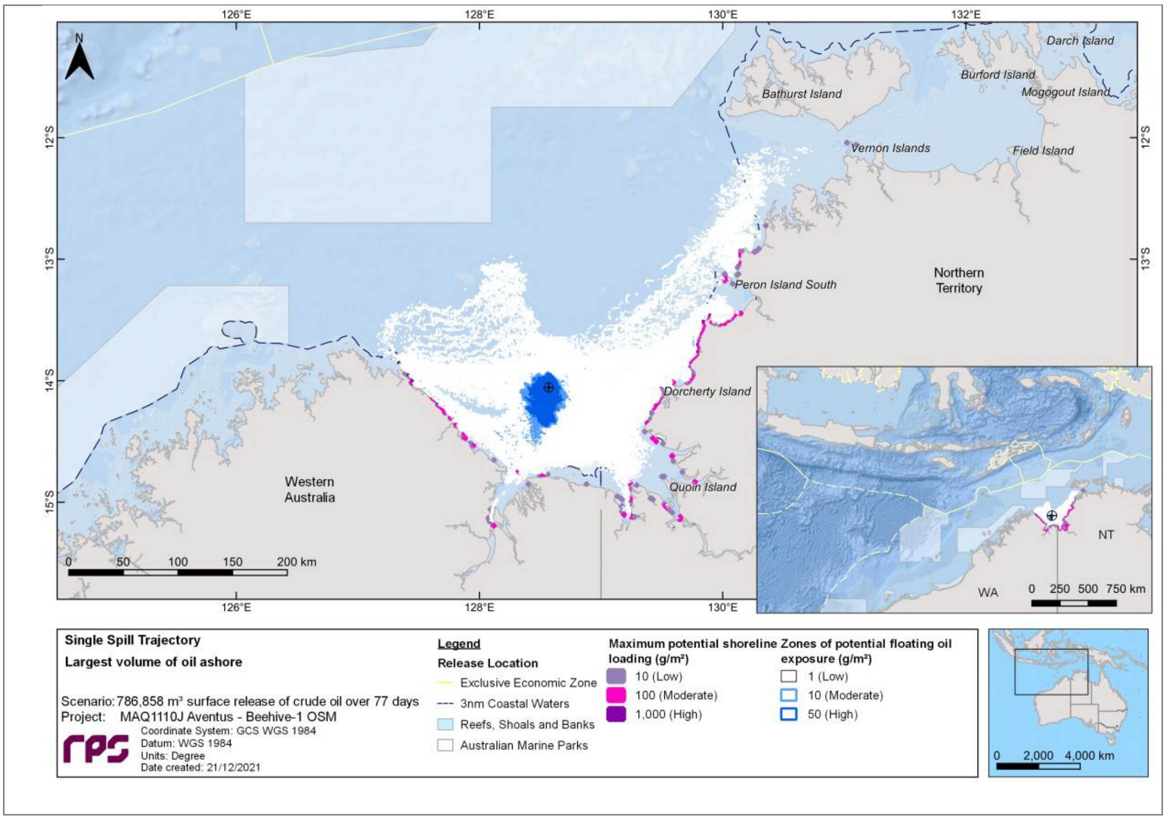


Figure 8.11. Zones of potential floating oil exposure and shoreline accumulation, for the trajectory with the largest volume of oil ashore

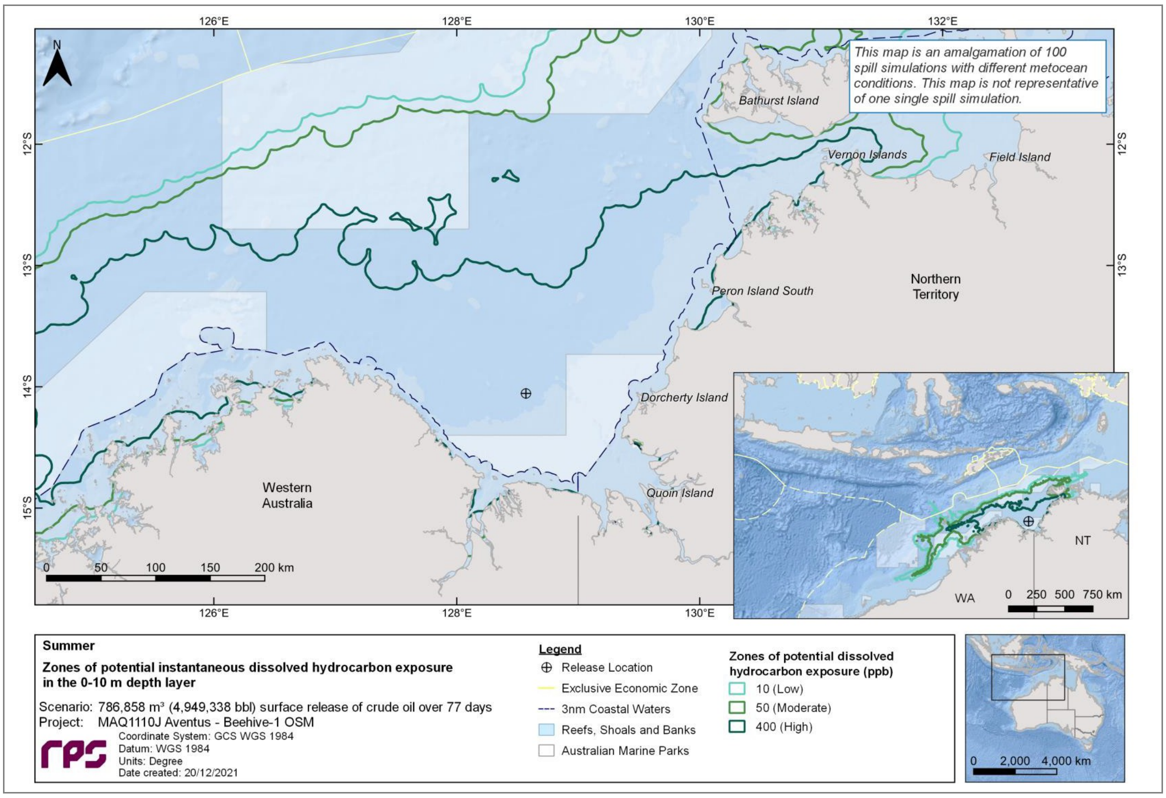


Figure 8.12. Zones of potential <u>dissolved</u> hydrocarbon exposure during <u>summer</u> conditions

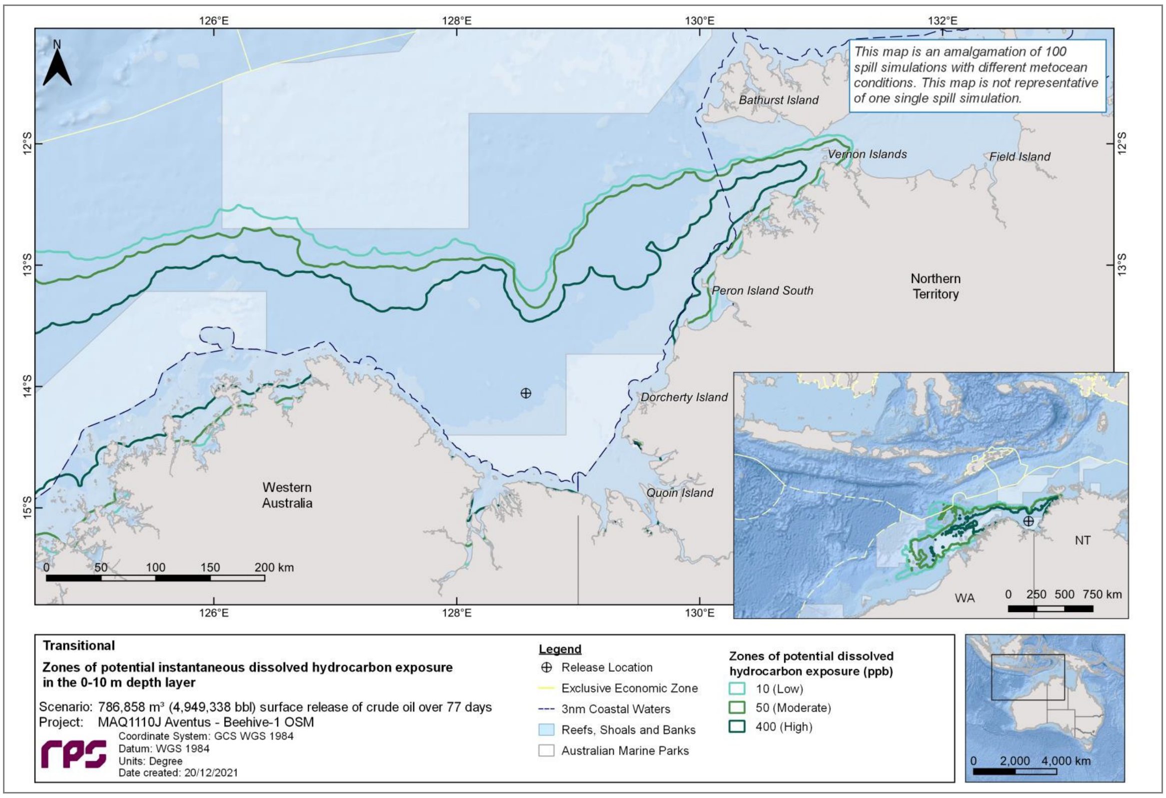


Figure 8.13. Zones of potential <u>dissolved</u> hydrocarbon during <u>transitional</u> conditions

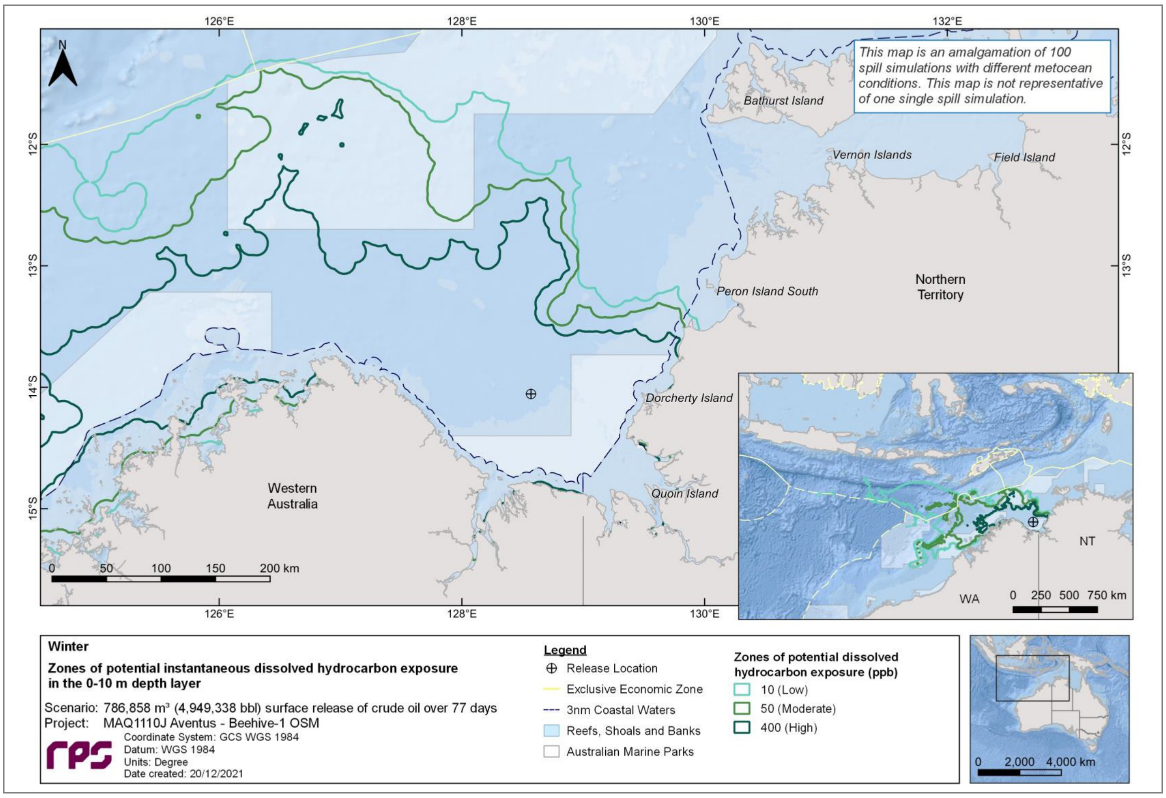


Figure 8.14. Zones of potential dissolved hydrocarbon exposure during winter conditions

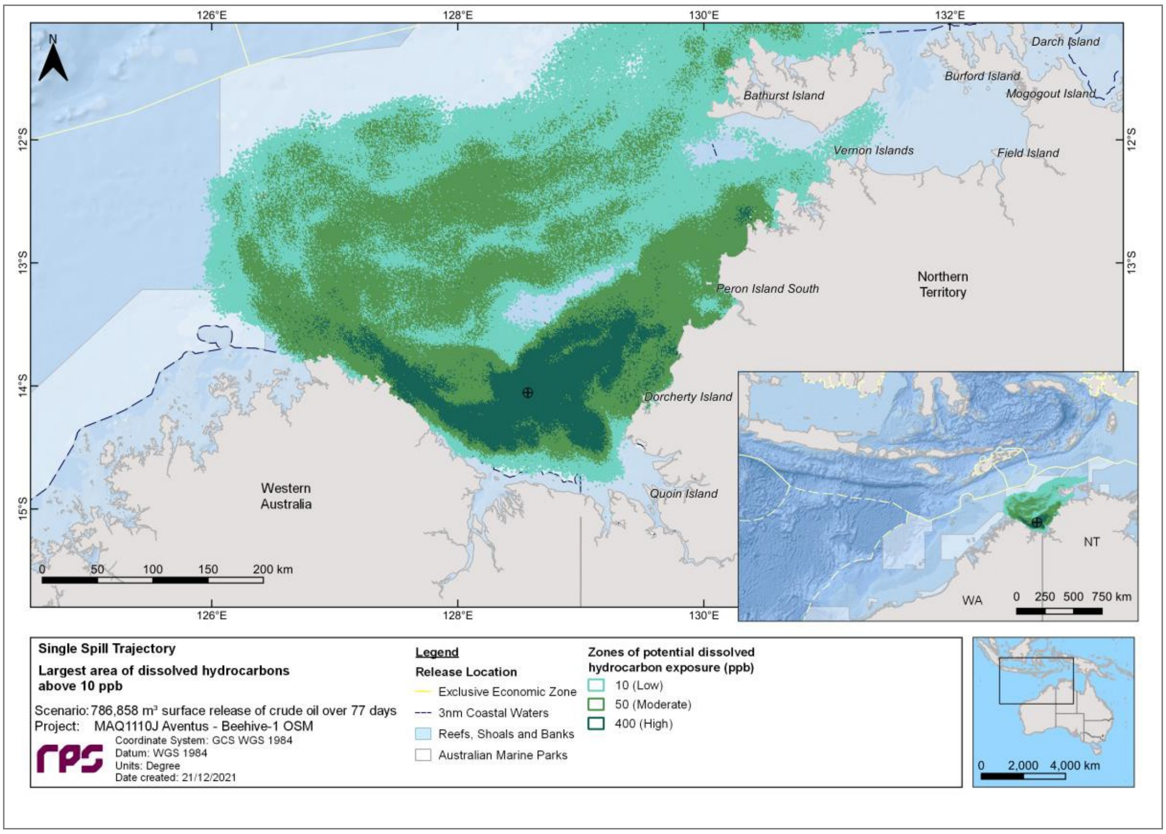


Figure 8.15. Zones of potential dissolved hydrocarbon exposure, for the trajectory with the largest area of dissolved hydrocarbons above 10 ppb

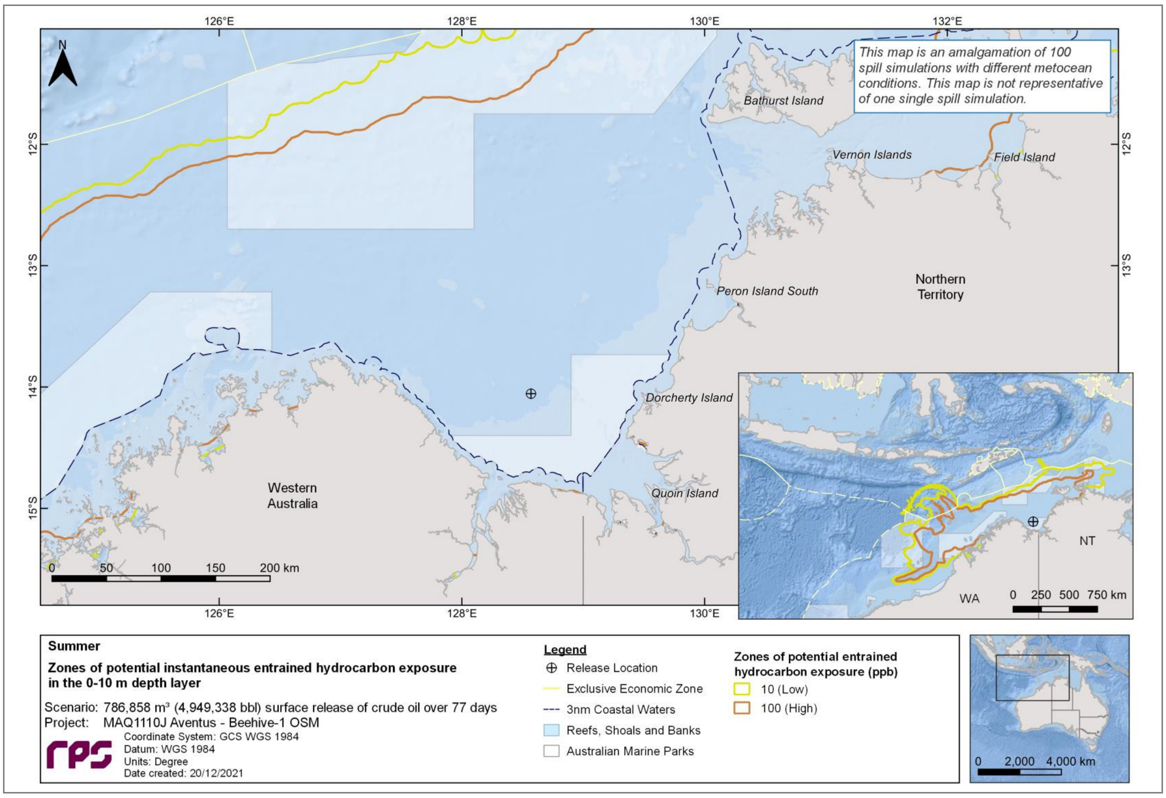


Figure 8.16. Zones of potential <u>entrained</u> hydrocarbon exposure during <u>summer</u> conditions

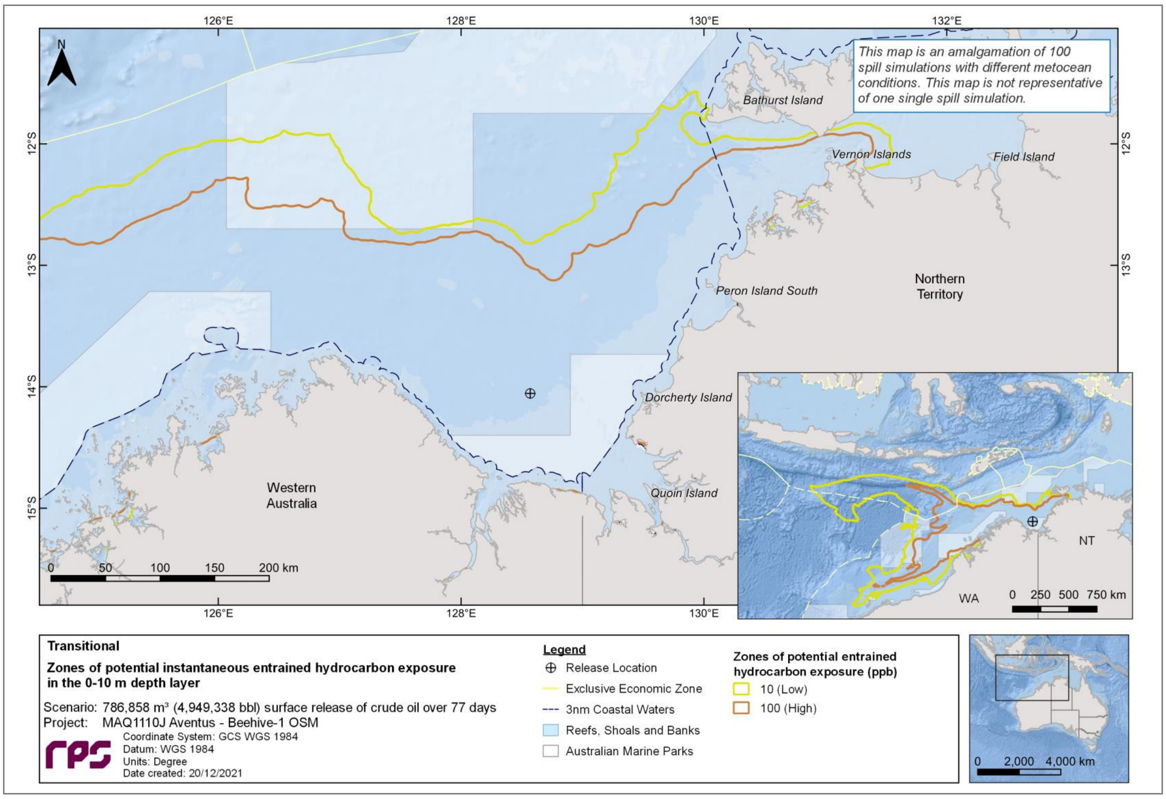


Figure 8.17. Zones of potential <u>entrained</u> hydrocarbon exposure during <u>transitional</u> conditions

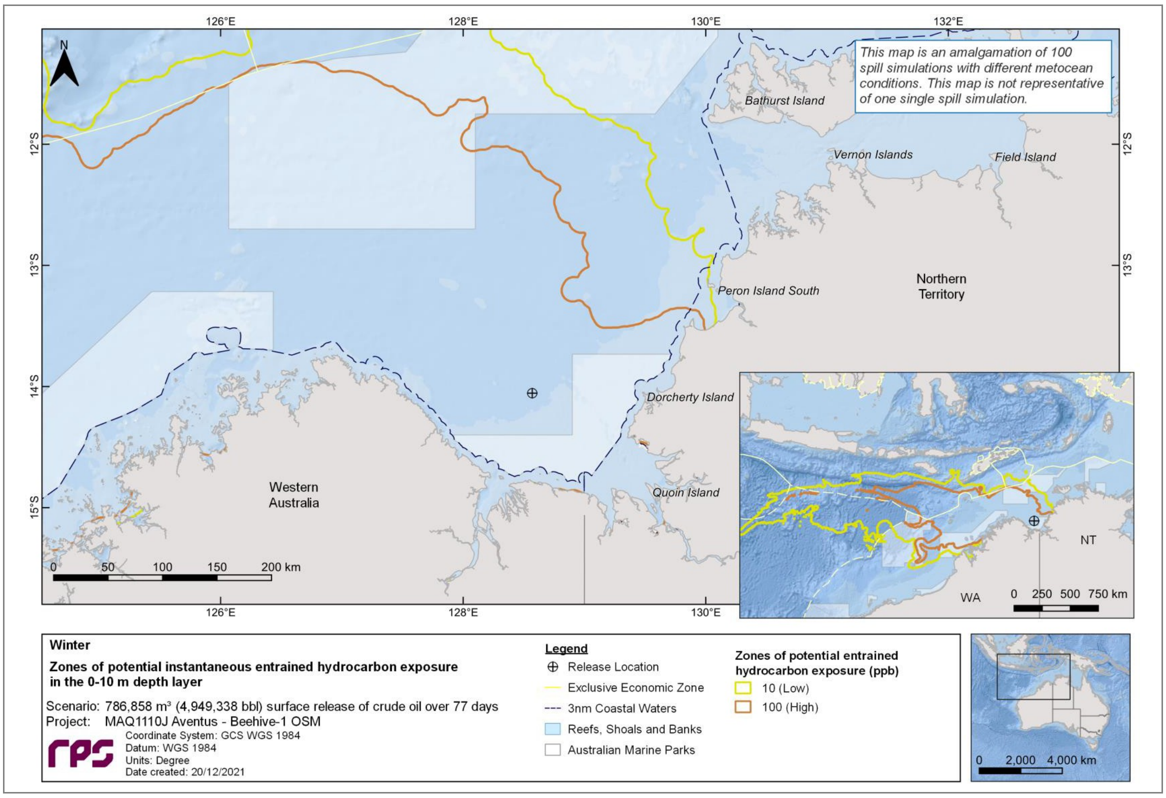


Figure 8.18. Zones of potential entrained hydrocarbon exposure during winter conditions

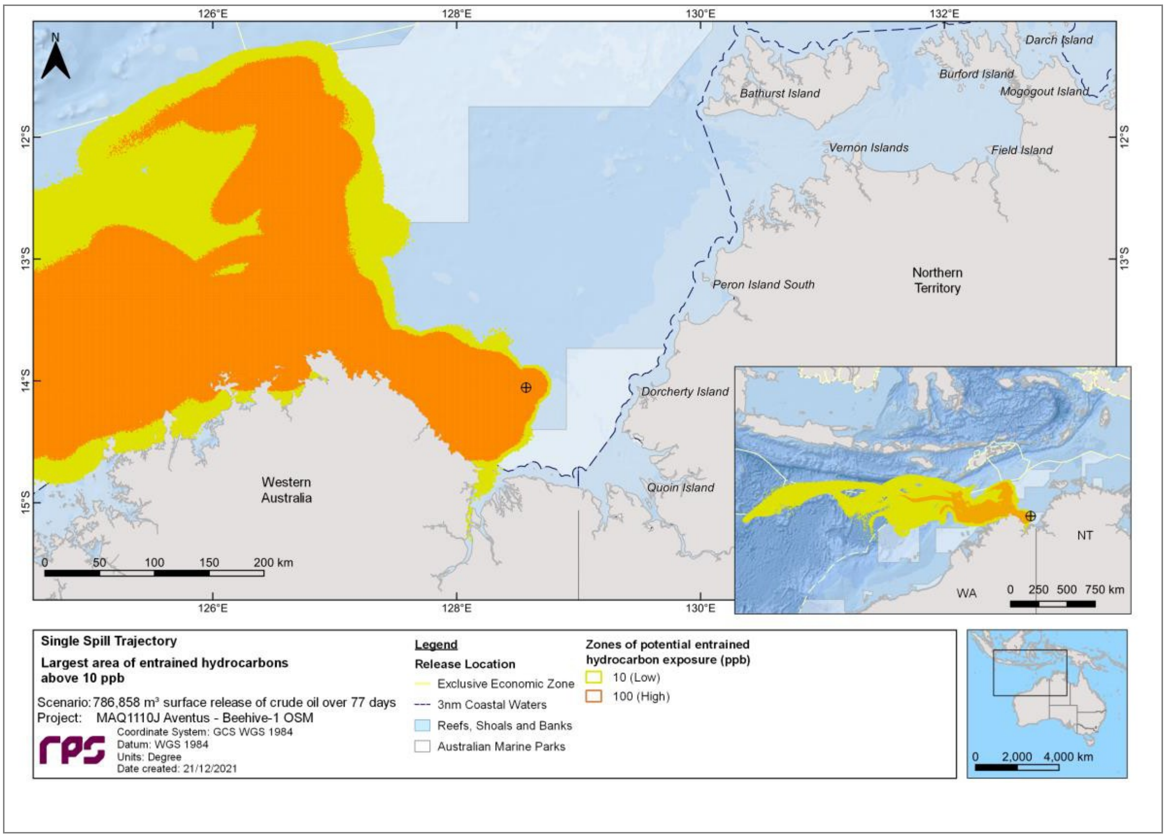


Figure 8.19. Zones of potential entrained hydrocarbon exposure, for the trajectory with the largest area of entrained hydrocarbons above 10 ppb

8.7.3 Potential Environmental Risks

The known and potential risks of a LoWC are:

- A temporary to long-term and widespread reduction in water quality;
- Injury or death of exposed marine fauna and seabirds;
- Habitat damage, especially where the spill reaches shorelines; and
- Changes to the functions, interests or activities of other users (e.g., commercial fisheries).

8.7.4 EMBA

The EMBA for a LoWC (sea surface, shoreline, entrained and dissolved hydrocarbons) is illustrated in Figure 8.4 to Figure 8.19. Receptors most at risk within this EMBA are those within the water column, whether resident or migratory, are:

- Water quality;
- Seabed sediments;
- Plankton;
- Fish;
- Marine mammals;
- Marine reptiles;
- Seabirds and shorebirds;
- Shoreline habitats (sandy beaches, mangroves, mud flats, rocky shores);
- Values of protected areas; and
- Socio-economic values (e.g., commercial fisheries).

8.7.5 Evaluation of Environmental Risks

A risk assessment for the receptors at risk from a LoWC at Beehive-1 is provided in this section, based on a literature review of the sensitivities of the receptors. Because the stochastic modelling does not take into account response actions to reduce the extent or impacts of a LoWC, the risk assessment is necessarily conservative.

The criteria for the sensitivity of receptors that may be affected by an MDO spill are presented in Table 8.23.

The impacts of the LoWC on environmental and socio-economic receptors in the spill EMBA are described in Table 8.24 to Table 8.36. This is divided into subtidal communities, intertidal communities and water column.

Table 8.23. Criteria used to determine receptor sensitivity in the spill 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. • Sandy beaches. • Rocky shores. • Pelagic fish.
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.	• Macroalgae. • Seagrass. • Marine reptiles.
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.	• Coral. • Mangroves and saltmarshes. • Marine mammals. • Seabirds. • Shorebirds. • Commercial fishing. • Marine parks.

Table 8.24. Sensitivity and consequence evaluation of hydrocarbon exposure to subtidal communities - 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:	Appendix 5, Section 5.3.1

Surface hydrocarbons

Benthic species are generally protected from exposure to surface hydrocarbon. The primary modes of exposure for benthic communities in oil spills include:

- Direct exposure to dispersed oil (e.g., physical smothering) where bottom discharges stay at the ocean bottom;
- Direct exposure to dispersed and non-dispersed oil (e.g., physical smothering) where oil sinks down from higher depths of the ocean;
- Direct exposure to dispersed and non-dispersed oil dissolved in sea water and/or partitioned onto sediment particles; and
- Indirect exposure to dispersed and non-dispersed oil through the food web (e.g., uptake of oiled plankton, detritus, prey, etc.) (NRDA, 2012).

Adult marine invertebrates and larvae usually reside within benthic substrates and pelagic waters, rarely reaching the water's surface in their life cycle (to breed, breathe and feed). Therefore, surface hydrocarbons are not considered to pose a high risk to marine invertebrates except at locations where surface oil reaches shorelines.

Acute or chronic exposure, through surface contact, and/or ingestion can result in toxicological risks. However, the presence of an exoskeleton (e.g., crustaceans) reduces the impact of hydrocarbon absorption through the surface membrane. Other invertebrates with no exoskeleton and larval forms may be more prone to impacts from hydrocarbons.

Water column/seabed hydrocarbons

Entrained and dissolved hydrocarbons can have negative impacts on marine invertebrates and associated larval forms, while impacts to adult species is reduced as a result of the presence of an exoskeleton. Localised impacts to larval stages may occur which could impact on population recruitment that year. If invertebrates are contaminated by hydrocarbons, tissue taint can remain for several months, although taint may eventually be lost. For example, it has been demonstrated that it took 2-5 months for lobsters to lose their taint when exposed to a light hydrocarbon (NOAA, 2002).

Exposure to microscopic oil droplets may also impact aquatic biota either mechanically (especially filter feeders) or act as a conduit for exposure to semi-soluble hydrocarbons (that might be taken up by the gills or digestive tract) (McCay-French, 2009). Toxicity is primarily attributed to water soluble PAHs, specifically the substituted naphthalene (C_2 and C_3) as the higher C-ring compounds become insoluble and are not bioavailable. ANZECC/ARMCANZ (2000) identifies the following 96-hr LC_{50} concentrations for naphthalene (a key primary PAH dissolved phase toxicant in crude oils):

- For the bivalve mollusc, *Katelysia opima*, a concentration of 57,000 ppb; and
- For six species of marine crustaceans, a concentration between 850 and 5,700 ppb.

Other possible impacts from the presence of dispersed and non-dispersed oil include effects of oxygen depletion in bottom waters due to bacterial metabolism of oil (and/or dispersants), and light deprivation under surface oil (NRDA, 2012). Surveys undertaken after the Montara well blowout in the Timor Sea in 2009 found no obvious visual signs of major disturbance at Barracouta and Vulcan shoals (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).	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	Not applicable to benthic fauna.
Water column (dissolved & entrained) (0-10 m from surface)	The OSTM predicts extensive areas where is a high probability that medium and high exposure thresholds are reached for dissolved and entrained oil. For much of this area, water depths are greater than 10 m and therefore ecological impacts to benthic fauna are unlikely. In areas of exposure at the seabed, the impacts are likely to be as described in the description of sensitivities. Where such areas contain coral reefs, shoals and/or banks, contact with dissolved and entrained oil may result in toxicity effects and potential mortality (see following tables). One of the key values of the JBG AMP is the Carbonate bank and terrace system of the Sahul Shelf KEF (unique seafloor feature with ecological properties of regional significance). Most of the JBG AMP is in water depths greater than 10 m, so hydrocarbons in the top 10 m of the water column are not likely to have significant impacts on this AMP value.

Shoreline	The areas predicted to have the highest average shoreline loading of oil at moderate or high thresholds across all seasons, and their dominant shoreline types, are the following sectors: • Adele Island - sandy beach. • Browse Island - sandy beach, coral reef. • Thamarrurr - tidal flats/mangroves, sandy beach, rocky shore. • Victoria-Daly - tidal flats/mangroves. • Wyndam-East Kimberley – tidal flats/mangroves, rocky shore, beach sediments. The OSTM predicts extensive shoreline exposure at thresholds that can cause biological impacts (224 km for at moderate threshold). The shoreline of the spill EMBA has a diverse array of benthic fauna, including molluscs (such as mussels) and crustaceans (such as crabs) that live in or on beach sediments, mangroves, mudflats and rocks. At the moderate and high loading thresholds, there is expected to be injury or mortality of exposed benthic fauna due to oil toxicity, which will likely result in bioaccumulation impacts further up the food chain when seabirds, shorebirds and other fauna consume them. How extensive this is depends on the volume that reaches the shoreline and where the oil is deposited. Oiling and contamination of benthic communities on the shorelines closest to the well is likely to result in temporary exclusion of members of the Wunambal Gaambera, Balanggarra, Ngarinyin and/or Miriuwung Gajerrong people using their traditional coastal country to seek food and other resources.

Inherent impact consequence	Severe

Table 8.25. Sensitivity and consequence evaluation of hydrocarbon exposure to subtidal communities – macroalgae and seagrasses

General sensitivity to oiling – macroalgal communities	
Sensitivity rating of macroalgal species and communities:	Medium
A description of macroalgal species and communities in the EMBA is provided in:	Appendix 5, Section 5.3.2
Macroalgae are generally limited to growing on intertidal and subtidal rocky substrata in shallow waters to 10 m depth where they have access to light to photosynthesise. Seagrasses generally grow in sediments in intertidal and shallow subtidal waters where there is sufficient light, and are common in sheltered coastal areas such as bays, lees of islands and fringing coastal reefs. Macroalgae and seagrass are also common features of shoals. As such, they may be exposed to subsurface entrained and dissolved hydrocarbons. Macroalgae 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). 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 plants to photosynthesise. Seagrass	

Seagrasses can be exposed to oil by direct contact (i.e., smothering) and by uptake by rhizomes through contaminated sediments. Exposure also can take place via uptake of hydrocarbons through plant membranes. In addition, seeds may be affected by contact with oil contained within sediments (NRDA, 2012).When seagrass leaves are exposed to petroleum oil, sub-lethal quantities of the WAF can be incorporated into the tissue, causing a reduction in tolerance to other stress factors (Zieman et al., 1984). The toxic components of petroleum oils are thought to be the PAH, which are lipophilic and therefore able to pass through lipid membranes and tend to accumulate in the thylakoid membranes of chloroplasts (Ren et al., 1994). As such, the susceptibility of seagrasses to hydrocarbon spills will depend largely on distribution. Deeper communities will be protected from oiling under all but the most extreme weather conditions. Shallow seagrasses are more likely to be affected by dispersed oil droplets or, in the case of emergent seagrasses, direct oiling. Theoretically, intertidal seagrass communities would be the most susceptible because the leaves and rhizomes may both be affected. Studies report that the phytotoxic effect of petroleum oil on seagrasses can lead to a range of sub-lethal responses including reduced growth rates (Howard & Edgar, 1994), bleaching, decrease in the density of shoots, reduced flowering success (den Hartog & Jacobs, 1980; Dean et al., 1998) and blackened leaves that can detach from the plant following oil contamination (den Hartog & Jacobs, 1980). Direct exposure, however, does not always induce toxic effects (Kenworthy et al., 1993; Dean et al., 1998), even under laboratory conditions (Wilson & Ralph, 2012). Studies of actual spills have found no significant differences between oiled and un-oiled seagrass meadows comprising *Halodule uninervis*, *Halophila ovalis* and *Halophila stipulacea* following large spills of crude oil during the Gulf War (Kenworth *et al*., 1993). Similarly, a spill of heavy fuel oil contaminated by lighter fuel products in Gladstone Harbour (Queensland) did not result in measurably short- or long-term impacts on meadows of *Zostera capricorni*, *H. ovalis*, *H. decipiens*, *H. spinulosa* or *H. uninervis* (Taylor & Rasheed, 2011). Conversely, one laboratory study using Bass Strait crude and diesel fuel did observe mortality of affected seagrass, with slow recovery (Clarke & Ward, 1994). One reason why seagrasses appear to be less vulnerable to oil impacts is that 50-80% of their biomass is in their rhizomes, which are buried in sediments, thus less likely to be adversely impacted by oil. Thus, even if the fronds are affected, the plant may still be alive and able to regrow (Zieman et al., 1984) In addition to the effects described, the presence of entrained hydrocarbons within the water column can affect light qualities and the ability of seagrass to photosynthesise. Studies of photosynthetic impacts on seagrass used WAF of Tapis crude and IFO-180, with concentrations ranging from 3 – 522 mg/L-1, found minimal or no negative impacts (Wilson & Ralph, 2012).	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	Not applicable.
Water column (dissolved & entrained) (0-10 m from surface)	The OSTM predicts extensive areas where there is a high probability that medium and high exposure thresholds are reached for dissolved and entrained oil. All nearshore environments along the coastline of the spill EMBA are expected to contain some degree of marine plant life presence, whether this be isolated or extensive seagrass meadows or stands of green, red and brown algae (seaweed), noting however that there is scant information about the

	presence of seagrasses north of Broome (WA). Seaweed is of course omnipresent in the marine environment. Areas where such subtidal communities are likely to be present include offshore islands, sheltered bays, crevices among rocky shores and offshore shoals. The impacts to macroalgae and seagrasses are likely to be as described in the description of sensitivities and may result in toxicity effects and potential mortality. Any reduced growth rates or temporary loss of grass cover (noting that rhizomes growing in seabed sediments would remain intact) may result in dieback of seagrasses. This may lead to a temporary reduction in fish nursery habitat, with consequent losses in fish diversity and abundance. This may have longer-term impacts on the size of fish populations. Contaminated macroalgae consumed by fish, turtles, dugongs and shorebirds will result in some level of bioaccumulation up the food chain. How extensive this is depends on the concentration of oil in the water column and the species exposed. Dugongs feed exclusively on seagrasses. The ecological spill EMBA intersects a very small area of the dugong foraging BIA in the area north of Broome, noting that there is only a 1% probability of oil contact at the low threshold in this area. This would not have ecological consequences and therefore dugong present in the area are unlikely to be impacted by a contaminated food source.
Shoreline	Addressed in ‘water column’.

Inherent impact consequence	Severe

Table 8.26. Sensitivity and consequence evaluation of hydrocarbon exposure to subtidal communities – coral

General sensitivity to oiling – rocky shores	
Sensitivity rating of coral:	High
A description of coral reefs in the EMBA is provided in:	Appendix 5, Section 5.3.2

Experimental studies and field observations indicate all coral species are sensitive to the effects of oil, although there are considerable differences in the degree of tolerance between species. Differences in sensitivities may be due to the ease with which oil adheres to the coral structures, the degree of mucous production and self-cleaning, or simply different physiological tolerances.

Direct contact of coral by hydrocarbons may impair respiration and also photosynthesis by symbitotic zooanthellae (Peter *et al*., 1981; Knap *et al*., 1985). Coral gametes or larvae in the surface layer where they are exposed to the slick may also be fouled (Epstein *et al*., 2000). Larvae in the water column at the time of spawning are especially vulnerable to oil (Hook *et al*., 2016). Physical oiling of coral tissue can cause a decline in metabolic rate and may cause varying degrees of tissue decomposition and death (Negri and Heyward, 2000). Oil may also cling to certain types of sediment causing oil to sink to the seafloor, covering corals in oiled sediment (IPIECA, 2011).

Where corals come into direct contact with surface exposures (i.e., intertidal/shallow areas), they are more susceptible due to physical presence, than toxicity associated with dissolved oil components within the water column which, in some cases, may be more toxic than the floating surface slicks (Volkman *et al*., 1994). A range of impacts is reported to result from toxicity including partial mortality of colonies, reduced growth rates, bleaching and reduced photosynthesis.

Chronic effects of oil exposure have been consistently noted in corals and, ultimately, can kill the entire colony. Chronic impacts include histological, biochemical, behavioural, reproductive and developmental effects. Field studies of chronically polluted areas and manipulative studies in which corals are artificially exposed to oil show that some coral species tolerate oil better than other species (NOAA, 2010c).

Reproductive stages of corals have been found to be more sensitive to oil toxicity. Fertilisation of coral species has been observed to be completely blocked in Acropora tenuis at heavy fuel oil concentrations of 0.15 mg/L^{-1} (Harrison, 1994; 1999), with significant reductions in fertilisation of *A. millepora* and *A. valida* at concentrations between 0.58 and 5.8 mg/L_{-1}, in addition to developmental abnormalities and reduced survival of coral larvae at similar concentrations (Lane and Harrison, 2000). Lower concentrations of less than 0.1 mg/L^{-1} crude oil were observed to inhibit larval metamorphosis in *A. millepora* (Negri & Heywood, 2000).

Studies undertaken after the Montara spill (a light crude) in northwest Australia included diver surveys to assess the status of Ashmore, Cartier and Seringapatam coral reefs. These found that other than a region-wide coral bleaching event caused by thermal stress (i.e., caused by sea water exceeding 32°C), the condition of the reefs was consistent with previous surveys, suggesting that any effects of hydrocarbons reaching these reefs was minor, transitory or sub-lethal and not detectable (Heyward *et al*., 2010). This is despite AMSA observations of surface slicks or sheen nears these shallow reefs during the spill (Heyward *et al*., 2010). Surveys in 2011 indicated that the corals exhibiting bleaching in 2010 had largely survived and recovered (Heyward *et al*., 2012), indicating that potential exposure to hydrocarbons while in an already stressed state did not have any impact on the healthy recovery of the coral.

In addition, surveys undertaken after the Montara blowout on the plateau areas of 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), and contain algae, hard coral and seagrass, found no obvious visual signs of major disturbance.	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	Not applicable.
Water column (dissolved & entrained) (0-10 m from surface)	The OSTM predicts extensive areas where there is a high probability that medium and high exposure thresholds are reached for dissolved and entrained oil, which may impact coral reefs. Key areas within the ecological spill EMBA known to contain coral reef, and their risk of contact within the water column, are: • JBG AMP – 66-97% (dissolved) and 83-100% (entrained) probability of contact across the seasons. • Ashmore Reef AMP – 0% (dissolved) and 0-14% (entrained) probability of contact across the seasons. • Cartier Island AMP – 0% (dissolved) and 0-15% (entrained) probability of contact across the seasons. • Mermaid Reef AMP – 0-2% (dissolved) and 2-5% (entrained) probability of contact across the seasons. • Browse Island – 1-13% (dissolved) and not reported (entrained) probability of contact across the seasons. • Heywood Shoal – 0-4% (dissolved) and 19-38% (entrained) probability of contact across the seasons. <check there's reef here> • Mermaid Reef – 0-3% (dissolved) and 0-5% (entrained) probability of contact across the seasons. • Vulcan Shoal – 0-3% (dissolved) and 0-22% (entrained) probability of contact across the seasons. • Scott Reef (north & south) – 0-2% (dissolved) and 1-6% (entrained) probability of contact across the seasons. • Seringapatam Reef – 0% (dissolved) and 0-7% (entrained) probability of contact across the seasons. • Ashmore Reef – 0% (dissolved) and 0-14% (entrained) probability of contact across the seasons. • Hibernia Reef – 0% (dissolved) and 0-5% (entrained) probability of contact across the seasons. The impacts to coral reef are likely to be as described in the description of sensitivities and may result in localised or widespread areas of colony mortality, decreased growth rates, decreased survival of larvae, decreased gonadal development and increased bleaching (Hook *et al*., 2016). Such impacts to coral reefs will have consequences for the fish and other species dependent on coral habitat. Corals also accumulate oil from the water column, which can persist and become biologically available to fish and other fauna that graze on them (Hook *et al*., 2016). Recovery of coral reefs after exposure to oil can be slow and they may become overgrown by algae and become susceptible to other stressors, such as predators (Hook *et al*., 2016).

	Impacts to coral reefs within AMPs and state marine parks may reduce the ecological values of those parks and possibly lead to lower ecotourism visits and associated loss of income for tourism businesses dependent on tourists.
Shoreline	Addressed in ‘water column’.

Inherent impact consequence:	Severe

Table 8.27. Sensitivity and consequence evaluation of hydrocarbon exposure to intertidal communities – mangroves and salt marshes

General sensitivity to oiling – rocky shores	
Sensitivity rating of mangroves and salt marshes:	High
A description of rocky shores in the EMBA is provided in:	Appendix 5, Sections 5.2.3 & 5.2.4
Mangrove and saltmarsh ecosystems are specially adapted to marine and estuarine conditions and play an important role in reducing wave energy at the coast and preventing shoreline erosion, with mangroves providing nursery habitat for many species of marine fauna (Hook *et al*., 2016). Mangroves The impacts of surface hydrocarbons on mangroves include damage as a result of smothering of lenticels (mangrove breathing pores) on pneumatophores or aerial roots (Hook *et al*., 2016), or by the loss of leaves (defoliation) due to chemical burning. It is also known that mangroves take up hydrocarbons from contact with leaves, roots or sediments, and it is suspected that this uptake causes defoliation through leaf damage and tree death (Wardrop *et al*., 1987). Entrained and dissolved hydrocarbons may potentially impact mangrove communities through the sediment/mangrove root interface. Entrained and dissolved hydrocarbons contain contaminants that may become persistent in the sediments (e.g., trace metals, PAHs), leading to direct effects on mangroves due to direct uptake, or indirect effects due to impacts on benthic infauna and thus leading to reduced rates of bioturbation and subsequent oxygen stress on the plants root systems. The following information is from IPIECA (1993) and NOAA (2014). Oil slicks enter mangrove forests when the tide is high and are deposited on the aerial roots and sediment surface as the tide recedes. This process commonly leads to a patchy distribution of the oil and its effects, because different places within the forests are at different tidal heights. Mangroves can be killed by heavy or viscous oil that covers the trees' breathing pores thereby asphyxiating the subsurface roots, which depend on the pores for oxygen. This is also likely to apply to oil emulsions that may flow into mangrove forests. Observed thresholds for impacts are likely to vary depending on the health of the system, the spilt hydrocarbon and the environmental conditions, however observations by Lin and Mendelssohn (1996), demonstrated that more than 1 kg/m^2 of oil during the growing season would be required to impact marsh or mangrove plants significantly. Mangroves can also be killed through the toxicity of substances in the oil, especially lower molecular weight aromatic compounds, which damage cell membranes in the subsurface roots. This in turn impairs the normal salt exclusion process, and the resulting influx of salt is a source of stress to the plants. The organisms among and on the mangrove trees are also affected by the oil. There may be heavy mortalities as a direct result of the oil penetrating burrows in the sediments, killing crabs and worms, or coating molluscs present on the sediment surface and aerial roots. Dead trees lead to loss of habitat for organisms living in the branches and canopy of the trees, and in the aerial root systems. Over time, several factors reduce the toxicity of oil that has been deposited in mangrove forests. The amount of oil in the soil is reduced by rain and tides. As the oil weathers, chemical changes such as oxidation make the residual oil less toxic. Eventually the soil can support mangrove growth once more, with the time-scale involved varying according to local conditions such as the amount of water circulation in the immediate area. White mangroves (*Avicennia marina*), which are found in pockets of the southern Australian coast, have been found to be highly susceptible to weathered crude oil, with field studies showing acute effects (mortality) of 96% to seedlings. Similar impacts may be expected for mangrove species in northern Australia. Observations from	

oil spill in mangroves indicate mangrove stress occurs within the first two weeks of a spill (ranging from chlorosis to defoliation to death). Chronic effects to mangroves can be more difficult to detect than acute effects, with defoliation and death of mangroves taking place anywhere from 30 days to years after exposure to crude oil. Root and pneumatophore abnormalities have been reported as a response to chronic oil exposures (Hook *et al*., 2016). Mendelssohn et al (2012) notes that PAHs are the most toxic contaminants and are persistent in marshes. The highest levels generally occur below the sediment surface, where there is limited oxygen and a concomitant shift from aerobic to anaerobic bacterial taxa. In a heavily contaminated mangrove forest, PAH concentrations increase with increasing substrate depth and decreasing oxygen content. PAH-degrading anaerobic bacteria have been identified in contaminated wetland sediments, but given their low oil-degradation capability, it is unlikely that anaerobic bacteria could greatly reduce PAH contamination, except at low concentrations of PAH.

Oil entrained within mangrove sediments can be available to invertebrates and fish inhabiting these systems, causing toxic impacts and changes in community structure (Hook *et al*., 2016). Recovery from oil in mangrove habitats can be very slow because the sediments are anoxic, which slows the rate of oil degradation (Hook *et al*., 2016).

<u>Saltmarsh</u>

The following information is from IPIECA (1994), except where otherwise stated.

As with mangroves, oil will readily adhere to both tidal and muted tidal marshes with the extent of coating varying according to the water level at the time of oiling. Large slicks will persist through multiple tidal cycles and will coat the entire stem from the high-tide line to the base. Once oil is deposited into saltmarshes, the low energy environment means that oil is not rapidly washed away. Following the *Deepwater Horizon* oil spill in the USA, studies demonstrated that oil deposited in oxic (well oxygenated) sediments degraded quickly (within 18 months), whereas oil in anoxic (low oxygen) sediments is expected to persist for decades (Hook *et al*., 2016).

Saltmarsh vegetation offers a large surface area for oil absorption, which tends to trap oil. Additionally, many saltmarsh grasses, which can be dominant over large areas, have corrugated leaf surfaces that increases the holding capacity of oil.

Heavy oil coating will be restricted to the outer fringe of thick vegetation, although lighter oils can penetrate deeper, to the limit of tidal influence. Medium to heavy oils do not readily adhere to or penetrate the fine sediments composed of organic muds, but can pool on the surface or in animal burrows and root cavities. Light oils can penetrate the top few centimeters of sediment and follow biological pathways burrows and cracks up to one meter deep.

Evidence from case histories and experiments shows that the damage resulting from oiling, and recovery times of oiled saltmarsh vegetation, are very variable. Lighter more penetrating oils are more likely to cause acute toxic damage than heavy or weathered oils.

In areas of light to moderate oiling where oil is mainly on perennial vegetation with little penetration of sediment, the shoots of the plants may be killed but recovery can take place from the underground systems. Good recovery commonly occurs within one to two years. Where thick deposits of viscous oil or mousse accumulate on the marsh surface, vegetation is likely to be killed by smothering and recovery will be delayed because persistent deposits inhibit recolonisation.

Oiling of shoots combined with substantial penetration of oil into sediments is more likely to happen with relatively fresh light crude oils (such as that predicted at Beehive-1) because these are less viscous. Damage to the underground systems and invertebrate communities results from the sub-surface oil, and recovery is delayed.

Abundant resident flora and fauna and high use by birds, fish and shellfish, means that oiling of saltmarsh environments can result in significant ecological impacts. Hook et al (2016) reports that there is expected to be a loss of invertebrate species diversity and abundance and productivity in oiled saltmarshes.

Damage to or dieback of saltmarshes can lead to coastal erosion (Hook *et al*., 2016). Recovery may be delayed if the species composition is altered as tolerant species gain a competitive advantage. Following the *Deepwater Horizon* oil spill in the USA, studies of the impacts to saltmarshes found that recovery was underway within one year of the spill, but proceeded the slowest in the areas closest to the shoreline (Hook *et al*., 2016).	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	Not applicable.
Water column	Addressed in 'shoreline.'
Shoreline	All of the shoreline sectors illustrated in **Appendix 5** in the ecological spill EMBA have mangroves present (and likely saltmarshes), except for the Scott Reef/Browse Island and Ashmore Reef/Cartier Island sectors. The shoreline sectors with the highest probability of moderate to high exposure are: • Mitchell River – up to 93% probability of contact, up to 415 m^3 of oil. • Wyndham-East Kimberley - up to 93% probability of contact, up to 415 m^3 of oil; • Victoria-Daly – up to 73% probability of contact, up to 258 m^3 of oil; • Thamarrurr – up to 74% probability of contact, up to 271 m^3 of oil; and • Daly – up to 41% probability of contact, up to 200 m^3 of oil (only during the summer period). All mangrove forests and saltmarshes are considered to be important because of their habitat values, which includes fish breeding and nurseries, shorebird feeding, roosting and breeding habitat, and shoreline protection. Any long-term damage to the health of these habitats resulting from oil exposure will result in loss of habitat and reduced protection of the shoreline. There are a number of NIWs along the coast close to Beehive-1 (Ord Estuary System, Legune Wetlands, Moyle Floodplain and Hyland Bay System). Damage to mangroves and saltmarsh within these NIWs will impact on their ecological values, including potential loss of habitat for sawfish species, crocodiles and various shorebird species, such as magpie geese that breed in the Legune Wetlands.

Inherent impact consequence	Severe

Table 8.28. Sensitivity and consequence evaluation of hydrocarbon exposure to intertidal communities – sandy beaches

General sensitivity to oiling – sandy beaches	
Sensitivity rating of sandy beaches:	Low
A description of sandy beaches in the EMBA is provided in:	Appendix 5, 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 (TOC) and large particle size of sand means that oil deposited on the beach would not generally be retained. However, sandy beaches are important socio-economically, so hydrocarbons reaching this type of shoreline may attract attention that is disproportionate to its sensitivity (Hook *et al*., 2016). Sediment grain sizes between 2 and 64 mm are not considered sensitive to oil spills because they are regularly cleaned by wave action and have low TOC and therefore a low diversity and abundance of marine life (Hook *et al*., 2016).

The depth of penetration in sandy sediment is influenced by:

- Particle size - penetration is great in coarser sediments (such as beach sand) compared to finder sediments and mud;
- Oil viscosity – light oil quickly penetrates sandy sediments (compared to heavy oil);
- Drainage – coarse beach sands allow for rapid drainage (it may reach depths greater than one metre in coarse well-drained sediments); and
- 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.

<table>
<tr><td colspan="2">The Deepwater Horizon 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).</td></tr>
<tr><th colspan="2">Consequence evaluation based on the Beehive-1 OSTM</th></tr>
<tr><td>Sea surface</td><td>Not applicable.</td></tr>
<tr><td>Water column</td><td>Not applicable.</td></tr>
<tr><td>Shoreline</td><td>Much of the shoreline within the ecological spill EMBA is dominated by mangroves and rocky shores, interspersed with short sections of sandy beaches.
The shoreline sectors with large areas of sandy beaches with the highest probability of moderate to high exposure are:
Wyndham-East Kimberley - up to 93% probability of contact, up to 415 m^3 of oil;
Thamarrurr – up to 74% probability of contact, up to 271 m^3 of oil;
Daly – up to 41% probability of contact, up to 200 m^3 of oil (only during the summer period).
Browse Island - up to 27% probability of contact, up to 64 m^3 of oil.
Areas of low exposure to shoreline loading are not expected to exhibit ecological harm.
Areas of high oil loading may result in acute toxicity impacts and therefore reduced infauna diversity and abundance, such as the loss of amphipods and replacement by more tolerant species, such as worms (Hook et al., 2016). This may then impact on species such as shorebirds and seabirds that feed on these animals.
See Table 8.32 for impacts to turtles nesting in sandy beaches and Table 8.33 for shorebirds.
Due to the remoteness of the coastline of the socio-economic EMBA, there is predicted to be negligible impacts to the socio-economic values of sandy beaches. There is little tourism in this region and the year-round presence of crocodiles and seasonal presence of stinging jellyfish means beaches are not used recreationally like they are in other parts of Australia. Isolated sections of the western shoreline of Bathurst Island are predicted to have some shoreline contact only in the summer metocean season (4-9% probability of contact at the low threshold) with low shoreline loadings</td></tr>
</table>

	(4-12 m^3). These beaches are located over 50 km from the Aboriginal township of Wurrumiyanga on the island (and 25 km from Pirlangimpi on Melville Island) and is not predicted to have any significant impacts on traditional beach-based fishing or recreational activities.

Inherent impact consequence	Moderate

Table 8.29. Sensitivity and consequence evaluation of hydrocarbon exposure to intertidal communities – rocky shores

<table>
<tr><th colspan="2">General sensitivity to oiling – rocky shores</th></tr>
<tr><td>Sensitivity rating of rocky shores:</td><td>Low</td></tr>
<tr><td>A description of rocky shores in the EMBA is provided in:</td><td>Appendix 5, Section 5.2.2</td></tr>
<tr><td colspan="2">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 rapid in tropical environments, such as that of northwest Australia. 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). Rocky shorelines are generally considered not to be sensitive environments (Hook et al., 2016).</td></tr>
<tr><th colspan="2">Consequence evaluation based on the Beehive-1 OSTM</th></tr>
<tr><td>Sea surface</td><td>Not applicable.</td></tr>
<tr><td>Water column</td><td>Not applicable.</td></tr>
</table>

Shoreline	Much of the shoreline within the ecological spill EMBA is dominated by rocky shores. The shoreline sectors with the largest sections of rocky shorelines and with the highest probability of moderate to high exposure are: • Wyndham-East Kimberley - up to 93% probability of contact, up to 415 m^3 of oil; • Thamarrurr – up to 74% probability of contact, up to 271 m^3 of oil; • Daly – up to 41% probability of contact, up to 200 m^3 of oil (only during the summer period). • Browse Island - up to 27% probability of contact, up to 64 m^3 of oil. Areas of high oil loading may result in acute toxicity impacts and therefore reduced infauna diversity and abundance, such as the loss of macroalgae, lichen, sponges, bivalves and crustaceans (Hook *et al*., 2016). The large tidal range in the northwest region is expected to result in stranded oil being removed once it's deposited. In high energy regions, where waves are crashing into the rocks, weathering will be rapid and it is not expected that oil would remain for a long period of time. There are no threatened species in the ecological spill EMBA known to be dependent on rocky shores.

Inherent impact consequence:	Moderate

Table 8.30. Sensitivity and consequence evaluation of hydrocarbon exposure to oceanic communities - plankton

<table>
<tr><th colspan="2">General sensitivity to oiling – plankton</th></tr>
<tr><td>Sensitivity rating of plankton:</td><td>Low</td></tr>
<tr><td>A description of plankton communities in the EMBA is provided in:</td><td>Appendix 5, Section 5.3.3</td></tr>
<tr><td colspan="2">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 hydrocarbon 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.</td></tr>
<tr><th colspan="2">Consequence evaluation based on the Beehive-1 OSTM</th></tr>
</table>

<table>
<tr><td>Sea surface</td><td rowspan="2">Plankton found in open water of the ecological spill EMBA is expected to be widely represented in the northwest region as a result of the southerly movement of the Indonesian Throughflow and the southeast and northwest monsoonal wind-driven currents (Brewer 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 surface, dissolved and entrained hydrocarbons at the moderate and high thresholds. Because the area affected by a spill will be smaller than that of the ecological EMBA (because the EMBA represents a combination of 100 random simulations, see also the deterministic OSTM results in Figures 8.7, 8.11, 8.15 and 8.19), 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.</td></tr>
<tr><td>Water column</td></tr>
<tr><td>Shoreline</td><td>Not applicable.</td></tr>
</table>

Inherent impact consequence:	Moderate

Table 8.31. Sensitivity and consequence evaluation of hydrocarbon exposure to oceanic communities - fish

General sensitivity to oiling – pelagic fish	
Sensitivity rating of fish	Low
A description of fish in the EMBA is provided in:	Appendix 5, Section 5.3.4

The behaviours and habitat preferences of fish species (including sharks and rays) 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 ‘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 LC_{50}) under different environmental conditions varied from 6 to 400 µg/L (ppb), with an average of 50 ppb. This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae). Based on scientific literature, a minimum threshold of 6 ppb over 96 hours or equivalent was used to assess in-water low exposure zones, respectively (Engelhardt, 1983; Clark, 1984; Geraci and St Aubin, 1988; Jenssen, 1994; Tsvetnenko, 1998). French-McCay (2002) indicates that an average 96-hour LC_{50} of 50 ppb and 400 ppb could serve as an acute lethal threshold to 50% and 97.5% to biota, respectively.

Studies of oil impacts on bony fishes report that light, volatile oils are likely to be more toxic to fish. Many studies conclude that exposure to PAHs and soluble compounds are responsible for the majority of toxic impacts observed in fish (e.g., Carls *et al*., 2008; Ramachandran *et al*., 2004). A range of lethal and sub-lethal effects to fish in the larval stage has been reported at water-accommodated fraction (WAF) hydrocarbon concentrations (48–hour and 96-hour exposures) of 0.001 to 0.018 ppm during laboratory exposures (Carls *et al*., 2008; Gala, 2001). In contrast, wave tank exposures reported much higher lethal concentrations (14-day LC_{50}) up to 1.9 ppm for herring embryos and up to 4.3 ppm for juvenile cod (Lee *et al*., 2011).

Toxicity in adult fish has been reported in response to crude oils, HFO and diesel (Holdway, 2002; Shigenaka, 2011). Uptake of hydrocarbons has been demonstrated in bony fish after exposure to WAF of between 24 and 48 hours. Danion et al (2011) observed PAH uptake of 148 µg/kg-1 after 48-hour exposures to PAH from Arabian Crude at high concentrations of 770 ppm. Davis et al (2002) report detectable tainting of fish flesh after a 24-hour exposure at crude concentrations of 0.1 ppm, marine fuel oil concentrations of 0.33 ppm and diesel concentrations of 0.25 ppm. The majority of studies, either from laboratory trials or of fish collected after spill events (including the *Hebei Spirit*, *Macondo*, and *Sea Empress* spills) find evidence of elimination of PAHs in fish tissues returning to reference levels within two months of exposure (Challenger and Mauseth, 2011; Davis *et al*., 2002; Gagnon & Rawson, 2011; Gohlke *et al*., 2011; Jung, 2011; Law, 1997; Rawson *et al*., 2011).

The toxicity of dissolved hydrocarbons and dispersed oil to fish species has been the subject of a number of laboratory studies (AMSA, 1998). Generally, concentrations in the range of 0.1–0.4 mg/L dispersed oil have been shown to cause fish deaths in laboratory experiments (96-hour LC_{50}). 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 Gulf of Mexico (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.	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	There is an extensive area in which moderate and high threshold hydrocarbons are predicted to occur on the sea surface. Fish associated with rafts of floating seaweed, such as syngnathid species, may come into contact with surface oil. Long exposure to the oil is likely to result in chronic toxicity effects, which is likely to lead to localised population reductions. The majority of fish tend to remain in the mid-pelagic zone, so they are not likely to come into contact with surface hydrocarbons.
Water column	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 the oil and the open, well-mixed waters of the JBG and Indian Ocean. 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 southern bluefin tuna and sharks such as the great white shark, shortfin mako and oceanic whitetip

	shark are highly mobile species and as such 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. Fish species with BIAs in the ecological spill area are: • Dwarf sawfish – this species is known to occur as adults and juveniles in waters 2-3 m deep along the coast of the ecological spill EMBA. If long sections of coastline are impacted by dissolved and entrained oil, this species may not have alternative habitat to retreat to, so chronic toxicity affects may occur to multiple individuals, resulting in population reductions. • Green sawfish – this species is known to occur as adults and juveniles in waters along the coast of the ecological spill EMBA, and there are also pupping areas likely to occur in the same area. If long sections of coastline are impacted by dissolved and entrained oil, this species may not have alternative habitat to retreat to, so chronic toxicity affects may occur to multiple individuals, resulting in population reductions. • Whale shark – foraging BIA is located outside of the JBG, so in the event of a LoWC, it is unlikely to be exposed to oil at the moderate or high threshold based on deterministic OSTM. At low thresholds, there would be little to no ecological impacts to this species. They are also unlikely to be present in the region at the time of drilling. Because vertebrate fish species can rapidly metabolise and excrete hydrocarbons (Hook *et al*., 2016), PAH levels in fish are expected to return to pre-spill levels within several months. Impacts to individuals and some populations will occur but are likely to be short-term. Widespread effects to fish populations (in terms of diversity and abundance) are not expected as a result of a LoWC based on the information presented for 'sensitivity to oil' and because of the wide geographical distribution of many of the fish species known to occur in the ecological spill EMBA.
Shoreline	Not applicable.

Inherent impact consequence:	Moderate

Table 8.32. Sensitivity and consequence evaluation of hydrocarbon exposure to oceanic communities - marine mammals

General sensitivity to oiling – cetaceans	
Sensitivity rating of marine mammals:	High
A description of cetaceans in the EMBA is provided in:	Appendix 5, Section 5.3.5
The pathways for exposure to oil to marine mammals (whales, dolphins and dugongs) is 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 Camden Sound as a nursery area for humpback 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. <u>Dugong</u> Dugongs can be exposed to oil in the same manner as whales and dolphins, as well as through ingestion of contaminated seagrass and sediments. Hook et al (2016) reports that no studies specifically report on the sensitivities of dugong to oil. Given that dugong consume vast amounts of seagrass, if the seagrass is contaminated, there is a high likelihood that acute toxicity and mortality may eventuate, or chronic long-term effects may result (such as organ damage).	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	Exposure to moderate and high thresholds of hydrocarbons at the sea surface is predicted to occur over a small portion of the JBG. The BIAs for the following marine mammal species are listed in Table 5.8 of Appendix 5; pygmy blue whale, humpback whale, Australian humpback dolphin, Australian snubfin dolphin, Indo-Pacific spotted bottlenose dolphin, and dugong. None of these BIAs are overlapped by the extent of moderate and high threshold oil, so impacts such as coating of skin when they surface are not expected. The seasonality of the presence of these species in the region also means they may not all be present at the time of drilling. Dugongs may be present along the Dampier Peninsula (the coastline north and south of Broome) where seagrass meadows are present. In this area, the OSTM predicts no exposure for surface hydrocarbons. As such, there should be no ecological effects on individuals or dugong populations as they surface to breathe.

Water column	The ecological spill EMBA for dissolved and entrained hydrocarbons overlaps with seasonal presence for most of the marine mammals described in Section 5.3.5 of Appendix 5, except for dugong, which are known only to occur in Ashmore Reef and around the Dampier Peninsula, where dissolved and entrained hydrocarbons are predicted to occur in low concentrations and therefore not have ecological impacts. Impacts to cetaceans 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 the oil and the open, well-mixed waters of the JBG and Indian Ocean. The impacts are likely to be as per those described in 'sensitivity to oil', with effects such as injury (infections, lesions, disease, reduced growth, growth abnormalities) or mortality as a result of ingestion of oil, contact with and absorption through skin and inhalation at surface. Of the threatened cetaceans known to occur in the ecological spill EMBA, effects are predicted below: • Sei whale – prefers deep offshore waters, with no BIAs in the EMBA. They may be present in outer extents of the EMBA where water depths are deep, and these are the areas where the concentrations of dissolved and entrained hydrocarbons are low (due to distance from the well). Impact consequence to this species is therefore low. • Bryde's whale – may be present in the ecological spill EMBA, with no BIAs in the EMBA. If present during a spill, impact consequences may be as described in 'sensitivity to oil' and the severity would depend on the number of individuals exposed to oil. They mostly feed on pelagic fish (which are at low risk of impacts from a spill) and small crustaceans. • Blue whale – most likely to be present in the outer extents of the spill EMBA (northwest Australia) from September to December. This is outside the drilling period, so the impact consequence to this species is therefore negligible. • Fin whale – prefers deep offshore waters, with no BIAs in the EMBA. They may be present in outer extents of the EMBA where water depths are deep, and these are the areas where the concentrations of dissolved and entrained hydrocarbons are low (due to distance from the well). Impact consequence to this species is therefore low. In general, the low likelihood of having high numbers of marine mammals in the ecological spill EMBA, the absence of resident populations, seasonality of movements, their highly mobile nature and absence of BIAs in and around the operational area (where hydrocarbon concentrations will be highest) means that the impacts of a LoWC are likely to be limited to a small number of individuals in localised areas. Displacement behaviours and sub-lethal biological effects could occur to cetaceans. Dugongs may be present along the Dampier Peninsula (the coastline north and south of Broome) where seagrass meadows are present. In this area, the OSTM predicts low exposure for entrained hydrocarbons and no exposure to dissolved hydrocarbons. Their foraging BIA is not overlapped by the ecological spill EMBA. As such, there should be no ecological effects on individuals or dugong populations.
Shoreline	Not applicable.
Consequence evaluation based on an assessment against the EPBC Act *Significant Impact Guidelines 1.1* (DoE, 2013)	

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 the crude 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 the crude, 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 a spill resulting from a LoWC, 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 impacted area would be temporarily reduced in the event of a spill. The portion of the oil that entrains or dissolves in the water column, where cetaceans spend the majority of their time, is dependent on ocean conditions during the spill (rough seas result in more entrainment than calm seas). The area affected by the oil is unlikely to form a significant part of marine mammal 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 the crude, it is highly unlikely that the breeding cycle of a cetacean population will be disrupted.
• Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The water quality of the ecological spill EMBA would be temporarily reduced in the event of a spill. 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.	A large-scale hydrocarbon spill is highly unlikely to result in the introduction and spread of IMS that are harmful to endangered marine mammals. Vessels that may be involved in the spill response strategies 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 species or populations is negligible due to the rapid weathering of the crude. 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, a crude oil spill will not interfere with the recovery of a cetacean species.

Inherent impact consequence:	Severe

Table 8.33. Sensitivity and consequence evaluation of hydrocarbon exposure to oceanic communities - 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:	Appendix 5, Section 5.3.6

Marine reptiles can be exposed to hydrocarbon through ingestion of contaminated prey, inhalation when surfacing to breathe 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:

1. Internally – eating or swallowing oil, consuming prey containing oil-based chemicals, or inhaling of volatile oil related compounds; and
2. 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* crude oil 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.	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	Exposure to moderate and high thresholds of hydrocarbons at the sea surface is predicted to occur over a small portion of the JBG. The BIAs for the following marine mammal species are listed in Table 5.8 of Appendix 5; pygmy blue whale, humpback whale, Australian humpback dolphin, Australian snubfin dolphin, Indo-Pacific spotted bottlenose dolphin, and dugong. None of these BIAs are overlapped by the extent of moderate and high threshold oil, so impacts such as coating of skin when they surface are not expected. The seasonality of the presence of these species in the region also means they may not all be present at the time of drilling. Dugongs may be present along the Dampier Peninsula (the coastline north and south of Broome) where seagrass meadows are present. In this area, the OSTM predicts no exposure for surface hydrocarbons. As such, there should be no ecological effects on individuals or dugong populations as they surface to breathe.
Water column	The ecological spill EMBA for dissolved and entrained hydrocarbons overlaps with BIAs for the loggerhead, green, hawksbill, olive ridley and flatback turtles. Impacts to marine reptiles from exposure to hydrocarbons in the water column is likely to be spatially limited to the areas of moderate to high (for dissolved hydrocarbons) and high (for entrained hydrocarbons) threshold exposure and temporally limited due to the rapid weathering of the oil and the open, well-mixed waters of the JBG and Indian Ocean. The impacts are likely to be as per those described in 'sensitivity to oil.' The potential impacts to each species within the ecological spill EMBA are predicted below: • Loggerhead turtle – this species feeds mainly on pelagic species, which in themselves are not overly sensitive to oil spills (see Table 8.31, 'Fish'). The foraging BIA to the immediate north of the JBG is overlapped, with probabilities of exposure to known feeding areas being: ○ Pinnacles of the Bonaparte Basin KEF – 8-37% probability for entrained hydrocarbons and 1-3% probability for dissolved hydrocarbons; and ○ Carbonate Bank and terrace system of the Sahul Shelf KEF – 87-100% probability for entrained hydrocarbons and 85-98% probability for dissolved hydrocarbons. • Green turtle – the foraging BIA occurs in the same area and is slightly larger than that for the loggerhead turtle, with the probabilities of exposure therefore being similar. • Hawksbill turtle – important foraging areas are located around Ashmore Reef and Cartier Island (also nesting areas), where they feed on a range of pelagic and benthic invertebrates and seagrass and algae that are not highly sensitive to crude oil. These are areas where the

	concentrations of dissolved and entrained hydrocarbons are low (due to distance from the well) and the probability of exposure to hydrocarbons in the water column is low: ○ Ashmore Reef – 14% probability for entrained hydrocarbons and 1% probability for dissolved hydrocarbons; and ○ Scott Reef – 1-6% probability for entrained hydrocarbons and 1% probability for dissolved hydrocarbons. • Olive ridley turtle – the foraging BIA occurs over much of the JBG, which has a 100% probability of exposure. As this species forages primarily at the seabed, they are less susceptible to entrained and dissolved hydrocarbons that generally occur in the top 10 m of the water column. • Flatback turtle - the foraging BIA occurs in the same area as that for the loggerhead turtle, with the probabilities of exposure therefore being the same. As this species forages primarily at the seabed, they are less susceptible to entrained and dissolved hydrocarbons that generally occur in the top 10 m of the water column. Sea snakes can be common in the shallow waters of reef lagoons and in shoals throughout the region, where the probabilities of exposure to moderate-high exposure thresholds vary from 0-72% depending on location and metocean season. There has been extremely limited study of the impacts of oil spills on sea snakes, so the effects of exposure are unknown.
Shoreline	See also Table 8.27 (sandy beaches). The following species are known to have nesting sites within the shoreline ecological EMBA: • Flatback turtle – known to nest in the thousands at Cape Domett (eastern side of the mouth of Cambridge Gulf). Breeding occurs year-round with a peak nesting period from July to September. This area has a 70-93% probability of contact at ecological thresholds. Elsewhere, nesting occurs primarily along the Arnhem Land coast, where the probabilities of shoreline loading at the ecological threshold are low (0-17%). • Green turtle – known to nest at Browse Island year-round, with a peak between December and January (11-27% probability of shoreline loading). Important (but low density) nesting areas at Ashmore Reef and Scott Reef have low probabilities of exposure (3% and 2-7%, respectively). • Hawksbill turtle – known to nest as Ashmore Reef (low density) and Scott Reef, which have low probabilities of exposure (3% and 2-7%, respectively). • Olive ridley turtle – nesting occurs primarily along the Arnhem Land coast, where the probabilities of shoreline loading at the ecological threshold are low (0-17%). In these areas, oil coating the sand can become entrained in the beach and nesting turtles are therefore at risk of dragging oil into nests (with potential toxicity impacts on developing embryos) or hatchlings may travel through oiled sediments after they have emerged from the nest (with any oil stuck to them after entering the water resulting in toxic effects). This may cause mortality of individuals and cause population declines.

	The impacts described here will not impact on the long-term recovery objective (to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act threatened species list) and interim recovery objectives listed in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017).

Inherent impact consequence:	Moderate

Table 8.34. Sensitivity and consequence evaluation of hydrocarbon exposure to 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:	Appendix 5, 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).	
Consequence evaluation based on the Beehive-1 OSTM	
Sea surface	The area of moderate and high threshold exposure at the sea surface does not overlap the foraging BIAs of any seabirds or shorebirds. Seabirds rafting, resting, diving or feeding at sea have the potential to come into contact with oil. However, because of the extensive ocean foraging habitat available to the species known to occur in the ecological spill EMBA, the area impacted by surface oil is unlikely to limit their ability to forage for unaffected prey. As such, surface oil is unlikely to affect species at a population level.
Water column	The area of high threshold exposure for entrained and moderate to high threshold exposure for dissolved hydrocarbons is extensive and is overlapped by BIAs for many seabirds and shorebirds (as described and mapped in Section 5.3.7 of Appendix 5). Seabirds spend a limited amount of time in the water column (diving for prey) and are therefore not likely to be significantly affected by hydrocarbons in the water column. Indirect effects through the ingestion of contaminated prey may affect individual birds but there are not likely to be impacts at the population level.
Shoreline	The northern WA and NT shorelines provide abundant feeding, roosting and nesting habitats for seabirds and shorebirds. The shoreline locations that intersect shorebird BIAs of the greatest significance are: • Finniss River floodplain (1-14% probability of contact at the moderate threshold, peak volume of 5-51 m^3) – major breeding area for magpie geese and a major migration stopover for shorebirds. • Daly-Reynolds floodplain (1-41% probability of contact at the moderate threshold, peak volume of 5-200 m^3) – at least 30 shorebird species, with a large number of magpie geese. • Moyle floodplain (13-54% probability of contact at the moderate threshold, peak volume of 22-134 m^3) – 47 shorebird species, a significant breeding area for magpie geese, rookeries for darter and cormorant species • Legune wetlands (24-47% probability of contact at the moderate threshold, peak volume of 20-29 m^3) – 47 shorebird species. • Ord River floodplain (Cambridge Gulf, 70-93% probability of contact at the moderate threshold) – over 200 species of waterfowl, migratory shorebirds, mangrove birds and terrestrial species, including the threatened Australian painted snipe. • Bigge Island (west of the Mitchell River mouth, 70-93% probability of contact at the moderate threshold) – breeding BIA for the lesser crested tern.

	• Sir Graham Moore Island (north of Kalumburu, 70-93% probability of contact at the moderate threshold) – roseate tern breeding. • Cartier Island (5% probability of contact at the moderate threshold, winter only, peak volume of 11 m^3) – breeding BIAs for the lesser frigatebird, red-footed bobby, wedge-tailed shearwater and white-tailed tropicbird, along with habitat for lesser sand plovers, eastern reef egrets, ruddy turnstones, crested terns, bridled terns and roseate terns. • Ashmore Reef (3% probability of contact at the moderate threshold, winter only, peak volume of 14 m^3) – breeding BIAs for the lesser frigatebird, red-footed bobby, wedge-tailed shearwater and white-tailed tropicbird, along with roseate tern and greater frigatebird breeding and habitat for common noddies (second largest colony in Australia), sooty terns (largest colony in WA) and crested terns. • Browse Island (11-27% probability of contact at the moderate threshold, peak volume of 14-64 m^3) – breeding BIA for crested tern and habitat for eastern reef egrets, ruddy turnstones and sooty terns. In these areas, impacts to birds may include oiling of feathers, oiling of feeding, roosting and nesting habitats (e.g., mudflats, mangroves, sandy beaches) and contamination of their food sources. Depending on the degree of oiling and the timing of a spill, this could result in small or large bird populations being injured or dying. Migratory birds may be too injured to fly to other feeding or breeding areas, resulting in a reduction of the next generation's population size. The values of NIWs and Ramsar wetlands may be temporarily compromised.

Consequence evaluation based on an assessment against the EPBC Act guidelines	
This hydrocarbon spill scenario will not have a 'significant' impact on threatened migratory shorebird species (see Section 5.3.7 of Appendix 5) when assessed against *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act-listed migratory shorebird species Policy Statement 3.21* (DoEE, 2017b):	
• Loss of habitat.	The habitats along the shorelines of the ecological spill EMBA will not be lost.
• Degradation of habitat leading to a substantial reduction in migratory shorebird numbers.	Habitat quality will temporarily decrease in parts, but given the predicted weathering profile of the crude, there will be no long-term degradation. The presence of large areas of rocky shoreline in the ecological spill EMBA reduces the risk of degradation in those areas.
• Increased disturbance leading to a substantial reduction in migratory shorebird numbers.	Crude will rapidly percolate through sandy and muddy beach sediments, resulting in short-term disturbance. The most likely shoreline response option will be to monitor and evaluate (rather than actively undertake a clean-up in sensitive coastal habitats), 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 predicted rapid weathering of the crude and the low likelihood of a large portion of a seabird or shorebird population being present in the affected areas at any one time.
• Reduce the area of occupancy of the species.	Given the small area of 'swept ocean' from a single spill, the predicted rapid weathering of the crude and the abundance of suitable nearby habitat, sea surface water quality and some shoreline habitat 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.	Seabirds have access to an expansive area of unpolluted waters and shorebirds similarly have access to expansive areas of unpolluted shorelines. A spill would not be likely to fragment an existing population.
• Adversely affect habitat critical to the survival of a species.	The quality of marine and coastal habitats will be affected for a short period of time, but given the broad areas of habitat use by the species present in the ecological spill EMBA, the survival of any one species is not likely to be adversely affected.
• Disrupt the breeding cycle of a population.	Most of the seabird and shorebird species known to occur in the ecological spill EMBA (e.g., common noddy, streaked shearwater and frigatebirds) breed outside of Australia or beyond the spill EMBA. Important breeding areas in Australia (e.g., Ashmore Reef, Cartier Island, Browse Island) generally have a low risk of contact and small volumes of predicted stranded oil, which can be removed through various response strategies. 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 predicted rapid weathering of the crude, the quality of marine waters and shorelines in the area of the spill will be temporarily reduced. However, marine and coastal 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 and shorebird species known to occur in the ecological spill EMBA breed outside of Australia or beyond the spill 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 shorelines, it is unlikely that spill-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.	Response strategies employed to response to a spill are highly unlikely to result in the introduction and spread of IMS that are harmful to birds. Vessels that may be involved in spill response 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.	As described in 'sensitivity to oil', disease of individual birds or small populations may occur in the event of a spill. With the appropriate spill response strategies, this is unlikely to result in long-term decline of populations.
• Interfere with the recovery of the species.	For all the reasons outlined above, a spill from a LoWC is not likely to interfere with the recovery of bird 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.	

Inherent impact consequence:	Severe

Table 8.35. Sensitivity and consequence evaluation of hydrocarbon exposure to socio-economic - 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:	Appendix 5, Section 5.6.1
Commercial fishing has the potential to be impacted through contaminated of fish stock, 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, and its impacts on fish markets and customer consumption patterns, may be much more significant and longer term than the spill itself. Fishing areas may be closed for fishing for short or long 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 heries 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 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. 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 spill resulting from a LoWC, 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).		
Consequence evaluation based on the Beehive-1 OSTM		
OSTM predicts extensive areas may be exposed to entrained and dissolved hydrocarbons at the moderate and high exposure (ecological) thresholds. A short- or long-term fishing closure may be implemented by AFMA, the WA and/or NT fishery authorities, with the duration depending on the results of water quality testing and fish sample testing. Fishers may lose access to traditional fishing grounds with consequential income losses and possible supply shortages to their commercial customers. In all instances, the worst-case deterministic OSTM results indicate that hydrocarbons in the water column would occupy small areas of each fishery. This section evaluates the consequences on a fishery-by-fishery basis.		
Commonwealth-managed fisheries (those known to fish within the EMBA)		
NPF	The area overlapped by the socio-economic EMBA represents 32% of the area available to the fishery. Given that drilling is expected to start in late Q1/early Q2 and that the fishery is closed from 1st December to 1st August, if a LoWC occurred, its effects would likely not result in lost fishing time.	**Consequence:** Moderate
North West Slope Trawl	The area overlapped by the socio-economic EMBA represents 64% of the area available to the fishery. Fishing is concentrated in water depths greater than 200 m, which represents waters that will have lower in-water hydrocarbon concentrations than those closer to the well. Target species are generally benthic or demersal, where hydrocarbon concentrations will be low (they are generally concentrated in the top 10 m of the water column).	**Consequence:** Moderate
Southern bluefin tuna	The area overlapped by the socio-economic EMBA represents 42% of the area available to the fishery. There has been no active fishing in the region for many years, but tuna spawn in the region between September and March. Given that drilling is expected to start in late Q1/early Q2, if a LoWC occurred, its effects would likely not result in toxicological effects to tuna spawning and larvae and therefore have a negligible to minor consequence on the fishery off the southern states where the tuna migrate to.	**Consequence:** Minor
WA-managed fisheries (those known to fish within the EMBA)		
Mackeral Managed Fishery	The area overlapped by the socio-economic EMBA represents 38% of the area available to the fishery. As a pelagic migratory species, mackeral are not likely to spend long periods of time in one location (e.g., waters with high hydrocarbon concentrations), so the risk of contamination is low.	**Consequence:** Moderate

	The fishing season overlaps the drilling window. If a LoWC occurred, a temporary fishery closure would be likely. In the Kimberley region, less than five vessels operate and catch levels are generally less than 300 t. There would be some impact to several fishers and some lost catch as a result of a fishery closure.	
Northern Demersal Scalefish Managed Fishery	The area overlapped by the socio-economic EMBA represents 73% of the area available to the fishery in Area 1 and 98% of Area 2. Fishing is assumed to occur year-round, so it will overlap with the drilling window. Given that the target species are generally benthic or demersal, where hydrocarbon concentrations will be low (they are generally concentrated in the top 10 m of the water column), impacts to fish stock are likely to be low. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 1,000 and 1,500 t.	**Consequence:** Moderate
Kimberley Crab Managed Fishery (North Coast Crab Fishery)	The area overlapped by the socio-economic EMBA represents 86% of the area available to the fishery. Fishing occurs from March to November, so it will overlap with the drilling window. Coastal waters in which the fishery operates would be exposed to hydrocarbons in the water column. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where six people are employed and who annual catches vary between 3 and 15 t.	**Consequence:** Severe
Kimberley Prawn Managed Fishery	The area overlapped by the socio-economic EMBA represents 97% of the area available to the fishery. Fishing occurs from April to mid-June, so it will overlap with the drilling window. Coastal waters in which the fishery operates would be exposed to hydrocarbons in the water column. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 100 and 333 t.	**Consequence:** Moderate
Kimberley Gillnet and Barramundi Fishery	The area overlapped by the socio-economic EMBA represents 71% of the area available to the fishery. Fishing occurs predominantly from April to September, so it will overlap with the drilling window. Coastal waters in which the fishery operates would be exposed to hydrocarbons in the water column. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 73 and 92 t.	**Consequence:** Moderate

Pearl Oyster Managed Fishery	The area overlapped by the socio-economic EMBA represents 70% of the area available to the fishery. The fishery operates predominantly between March and June, so it will overlap with the drilling window. As a filter feeding species, oysters are sensitive to hydrocarbons in the water column, so the consequence of filtering large volumes of contaminated water could be severe. If a LoWC occurred, there could be contamination or loss of stock (and associated financial losses), with annual production varying between 468,000 and 614,000 shells.	**Consequence:** Severe
Abalone Managed Fishery	The area overlapped by the socio-economic EMBA represents 48% of the area available to the fishery. The fishery operates predominantly between October and May, so it will overlap with the drilling window. Coastal waters in which the fishery operates would be exposed to hydrocarbons in the water column. As a filter feeding species, abalone are sensitive to hydrocarbons in the water column, so the consequence of filtering large volumes of contaminated water could be severe. If a LoWC occurred, there could be contamination or loss of stock (and associated financial losses), with annual production varying between 47 and 51 t.	**Consequence:** Severe
Marine Acquarium Fish Managed Fishery	The area overlapped by the socio-economic EMBA represents 27% of the area available to the fishery. Fishing is assumed to occur year-round, so it will overlap with the drilling window. Waters in which the fishery operates would be exposed to hydrocarbons in the water column of various concentrations given the extent of the fishery. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 12,000 and 27,500 individuals.	**Consequence:** Severe
Broome Prawn Managed Fishery	The area overlapped by the socio-economic EMBA represents 78% of the area available to the fishery. There is a very low risk of entrained (1-2%) hydrocarbons reaching the fishing area, and very low instantaneous concentrations (30-65 ppb). The probability of dissolved hydrocarbons in the area is not reported in the OSTM. As such, impacts are expected to be minor and effects to target species will be minor and there would be limited to no effects to the fishery.	**Consequence:** Minor
Nickol Bay Managed Prawn Fishery	The area overlapped by the socio-economic EMBA represents 39% of the area available to the fishery. There is a very low risk of entrained (<1-2%) hydrocarbons reaching the fishing area, and very low instantaneous concentrations (<30-65 ppm). The reporting thresholds for dissolved hydrocarbons were not met in the OSTM. As such, impacts to target species will be minor and there would be limited to no effects to the fishery.	**Consequence:** Negligible

Onslow Managed Prawn Fishery	The area overlapped by the socio-economic EMBA represents 26% of the area available to the fishery. There is a very low risk of entrained (<1-2%) hydrocarbons reaching the fishing area, and very low instantaneous concentrations (<30-65 ppm). The reporting thresholds for dissolved hydrocarbons were not met in the OSTM. As such, impacts to target species will be minor and there would be limited to no effects to the fishery.	**Consequence:** Negligible
Specimen Shell Fishery	The area overlapped by the socio-economic EMBA represents 48% of the area available to the fishery. Fishing (hand collection) is assumed to occur year-round, so it will overlap with the drilling window. This fishery is not expected to be affected by an oil spill because it does not depend on catching live specimens for sale.	**Consequence:** Negligible
Pilbara Demersal Scalefish Managed Fishery	The area overlapped by the socio-economic EMBA represents 33% of the area available to the fishery. Fishing (hand collection) is assumed to occur year-round, so it will overlap with the drilling window. The fishery covers a large area so target pelagic species would be exposed to in-water hydrocarbon at various concentrations. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 1,800 and 3,000 t.	**Consequence:** Moderate
Pilbara Crab Managed Fishery	The area overlapped by the socio-economic EMBA represents 30% of the area available to the fishery. There is a very low risk of entrained (<1-2%) hydrocarbons reaching the fishing area, and very low instantaneous concentrations (<30-65 ppb). The reporting thresholds for dissolved hydrocarbons were not met in the OSTM. As such, effects to target species will be minor and there would be limited to no effects to the fishery.	**Consequence:** Negligible
West Coast Deep Sea Crustacean Managed Fishery	The area overlapped by the socio-economic EMBA represents 39% of the area available to the fishery. Fishing occurs from January to June, with the greatest intensity in January and February. This high intensity fishing period is outside the drilling window. Given that the target species are benthic and in deep waters (targeting the 150 m bathymetry contour), where hydrocarbon concentrations will be low (they are generally concentrated in the top 10 m of the water column), impacts to deep sea crustacean stock are likely to be low. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 153 and 164 t.	**Consequence:** Minor
Seafarms Project Seadragon –	Project Sea Dragon has a sub-lease on an area of the Legune Pastoral Lease, southwest of the mouth of the Victoria River. Seafarms is focused on land-based production of Australia prawns for the domestic and international markets. The quality of seawater from the Victoria River area tidal creeks is important to underpinning potential prawn production in sub lease area.	**Consequence:** Severe

onshore prawn aquaculture (planned)	The probabilities of contact in the Victoria-Daly sector at the low threshold are as follows (ranges account for seasons): • Shoreline – 48-78%; • Sea surface – 36-67%; • Dissolved – 46-59%; and • Entrained – 53-80%. If a LoWC occurred, seawater intakes would need to be closed as a precautionary measure to protect water quality of the aquaculture operations (if it is operational at the time of drilling). This could result in the loss of stock and therefore loss of income associated with that stock.	
NT-managed fisheries (those known to fish within the EMBA)		
Demersal Fishery	The area overlapped by the socio-economic EMBA represents 38% of the area available to the fishery. The fishing season is year-round, so it overlaps the drilling window. Given that the target species are demersal, where hydrocarbon concentrations will be low (they are generally concentrated in the top 10 m of the water column), the effects of a spill on target fish species are likely to be low. If a LoWC occurred, a temporary fishery closure would be likely. About seven vessels operate and annual catch levels are generally up to 3,000 t. There would be some impact to several fishers and some lost catch as a result of a fishery closure.	**Consequence:** Minor
Spanish Mackerel Fishery	The area overlapped by the socio-economic EMBA represents 39% of the area available to the fishery. The fishing season is year-round, so it overlaps the drilling window. As a pelagic migratory species, mackeral are not likely to spend long periods of time in one location (e.g., waters with high hydrocarbon concentrations), so the risk of contamination is low. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 357 and 411 t.	**Consequence:** Severe
Offshore Net and Line Fishery	The area overlapped by the socio-economic EMBA represents 39% of the area available to the fishery. There is little information available for this fishery, so it is assumed that the fishing season overlaps the drilling window. The fishery targets shark and mackeral. As pelagic (and migratory in the case of mackeral) species, they are not likely to spend long periods of time in one location (e.g., waters with high hydrocarbon concentrations), so the risk of contamination is low. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers.	**Consequence:** Moderate

Coastal Line Fishery	There is little information available for this fishery, so it is assumed that the fishing season overlaps the drilling window. The fishery covers the entire NT coastline and is concentrated around Darwin. There probability of entrained hydrocarbons around Darwin is 0-28% with instantaneous concentrations of 583-1,354 ppb, and for dissolved hydrocarbons it is 0-12% with instantaneous concentrations of 45-497 ppb. At these concentrations, sub-lethal effects to marine fauna are possible, though black jewfish, like other fish, are able to metabolise and excrete hydrocarbons. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 124 and 173 t.	**Consequence:** Moderate
Barramundi Fishery	There is little information available for this fishery. The fishery operates from February to September, so it overlaps the drilling window. The fishery is focussed on tidal mud flats and inside a restricted number of rivers, presumed to be concentrated around Darwin. There probability of entrained hydrocarbons around Darwin is 0-28% with instantaneous concentrations of 583-1,354 ppb, and for dissolved hydrocarbons it is 0-12% with instantaneous concentrations of 45-497 ppb. At these concentrations, sub-lethal effects to marine fauna are possible, though barramundi, like other fish, are able to metabolise and excrete hydrocarbons. If a LoWC occurred, a temporary fishery closure would be likely. The greatest impact would come from a precautionary closure of the fishery and associated loss of income for fishers, where annual catches vary between 276 and 392 t.	**Consequence:** Moderate

Table 8.36. Sensitivity and consequence evaluation of hydrocarbon exposure to socio-economic sensitivities – protected areas

General sensitivity to oiling – plankton	
Sensitivity rating of protected areas:	High
Protected areas are declared for their various physical, ecological, biological and social values, and these are described in various sections of Appendix 5, as noted below.	
Consequence evaluation based on the Beehive-1 OSTM	
Marine parks	AMPs and state marine parks in the spill EMBA are described in Sections 5.4.1 and 5.4.9 respectively, in Appendix 5, and the probabilities of contact and exposure values are listed in Section 10 of **Appendix 6**. While the values of each of the marine parks vary, they support all the habitats and faunal groups described in the previous tables. A decrease in water quality in the marine parks will impacts on their habitat and fauna receptors and therefore have an adverse impact on the values of these reserves. This may have flow-on effects to tourism and a loss of revenue for coastal communities that provide access to these marine reserves. Marine parks often provide protected nursery grounds for fisheries species and therefore have a role in maintaining healthy fish stocks for commercial and recreational fisheries.
Ramsar wetlands	Ramsar wetlands in the spill EMBA are described in Section 5.4.4 in Appendix 5, and the probabilities of contact and exposure values are listed in Section 10 of **Appendix 6**. The Ramsar wetland with the highest probability of shoreline contact is the Ord River Floodplain, with a 70-93% probability of contact, depending on season. Receptors are risk at this wetland include mangroves, mud flats, sawfish, crocodiles and migratory shorebirds. The wetland also contains various Aboriginal cultural heritage artefacts. **Consequence:** severe.
TECs	There is one TEC in the spill EMBA, which is described in Section 5.4.5 in **Appendix 5**. This is the monsoon vine thickets on the coastal sand dunes of Dampier Peninsula. It occurs on dunes just above the high tide mark. The risk of shoreline contact in this area is 1%. **Consequence:** negligible.
KEFs	KEFs in the spill EMBA are described in Section 5.4.7 in Appendix 5, and the probabilities of contact and exposure values are listed in Section 10 of **Appendix 6**. These KEFs are subsea features, generally reefs, shoals, canyons, banks and pinnacles. As subsea physical features, they are generally at low risk from a spill associated with a LoWC. Impacts to the biological values of these KEFs, including fish and corals, are addressed in earlier tables. **Consequence:** moderate.

NIWs	NIWs in the spill EMBA are described in Section 5.4.8 in Appendix 5, and the probabilities of contact and exposure values are listed in Section 10 of **Appendix 6**. The NIWs with the highest probabilities of shoreline contact at the moderate threshold are: • Ord Estuary System (70-93% probability); • Legune Wetlands (24-47% probability); • Moyle Floodplain and Hyland Bay System (13-54% probability); and • Daly-Reynolds Floodplain-Estuary System (1-41% probability). The key values of the NIWs are associated with fish (see Table 8.31) and birds (see Table 8.33). **Consequence:** severe.
National Heritage	The spill EMBA intersects the West Kimberley National Heritage Place, which is described in Section 5.4.3 in Appendix 5. The section of coastline it covers is vast, with probabilities of shoreline contact ranging from 0-99% depending on location and season. The values most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds. Roebuck Bay is located south of Broome and does not fall within the ecological spill EMBA. As such, the key marine values associated with the West Kimberley National Heritage Place will not be affected by a spill. **Consequence:** negligible.

8.7.6 Risk Assessment

Table 8.37 presents the risk assessment for a LoWC.

Table 8.37. Risk assessment for a LoWC

<table>
<tr><th colspan="3">Summary</th></tr>
<tr><td>Summary of risks</td><td colspan="2">Widespread and temporary reduction in water quality.
Sub-lethal to lethal toxicity impacts to marine life.
Temporary fisheries closures.</td></tr>
<tr><td>Extent of risks</td><td colspan="2">The spill EMBA is presented in Figure 5.1 in Appendix 5.</td></tr>
<tr><td>Duration of risks</td><td colspan="2">Days, weeks or months, depending on the location, level of contact and receptor.</td></tr>
<tr><td>Level of certainty of risks</td><td colspan="2">HIGH – the environmental impacts of spilled hydrocarbons are well understood.</td></tr>
<tr><td rowspan="4">Risk decision framework context</td><td>Decision type</td><td>B – new to the organisation or geographical area.</td></tr>
<tr><td>Activity</td><td>Infrequent activity.</td></tr>
<tr><td>Risk & uncertainty</td><td>Risks amenable to assessment using well-established data and methods. Some uncertainty.</td></tr>
<tr><td>Stakeholder influence</td><td>Pressure groups likely to object, significant media interest.</td></tr>
<tr><td>Defined acceptable level</td><td colspan="2">No LoWC that results in a crude oil spill.</td></tr>
</table>

Risk Assessment (inherent)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Severe	Rare	High
Macroalgae & seagrass	Severe	Rare	High
Coral	Severe	Rare	High
Mangroves & saltmarshes	Severe	Rare	High
Sandy beaches	Severe	Rare	High
Rocky shores	Moderate	Rare	Low
Plankton	Moderate	Rare	Low
Fish	Moderate	Rare	Low
Marine mammals	Severe	Rare	High
Marine reptiles	Severe	Rare	High
Seabirds & shorebirds	Severe	Rare	High
Commercial fisheries	Minor to Severe	Rare	Negligible to High
Protected areas	Negligible to Severe	Rare	Negligible to High

Assessment of Proposed Control Measures			
Control measure	Control type	Adopt	Justification
PDSA investigation results are used to inform MODU positioning to avoid shallow gas hazards **(RSK-07:EPS-01)**.	Engineering	Yes	**EB:** Avoiding gas pockets and ensuring the stability of the MODU while drilling minimises the risk of an unplanned hydrocarbon release. **C:** Significant cost (millions of dollars). **Ev:** The significant costs are outweighed by the benefits of not drilling through a gas pocket and avoiding a significant release of gas.
BOP is fitted and tested **(RSK-07:EPS-02, -03, -04)**.	Engineering	Yes	**EB:** Fitting a BOP and ensures its correct functioning reduces the likelihood of a spill resulting from a LoWC. **C:** BOPs are available with every MODU, and the cost of their supply and maintenance is built into MODU day rates, which are significant (up to $1 million per day). **Ev:** Having a BOP fitted is best practice and required as part of the Safety Case regime. The environmental benefits outweigh the significant costs.
Pre-campaign MODU assurance inspection **(RSK-07:EPS-05)**.	Engineering & Administrative	Yes	**EB:** Ensures that the physical status of the MODU, along with the systems and processes that govern its day-to-day operations, are suitable for this drilling program, and therefore minimises the likelihood of a LoWC. **C:** Moderate costs. **Ev:** It is best practice to conduct an independent review of the physical status of the MODU and its operating systems. The cost of doing so is outweighed by the environmental benefits.
AGR WDP **(RSK-07: EPS-06, -07, -08)**.	Engineering & Administrative	Yes	**EB:** Considering all engineering and safety risks when drilling a well through the development of, continuous updates and training in detailed plans available for each stage of well design ensures best practice engineering design is achieved and minimises the risk of a LoWC. **C:** High cost of developing and continuously refining this system. **Ev:** It is best practice to have in place a management system to consider and plan for risks. The high costs are outweighed by environmental benefits.

Maintain a second MODU on standby for the purpose of drilling a relief well.	Engineering & Administrative	No	**EB:** Would reduce the mobilisation time for drilling a relief well, thereby minimising the volume of crude spilled to the sea. **C:** Significant, likely up to $1 million per day. Would also require an in-force Safety Case/SCR, which could cost several hundred thousand dollars more to prepare. **Ev:** With all other control measures in place, the significant cost of this measure is grossly disproportionate to the low risk of a LoWC.
Maintain support vessels on standby for the purpose of responding to a LoWC.	Engineering & Administrative	No	**EB:** Would reduce the mobilisation time for deploying spill response equipment, thereby potentially minimising the impacts of spilled crude oil. **C:** Significant, likely several hundred thousand dollars per day. **Ev:** With all other control measures in place, the significant cost of this measure is grossly disproportionate to the low risk of a LoWC.
Time drilling to avoid the cyclone season (start November to end April).	Administrative	No	**EB:** Avoiding the cyclone season minimises the risk of having to quickly de-man the MODU in the event of a cyclone and minimises the risk of unintentionally leaving the well in an unsafe safe (and potentially prone to a LoWC). **C:** Removes 6 months of the year from the drilling schedule, meaning that securing access to a MODU would be extremely difficult. **Ev:** Drilling throughout the cyclone season in northwest Australia has taken place for decades, with well established and tested de-manning practices in place. The high costs associated with not being able to drill the well to schedule are not commensurate with the low risks of de-manning in the event of a cyclone.
Accepted Safety Case, SCR and WOMP are in place **(RSK-07:EPS-07)**.	Administrative	Yes	**EB:** Ensures titleholder has plans in place to safely operate the MODU and drill the well, thereby minimising the risk of a LoWC. **C:** Moderate costs involved in preparing documents through to acceptance. **Ev:** It is a regulatory requirement to have these documents in place. The moderate costs are outweighed by environmental benefits in terms of minimising the risk of a LoWC.

IAWC/IADC WellCap training **(RSK-07:EPS-09)**.	Administrative	Yes	**EB:** Ensures that the Drilling Superintendent and Drilling Supervisor are equipped to properly respond to a well kick and LoWC, which may reduce the volume of oil lost to the sea through an efficient technical response. **C:** Moderate cost to undertake initial and refresher training. **Ev:** Moderate costs are outweighed by environmental benefits in the event of a spill.
Accepted OPEP is in place **(RSK-07:EPS-10)**.	Administrative	Yes	**EB:** Ensures titleholder has considered risks and planned for a response, which may reduce impacts to marine fauna and sensitive shoreline habitats. **C:** Significant cost to prepare plan and put in place agreements and contracts with suppliers. **Ev:** It is a regulatory requirement to have this document in place. High costs are outweighed by environmental benefits in the event of a spill.
The RWP is in place and reviewed regularly **(RSK-07:EPS-11)**	Administrative	Yes	**EB:** The pre-drilling identification of MODUs in the region suitable as drilling a relief well, and mobilisation planning, will aid in a prompt response to drilling a relief well in the event of a LoWC. This is considered industry best practice. **C:** Low cost involved in preparing RWP. **Ev:** The low cost of preparing the RWP is outweighed by the environmental benefits.
All DIMT positions have undertaken relevant spill response training (e.g., IMO II or III) **(RSK-07:EPS-12).**	Administrative	Yes	**EB:** Spill response trained ensures a response is smoother than it otherwise would be, with potential benefits in reducing the volume of oil lost and/or the volume of oil recovered. **C:** Moderate, depending on the number of personal requiring training. **Ev:** There is significant benefit in personnel being trained and practiced in their responsibilities in the event of a LoWC. The cost is outweighed by the environmental benefits.
Mutual aid agreement (MAA) is in place for access to other MODUs **(RSK-07:EPS-13)**.	Administrative	Yes	**EB:** Access to other MODUs operating in the region reduces the response time with regards to drilling a relief well, in turn potentially reducing the volume of oil released to the ocean.

			C: High costs of APPEA membership and cost of time in negotiating access to the MAA. **Ev:** The high costs are outweighed by the environmental benefits.
Agreement(s) in place with well blowout engineering expertise **(RSK-07:EPS-19)**.	Administrative	Yes	**EB:** Access to well blowout expertise (e.g., WWC) reduces the response time with regards to killing the well, in turn potentially reducing the volume of oil released to the ocean. This is considered industry best practice **C:** Moderate costs of putting agreement in place and maintaining access. **Ev:** The high costs are outweighed by the environmental benefits.
Compensate for economic loss due to a spill associated with a LoWC **(RSK-07:EPS-17)**.	Administrative	Yes	**EB:** Affected fishers are compensated for any economic loss due to a spill, thereby mitigating the potential socio-economic consequences of the spill. **C:** Minor costs to prepare the procedure and administer the claims process. Potentially significant costs for a claim or claims. **Ev:** The principal of the control measure is to ensure that fishers are no worse off as a result of a spill associated with a LoWC. The benefits outweigh the high costs of potential claims.
Agreement(s) are in place with spill response organisations **(RSK-07:EPS-18, -19)**.	Administrative	Yes	**EB:** Access to organisations such as AMOSC and OSRL ensure that there is access to expert spill response preparedness advice during the planning phase and advise and response in the event of a LoWC. This may reduce the volume of oil released to the ocean and maximise the volume of oil recovered. This is considered industry best practice **C:** Significant costs of initial membership and maintaining access (hundreds of thousands to millions of dollars). **Ev:** The significant costs are outweighed by the environmental benefits.
Agreement(s) are in place with OSMP service provider(s) **(RSK-07:EPS-21)**.	Administrative	Yes	**EB:** Access to organisations that can implement OSMP studies quickly and to a high standard allows impacts to be quantified, in turn informing spill response activities. **C:** Significant costs of initial membership and maintaining access (hundreds of thousands to millions of dollars).

			Ev: The moderate costs are outweighed by the environmental benefits and is considered industry best practice in Australia.
Accepted OSMP **(RSK-07:EPS-21)**.	Administrative	Yes	**EB:** Ensures titleholder has considered plans to monitor impacted areas, which will inform future response efforts. **C:** Significant cost to prepare plan and put in place agreements and contracts with suppliers. **Ev:** It is a regulatory requirement to have this document in place. High costs are outweighed by environmental benefits in the event of a spill.

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Preparedness		
Natural hazards that pose a risk to drilling are avoided.	**(RSK-07:EPS-01)** The results of the PDSA investigations are used to avoid shallow gas hazards.	MODU station records verify that it is pinned on location that avoid hazards identified in the PDSA reports.
BOP is fitted and tested to industry standards.	**(RSK-07:EPS-02)** A functional and reliable BOP is installed with the riser that meets the requirements of API Standard 53 (Blowout Prevention Equipment Systems for Drilling Wells).	DDRs confirm BOP is fitted. Survey report confirms that the BOP meets the standard.
	(RSK-07:EPS-03) An Integrated Acceptance Test (IAT) Part 2 is undertaken and accepted on the BOP prior to its use.	IAT Part 2 report is signed off by EOG.
	(RSK-07:EPS-04) The BOP is pressure tested prior to deployment, upon initial latch-up with the wellhead and every 21 days in accordance with API Standard 53. The BOP is function tested every 7 days.	BOP testing records confirm testing is performed to schedule.
	(RSK-07:EPS-05) EOG will arrange for an independent pre-campaign assurance check of the MODU, including the BOP system.	Independent assurance report is available and confirms the BOP system is functional.
The well is drilled in accordance with industry standards by qualified and experienced drillers.	**(RSK-07:EPS-06)** The Beehive-1 well is designed in accordance with the AGR WDP to ensure that the well is designed in accordance with all required codes of practice and industry standards.	EOG's review of the well design verifies that the WDP has been adhered to.

	(RSK-07:EPS-07) The following plans are implemented in order to minimise the probability of a LoWC: • WOMP. • Safety Case Revision. • Drilling Program. • Well Control Bridging Document. • Drilling fluid program. • Cement program. • P&A suspension program. • BOP risk assessment.	Daily operator, third-party contractor and pre-tower meetings (and daily reports from key third-party contractors) confirm that the requirements of each plan are widely communicated and safely implemented.
EOG maintains preparedness to respond to a LoWC.	**(RSK-07:EPS-08)** The drilling contractor ensures that well kick drills are undertaken during the campaign in accordance with the drill schedule.	DDRs confirm that well kick drills are undertaken.
	(RSK-07:EPS-09) The Drilling Supervisor and Drilling Superintendent are trained and qualified to IWCF/IADC WellCap well control standards and AGR Well Standards so that well control emergencies are efficiently and properly managed.	Training records and certificates confirm these personnel are qualified and trained in well control.
	(RSK-07:EPS-10) A Beehive-1 OPEP and ERP are in place and prior to the activity commencing, a desktop LoWC and spill response exercise is conducted to test the DIMT functions.	Oil spill response exercise report verifies that an LoWC desktop exercise was undertaken.
	(RSK-07:EPS-11) The RWP is developed consistent with IOGP 594 (2019) and reviewed by WWC at least 2 months prior to the start of drilling.	RWP is place, with review comments from WWC available.
	(RSK-07:EPS-12) All DIMT roles have undertaken the necessary external training to fulfil their roles.	Training records verify that all DIMT roles have undertaken the necessary training (e.g., IMO II or III).
	(RSK-07:EPS-13) MAA is in place to provide access to other MODUs operating in Australia to reduce mobilisation time.	APPEA MoU signed by EOG prior to the start of drilling.
	(RSK-07:EPS-14) Agreement(s) are in place with well blowout engineering expertise (e.g., WWC) prior to the start of drilling.	Agreement(s) with WWC are in place prior to the start of drilling.

	(RSK-07:EPS-15) Agreement(s) are in place with oil spill response organisations (AMOSC & OSRL) prior to the start of drilling.	Agreements with AMOSC and OSRL are in place prior to the start of drilling.
	(RSK-07:EPS-16) Agreement(s) are in place with OSMP service provider(s) prior to the start of drilling.	Agreement with OSM provider is in place prior to the start of drilling.
	(RSK-07:EPS-17) EOG makes its fisheries compensation procedure available to fishing associations, companies or individuals who have requested it so that they are able to make a claim for losses.	Email correspondence verifies the fisheries compensation procedure was provided to those that requested it. Completed claims forms are available for any lodged claims.
Emergency response		
The DIMT responds in accordance with the OPEP, ERP and their training.	**(RSK-05:EPS-18)** The DIMT will be activated and support resources (such as AMOSC and OSRL) will be mobilised to implement the OPEP and ERP.	DDRs and incident investigation reports verify that the OPEP and ERP were implemented.
	(RSK-05:EPS-19) The RWP will be implemented to stop the LoWC.	DDRs and incident investigation reports verify that the RWP was implemented.
Recording & reporting		
Regulatory authorities are promptly made of aware of a spill.	**(RSK-05:EPS-20)** EOG will report a spill associated with a LoWC to regulatory authorities within 2 hours of becoming aware of the incident.	Incident report verifies that contact with regulatory agencies was made within 2 hours.
Monitoring		
Characterise environmental impacts of a LoWC spill.	**(RSK-05:EPS-21)** 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	Severe	Remote	Medium
Macroalgae & seagrass	Severe	Remote	Medium
Coral	Severe	Remote	Medium
Mangroves & saltmarshes	Severe	Remote	Medium
Sandy beaches	Severe	Remote	Medium
Rocky shores	Moderate	Remote	Low
Plankton	Moderate	Remote	Low

<table>
<tr><td>Fish</td><td>Moderate</td><td>Remote</td><td>Low</td></tr>
<tr><td>Marine mammals</td><td>Severe</td><td>Remote</td><td>Medium</td></tr>
<tr><td>Marine reptiles</td><td>Severe</td><td>Remote</td><td>Medium</td></tr>
<tr><td>Seabirds & shorebirds</td><td>Severe</td><td>Remote</td><td>Medium</td></tr>
<tr><td>Commercial fisheries</td><td>Minor to Severe</td><td>Remote</td><td>Negligible to Medium</td></tr>
<tr><td>Protected areas</td><td>Negligible to Severe</td><td>Remote</td><td>Negligible to Medium</td></tr>
<tr><td colspan="4">The reasons for the LoWC risk ratings are outlined in the previous tables corresponding to each faunal group or habitat type or socio-economic sensitivity.</td></tr>
<tr><th colspan="4">Demonstration of ALARP</th></tr>
<tr><td colspan="4">The ‘medium’ residual risk ratings are considered to be intolerable and higher order risks. However, the adopted control measures and associated EPS cannot lower the risk ratings any lower. Engineering risk assessments including BOP risk assessments, well integrity risk assessments and the precautionary principle have been factored into the control measures.</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 9 describes the EP implementation strategy to be employed for this activity.</td></tr>
<tr><td>Risk matrix standard compliance</td><td colspan="3">The residual risk for each receptor ranges from negligible to medium.</td></tr>
<tr><td>External context</td><td>Relevant persons</td><td colspan="2">One relevant person has raised concerns with regards to the potential impacts of a hydrocarbon spill on a water intake for a planned onshore aquaculture operation near the Victoria River in the NT. This is addressed in Table 8.35.</td></tr>
<tr><td>Legislative context</td><td colspan="3">The EPS align with the requirements of:
• 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 9 (Prohibition of discharge of oil or oily mixture to sea).
  ○ Section 11A (SOPEP).
  ○ AMSA Marine Orders Part 91 (Marine pollution prevention – oil).</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="3">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>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 major spills from exploration facilities in Section 4.7.4 of the guidelines:
• Well design undertaken in accordance with industry best practice (RSK-07: EPS-06 to -013).</td></tr>
</table>

		• OSTM undertaken to determine potential impacts to the surrounding environment (**part of ERA)**. • Blowout prevention measures to focus on maintaining wellbore hydrostatic pressure **(RSK-07: EPS-02 to -05)**. • Well integrity testing to be performed **(RSK-07: EPS-07 to -011)**. • RWP in place to regain control of the well if there is a loss of integrity **(RSK-07: EPS-07, -015)**.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	The EPS developed for this activity are in line with the management measures listed for well blowouts in Section 18.2 of the guidelines: • Have in place a spill contingency plan **(RSK-07: EPS-014 to -020)**. • Primary and secondary well control **(RSK-07: EPS-02, -03, -04, -05, -11)**. • Well monitoring **(RSK-07: EPS-08, -09, -10, -11)**. • Relief well planning **(RSK-07: EPS-015)**.
	Health, Safety and Environmental Case Guidelines for Mobile Offshore Drilling Units (IADC, 2015)	The EPS developed for this activity are in line with Section 2.3.12 of the guidelines (drilling and well control operations), which specify that: • Personnel involved in the operations are competent **(RSK-07: EPS-013, -016)**. • Drilling and well control procedures are in place to shut-in and abandon the well **(RSK-07: EPS-07)**.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS developed for this activity are in line with the following parts of the guidelines: • Section 75 (Spills): Conducting a spill risk assessment, implementing personnel training and field exercises, ensuring spill response equipment is available **(RSK-07: EPS-015 to -019)**. • Sections 76-79 (Spill response planning): A spill response plan should be prepared **(RSK-07: EPS-014, -015)**. • Section 115 (Well blowout). Blowout prevention measures should focus on maintaining wellbore hydrostatic pressure by effectively estimating formation fluid pressures and the strength of subsurface formation **(RSK-07: EPS-09)**. • Section 116 (Well blowout). A BOP system should be installed that can be closed rapidly. It should be tested at regular intervals (at least every 14 days) **(RSK-07: EPS-02, -03, -04)**. • Section 117 (Well blowout). The BOP system design, maintenance and report should comply

		with international standards. BOP systems should consist of one annular preventer, two blind-shear ram preventers and two pipe ram preventers **(RSK-07: EPS-02)**. • Section 118 (Well blowout). Contingency plans should be prepared for well operations **(RSK-07: EPS-014, -015, -024)**. • Section 119 (Well blowout). A dedicated blowout risk analysis and emergency plan should be prepared, detailing the measures in place to prevent a blowout, the provisions for well control in a blowout scenario and the time necessary for intervention **(RSK-07: EPS-015)**.
	APPEA CoEP (2008)	The EPS for this activity meet the code's following objectives for offshore geophysical surveys: • To reduce the risk of damage and cross-flow between fluid strata to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs	As per Table 8.36.
	Ramsar wetlands	As per Table 8.36.
	TECs	As per Table 8.36.
	Nationally threatened and migratory species	As per Tables 8.31 to Table 8.34.
	Other matters	
	KEFs	As per Table 8.36.
	NIWs	As per Table 8.36.
	State marine parks	As per Table 8.36.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Marine pollution is a threat identified for many fish, marine mammal, turtle and bird species. In general, population monitoring is the suggested action to deal with marine pollution. The Beehive-1 OSMP addresses 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 a spill resulting from a LoWC to be acceptable because: • It will adhere to the company's Safety and Environmental Policy; • The residual risk ratings are as low as can be achieved;	

	• An Implementation Strategy (described in Chapter 9) is in place to ensure the EPS are achieved. • Input from engagement with relevant persons has been considered and incorporated into the risk assessment; • Relevant legislation and industry best practice will be complied with; • A spill is not predicted to have long-term or significant impacts on MNES; • The management of a spill 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 spill is not inconsistent with the aims of relevant marine reserve management plans; and • The management of a spill is not inconsistent with ESD principles.
Environmental Monitoring	
• As per the OPEP and OSMP.	
Record Keeping	
• PDSA data reports. • APPEA MoU. • Agreements with service providers. • Emergency response exercise reports. • DDRs. • BOP installation and testing reports.	• BOP IAT Part 2 report. • Crew training records and certificates. • WDP review. • DIMT training records. • Incident reports.

8.8 RISK 8 – Hydrocarbon Spill Response Activities

In the event of a crude oil release associated with a LoWC, spill responses will be implemented in an attempt to reduce the volume of crude oil released to the environment and to remove oil from the environment to minimise impacts associated with the spill.

The response strategies have been identified through a strategic Net Environmental Benefits Analysis (NEBA) for a LoWC (**Appendix 7**), which also assesses the feasibility and effectiveness of each strategy.

Table 8.38 lists the strategies that will be adopted to respond to a spill associated with a LoWC, noting that the responses that would be implemented are dependent on the trajectory of the spill.

This section assesses the environmental and socio-economic risks associated with the response strategies listed above.

The equivalent assessment for a response to an MDO spill is addressed in Section 7.17 of the Beehive-1 PDSA EP (996161-2022-Beehive#1-PDSA-EP-Rev2), which was accepted by NOPSEMA in March 2022. The Beehive-1 PDSA EP can be accessed at the NOPSEMA website at: https://info.nopsema.gov.au/activities/468/show_public.

Table 8.38. LoWC spill response options

Response option	Primary or secondary response
Source control - relief well	Primary
Source control – capping stack	No
Source control – subsea dispersant application	No
Monitor and evaluate	Primary
In-situ burning	No
Mechanical dispersion	No
Chemical dispersant application - aerial	Primary
Chemical dispersant application - vessel	Secondary
Containment and recovery	Secondary
Shoreline protection and deflection	Secondary
Shoreline clean-up	Secondary
Oiled Wildlife Response (OWR)	Secondary
Waste management	Secondary

8.8.1 Known and Potential Environmental Impacts

The known and potential risks associated with the LoWC response strategies are broadly similar to the impacts and risks previously described for MODU and support vessel operations, these being:

- Physical presence of MODU drilling the relief well and response vessels;
- Seabed disturbance;
- Routine emissions – light, air underwater sound;
- Routine discharges – putrescible waste, sewage and grey water, cooling and brine water, bilge water and deck drainage;
- Routine risks – accidental discharge of waste, vessel collision with megafauna, introduction of IMS, interference with other marine users, MDO release; and
- Non-routine risks – disturbance to shorelines, dispersant toxicity.

8.8.2 EMBA

The EMBA for the LoWC response strategy cannot be determined until a spill occurs. The LoWC EMBA is described in **Appendix 5;** the LoWC OSTM indicates that a spill could occur anywhere within this area. Receptors at risk within the spill EMBA, whether resident or migratory, include:

- Plankton;
- Fish;
- Marine mammals;

- Marine reptiles;
- Seabirds and shorebirds;
- Shoreline habitats; and
- Commercial fisheries.

8.8.3 Evaluation of Environmental Impacts and Risks

In the event of a LoWC, the response strategies will involve a MODU drilling a relief well (up to several kilometres from the Beehive-1 well), many offshore vessels, fixed wing aircraft and helicopters, and vessels close to the coastline and people on the coastline (if and where accessible).

Physical presence of MODU and vessels

The impacts associated with the physical presence of the MODU and support vessels is provided in Section 7.2.2 of this EP, noting that the extent of presence will be expanded in the event of a spill response.

The physical presence of a MODU and support vessels in the event of a spill, has the potential to temporarily displace other marine users (from operating within a 500-m radius of the MODU from around the MODU in line with safety standards) such as commercial fishing vessels and merchant vessels from areas in which they would normally operate. However, the extent of disturbance relative to the operating areas of the mariner users is considered to be small and temporary, with disruption considered minimal compared to the environmental effects of the spill itself. With the implementation of control measures, the consequence of displacement of other marine users is considered negligible.

Seabed disturbance

The impacts associated with seabed disturbance is provided in Section 7.1.2 of this EP, noting that the extent of displacement may be expanded in the event of a spill response due to the greater number of vessels and aircraft.

The use of vessels and spill booms in nearshore areas during a spill response has the potential to disturb benthic and/or shoreline habitats including sensitive habitats such as corals, seagrass, macroalgae and mangroves. With the implementation of control measures, the consequence of seabed disturbance is considered to be negligible.

Routine emissions (light, air, underwater sound)

The impacts associated with light emissions, air emissions and underwater sound are provided in Sections 7.3.2, 7.4.2 and 7.5.2 of this EP, noting that the extent of such emissions may be expanded in the event of a spill response due to the greater number of vessels and aircraft.

Shore-based response activities involving the use of artificial lighting may take place in areas of shoreline that are known bird or turtle BIAs. The most sensitive receptors to lighting are seabirds/shorebirds and marine turtles. Females can be unsettled by lighting on beaches and prone to abandon nesting attempts. Emerging turtle hatchlings on the beaches are particularly sensitive to light spill and may become disorientated during attempts to enter the sea. However, sea-based response activities by vessels will be restricted to daylight hours, with vessels moving after sunset to mooring areas offshore where only navigation/safety lighting is used.

Lighting from any camp accommodation for spill response crew (if established) will be limited to as necessary to minimise disturbance to fauna. With the implementation of control measures, the consequence of lighting emissions is considered to be negligible.

Routine discharges (putrescible waste, sewage and grey water, cooling and brine water, bilge water and deck drainage)

The impacts associated with putrescible waste, sewage and grey water, cooling and brine water, bilge water and deck drainage are provided in Sections 7.8.2, 7.9.2, 7.10.2 and 7.11.2 of this EP, noting that the extent of such discharges will be greater in the event of a spill response due to the greater number of vessels.

Routine discharges from vessels used in response activities will generate a localised and temporary reduction in marine water quality. However, with the implementation of control measures such as standard maritime regulatory requirements for vessel discharges for example treated sewage is only discharged when the support vessel is greater than 3 nm from shore and at a speed not less than 4 knots (for further information on sewage control measures refer to Section 7.9.5), the consequence of routine vessel discharges is considered negligible.

Routine risks (accidental discharge of waste, vessel collision with megafauna, introduction of IMS, interference with other marine users, MDO release)

The impacts associated with accidental discharge of waste, vessel collision with megafauna, introduction of IMS, interference with other marine users, MDO release are provided in Sections 8.1.2, 8.2.2, 8.3.2, 8.4.2 and 8.6.2 of this EP, noting that the risk will be greater in the event of a spill response due to the greater number of vessels.

Waste generated during response activities, particularly oily wastes associated with spill clean-up, has the potential to cause adverse effects on fauna if not appropriately managed. In addition, there is a potential risk for contamination to be spread if vessels, vehicles and/or equipment are not appropriately cleaned to remove oily wastes when moving from spill impacted areas to non-impacted areas. With the implementation of control measures including waste management procedures for the collection, containment and appropriate disposal of oily/contaminated waste to ensure potential physical (oiling) or toxic effects are avoided, the consequence is considered to be minor.

During spill response there is potential for vessel collision with megafauna due to increased vessel use and movements, and in the nearshore waters there is the potential for physical disturbance with turtles and dugongs. With implementation of control measures), the consequence of disturbance to megafauna is considered minor.

Vessels and vehicles (including equipment and personnel) mobilised during spill response into nearshore waters and coastal habitats have the potential to introduce IMS from biofouling or in ballast water from vessels and/or via seed/plant propagules translocated by vehicles, equipment and personnel. All response vessels are subject to quarantine and biosecurity requirements including pre-inspection and cleaning prior to site mobilisation. With control measures implemented, the consequence rating is considered to be moderate.

The presence of spill response vessels may result in unplanned interference with other marine users and equipment, such as commercial fishing gear and merchant shipping. With the implementation of control measures (as provided in Section 8.4.5), the consequence of interference with other marine users is considered minor.

Potential impacts from a release of MDO may occur from the support vessels as a result of refuelling, a vessel-to-vessel collision or a support vessel colliding with the MODU legs. With standard control measures, the consequence of a large level 2 or 3 spill from a vessel-to-vessel collision is considered to be moderate.

Non-routine risks – disturbance to shorelines

Disturbance to shoreline habitats from personnel, equipment and vehicle movements during shoreline response may impact dune vegetation, mangroves and saltmarshes, including encroaching on bird and turtle nests and/or bird roosting areas. Shoreline clean-up may involve the physical removal of substrates (e.g., beach sands) that could affect habitat values and alter local erosion/accretion patterns. With the implementation of control measures, the consequence of seabed or ground disturbance (in relation to shorelines) is considered to be negligible.

Non-routine risks – dispersant toxicity

The application of chemical dispersants to remove surface oil is a globally recognised method, including with the Australian NatPlan, that reduces the risk of impacts of marine fauna, seabirds and sensitive shoreline receptors (e.g., shorebirds, nesting turtles and mangroves) located in coastal areas of the spill EMBA.

Dispersants comprise a mix of solvents, surfactants and additives, with the surfactant formulations commonly used in many household products (e.g., dishwashing soap and laundry detergents). The ingredients reduce the interfacial tension between water and oil, thus facilitating the formation of small oil droplets that disperse rapidly into the water column. It is difficult to make generalisations about the toxicity of dispersants and dispersed oil because this is dependent on a range of factors including oil type, dispersant composition and concentration, sensitivity of receptor species and their life history.

<u>Advantages</u>

The application of chemical dispersant to a crude oil spill has the following advantages:

- Removing oil from the surface reduces the severity of shoreline impacts, reduces impacts on sensitive fauna and flora as well as reducing the volume of wastes generated by clean-up activities;
- It is often the quickest response option;
- It is viable in a wide range of sea and weather conditions;
- Minimises oil contact with fauna at the sea surface (such as birds);
- Inhibits the formation of emulsions (which can be difficult to recover);
- It increases the surface area of oil available for natural degradation; and
- It reduces the volatile organic compounds (VOCs) at the sea surface, reducing the safety risk to response personnel.

Based on the most studied dispersant formulations, the increased risk for most taxa from dispersants comes from the increased solubility (and therefore bioavailability) of the toxic components of the oil, not the dispersant itself (Negri *et al*., 2018). Many other recent studies (e.g., Brakstad *et al*., 2018; Fingas, 2002; 2011; and Hansen *et al*., 2014), found modern dispersants to be significantly less toxic than the oil alone or the dispersed oil.

The benefits of the use of dispersant were demonstrated during the Macondo oil spill in 2010. Macondo oil that reached the shoreline was heavily weathered and degraded, and contained only a small fraction of the compounds of concern, according to the multi-agency Operational Science Advisory Team study (OSAT-2) released on the 10th of February 2011. That study found that the concentrations in residual oil or 'tar balls' were below EPA-established levels of concern for human health. According to the OSAT-2 study, weathered oil samples showed 86-98% depletion of total PAHs. The study also found that the tar balls contain mostly sand (87-96%). Extensive government seafood testing results (tested by the FDA, the US NOAA and the Gulf states) and landing information indicate no seafood exceeded the FDA's human health threshold for dispersant constituents. In fact, 99% of the samples showed no detectible residue at all (BP, 2013).

The EPA Administrator at the time of the Macondo spill stated that the surface application of dispersants was effective in breaking up the oil and reduced risk to shorelines and to surface-dwelling organisms (BP, 2014b). However, the Federal On-Scene Coordinator (FOSC) limited BP's use of dispersant five weeks after the blowout started. In the After Action Report, it was stated the decrease in dispersant use led to increased surface oil that could not be recovered, and that this oil most likely found its way to the shores of the Gulf of Mexico (BP, 2014b).

Disadvantages

The application of chemical dispersants to a crude oil spill has the following disadvantages:

- It results in more oil moving into the water column;
- If chemical dispersant is applied but not effective, it may decrease the effectiveness of other response measures (such as oleophilic recovery);

- It is not effective on all types of oil under all conditions;
- It adds additional extraneous substances into the marine environment; and
- There is a limited time window for use.

The use of chemical dispersants is an environmental trade-off; it is recognised that dispersants have their own set of environmental impacts (though are generally less toxic than the oils they break down), but they are used in an attempt to minimise contact with shorelines, where the oil can cause significantly more damage.

Exposure of marine organisms to dispersed oil and dissolved (water-soluble) oil compounds in the water column will be dependent on their proximity to the release, the drift direction of the plumes, and the ability of the marine organisms to detect oil and move away to avoid the oil. Sessile organisms on the seabed that cannot move away may experience higher exposure to dispersed oil than those organisms that can swim away. Sessile organisms close to the release can be exposed to high concentrations of dispersed oil for prolonged periods, though it is recognised that fauna population densities in deep waters is less than that closer to the sea surface (IPIECA-IOGP, 2015a).
Recent results from studies looking at potential synergetic effects of dispersants in oil exposure have suggested that the dispersants make it easier to move hydrocarbons across membranes – and thus may enhance exposure (NRDA, 2012).

Effective dispersion of oil may increase the acute (short-term, sometimes lethal) impacts on marine life living in the top few metres of the sea in the vicinity of the spill due to the dissolution of the smaller more volatile molecules into the water column rather than evaporating from the sea surface. However, these impacts are usually time-limited because of the rapid dilution of the dispersed oil (IPIECA-IOGP, 2014a). This is supported by earlier research that states where the dilution potential is greatest (i.e., the open ocean), concentrations of dispersed oil high enough to cause adverse effects are unlikely to persist for more than several hours (API, 2001).

Filter feeding organisms that prey on plankton can ingest naturally- or chemically-dispersed oil droplets when they are of a similar size to some plankton. Relatively simple organisms, such as bivalves, cannot biochemically process the higher molecular weight PAHs in the oil, and these PAHs can build up (bioaccumulate) in some organs (IPIECA-IOGP, 2015a). Predators that consume oil-contaminated bivalves can therefore be exposed to elevated concentrations of the higher molecular PAHs by this ingestion route. Organisms that possess livers, such as fish, can quickly metabolise PAH although some of these metabolites may be harmful. As benthic organisms, bivalves may be exposed to dispersed oil if it reaches shallower waters. Plankton found in the top layer of the water column is at risk of exposure to the dispersed oil.

Dispersants can also injure aquatic vegetation by breaking down the thin waxy cuticle of the plant, allowing greater penetration of oil fractions into leaves, thereby increasing phytotoxicity. In addition, this physical damage to the cuticle could cause a reduction in growth due to the increased physiological stress on the plant (NRDA, 2012). A study of the effects of oil and dispersed oil on temperate seagrasses by the Sydney University of Technology (Wilson, 2010) found that in most cases, the non-dispersed oils had less of an impact (photosynthetic stress) to the seagrasses *Zostera capricorni* and *Halophila ovalis* than the dispersed oil treatments. Wilson (2010) reports that seagrasses absorb more aliphatic and aromatic oil fractions when the oil is dispersed, thereby increasing its toxicity. The dispersants may affect the waxy cuticle of the seagrass blade, thereby increasing the penetrability of the dispersed oil to the photosynthetic organs, particularly the thylakoid membrane. As dispersed oil is more susceptible than non- dispersed oil to microbial breakdown, this leads to greater oxygen demand by microbes. A reduction in the oxygen in the seagrass community may impact on the seagrass system, as they have a high respiratory demand to support their large non-photosynthetic underground biomass (Wilson, 2010). While it is unlikely such effects will manifest themselves along the coast of the EMBA (because dispersant will be sprayed in offshore areas a significant distance from the coast), if such effects do occur, they are likely to be isolated given the patchy distribution of macroalgal communities along the coastline.

Shortly after the Macondo oil spill, reports suggest that oil and dispersant constituents became entrained in the pelagic food web (Tjeerdema *et al*., no date). Dispersed oil in the shallow water column became incorporated into at least two trophic levels beyond prokaryotic hydrocarbon consumers. Dispersed oil was also observed in blue crab larvae. Contaminants from dispersed oil may result in long-term adverse effects such as carcinogenesis, impaired reproduction, shortened life spans and decreased population numbers in planktonic organisms. Additionally, exposure to contaminants found in oil and dispersants during early phases of the life cycle can lead to infertility and a host of developmental problems (Tjeerdema *et al*., no date).

The ultimate long-term effects will depend on the concentration, location and persistence of dispersed oil and the duration and timing of exposure to organisms (Tjeerdema *et al*., no date).

Based on API (2001), the following impacts may occur to these fauna groups:

- Birds – those inadvertently sprayed with dispersant may experience a loss of natural oils necessary for insulation and buoyancy.
- Pelagic species – acute toxicological data indicates that water column concentrations at or below 10 ppm, exposures to dispersed oil for 2-4 hour durations are not expected to cause adverse ecological impacts. In general, plankton, invertebrates and fish are unlikely to be at risk any more than that posed by the undispersed oil.
- Benthic species – in shallow waters (<10 m), toxicity from dispersed oil may be high enough to cause lethal and sub-lethal effects in some species, especially immobile or slow-moving invertebrates. Dispersed oil residues (i.e., non-degraded oil) may end up in bottom sediments, where it remains for a considerable time due to low oxygen levels, leading to low biodegradation.

- Intertidal species – impacts to invertebrates are similar to those from undispersed oil.

<u>Dispersant application in the Australian context</u>

Only dispersants pre-approved by AMSA as listed in the Oil Spill Control Agent (OSCA) Register would be used in the event of a LoWC and only after the preparation of a NEBA, based on real-time OSTM, demonstrates there is a net environmental benefit in doing so.

The AMSA Efficacy Test Protocol for the Register (AMSA, 2012) lists the toxicity testing requirements that ensure products meet the requirements of acceptable practice for the NatPlan, and products with a high acute toxicity (LC_{50} < 10 ppm, 96 hrs) (NRC, 1989) or containing prohibited substances are not permitted. Impacts to the environment from the use of OSCA-registered dispersants are therefore considered acceptable by AMSA and in applying dispersant at the recommended dosage, dilution and dispersion will significantly reduce the concentrations to levels considered unlikely to have significant effects on protected species or marine biota and habitats.

The overall consequence of dispersant toxicity is considered to be moderate.

8.8.4 Risk Assessment

Table 8.39 presents the risk assessment for LoWC spill response activities.

Table 8.39. Risk assessment for LoWC spill response activities

Summary		
Summary of risks	Disturbance to marine and nearshore fauna. Toxicity effects to marine fauna (dispersant application). Disturbance to shorelines. Disturbance to coastal cultural heritage values.	
Extent of risk	Widespread – large areas of open ocean, nearshore waters and long sections of shoreline, accessed by vessel, aircraft and on foot (where safe to do so).	
Duration of risk	Medium- to long-term (depending on spill volume, trajectory and shorelines affected).	
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)			
Response strategy	Likelihood	Consequence	Risk rating
Relief well drilling	Remote	Minor	Negligible
Monitor and evaluate	Remote	Negligible	Negligible
Dispersant application	Remote	Moderate	Low
Containment and recovery	Remote	Minor	Negligible
Shoreline protection and deflection	Remote	Minor	Negligible
Shoreline clean-up	Remote	Moderate	Low
OWR	Remote	Moderate	Low
Waste management	Remote	Minor	Negligible
Receptor	Likelihood	Consequence	Risk rating
Fauna disturbance	Remote	Minor	Negligible
Fauna injury	Remote	Minor	Negligible
Fauna death	Remote	Minor	Negligible
Assessment of Proposed Control Measures			
The suitability of response techniques to a spill of crude oil from a Beehive-1 LoWC are based on a strategic (or *a-priori*) NEBA, which is presented in **Appendix 7**. A strategic NEBA is based on theory and experience from other global LoWC incidents, but not on experience for this well, this oil type (which is speculative) and this location. An operational (*a-posteriori*) NEBA will be undertaken at the time of the spill once key facts about the spill are established (nature of the oil, flow rate, trajectory of movement, etc).			

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Notifications		
Make notifications and reports within regulatory and defined timeframes.	**(RSK-08:EPS-01)** OPEP contact details for regulatory and service provider notifications are checked prior to the start of drilling.	Test records.
	(RSK-08:EPS-02) External notification and reporting is undertaken as per Section 9.7 of this EP.	Incident logs.
Common to all response strategies		
EOG retains access to response equipment and trained personnel for the duration of the	**(RSK-08:EPS-03)** EOG's membership with AMOSC, OSRL, APPEA and WWC remain valid through the course of the project to facilitate mutual aid arrangement and	Membership contracts and/or agreements verify currency of memberships or contracts.

activity in order to ensure a prompt response.	access to first responders, equipment and expertise.	
	(RSK-08:EPS-04) Vessels, aircraft and equipment suppliers have contracts or call-off agreements in place with EOG prior to the project commencing.	Contracts or call-off agreements verify the contractor is suitable for deployment.
	(RSK-08:EPS-05) DIMT will be appropriately trained to fulfil their spill response roles.	Training records verify capacity to fulfil nominated DIMT role.
There is no increase in environmental harm from oil spill response activities.	**(RSK-08:EPS-06)** The response strategy is only undertaken if an operational NEBA determines it is likely to have a net environmental benefit and if it is safe to do so.	Operational NEBA.
	(RSK-08:EPS-07) A NEBA is undertaken during each operational period to determine if the response strategy is continuing to have a net environmental benefit.	Operational NEBAs.
	(RSK-08:EPS-08) 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-08:EPS-09) 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-08:EPS-010) Environmental briefings are conducted for shoreline monitoring crews to identify site-specific risks and suitable controls.	Briefing records are available.
Relief well		
Preparedness		
The RWP is current so that resources to stop the release of hydrocarbons can be readily deployed.	**(RSK-08:EPS-011)** The RWP is in place and maintained up to date during the activity, including the MODU capability register.	RWP revision history.
	(RSK-08:EPS-012) A well engineering contractor confirms availability to perform services to support relief well operations.	Contract/agreement in place with a well engineering contractor.
	(RSK-08:EPS-013) WWC confirms availability to perform well kill operations.	Correspondence from WWC confirming availability for the project.
Response		

The RWP is implemented to stop the release of hydrocarbons.	**(RSK-08:EPS-014)** The RWP is implemented in accordance with the timelines detailed in the plan.	Incident logs.
Monitor and evaluate		
Preparedness		
Implement monitor and evaluate tactics in order to provide situational awareness to inform DIMT decision-making.	**(RSK-08:EPS-015)** Oil sampling kits and dispersant efficacy kits are available on the support vessels.	Pre-survey inspection verifies kits are available.
	(RSK-08:EPS-016) Arrangements with NATA accredited laboratories are in place to enable efficient sample logistics and analysis.	Arrangements with NATA accredited laboratories available.
	Vessel and aerial surveillance **(RSK-08:EPS-017)** EOG maintains Master Services Agreements (MSAs) (or similar) with multiple vessel providers.	MSAs are in place.
	(RSK-08:EPS-018) MSA in place with helicopter provider throughout activity.	Helicopter MSA is in place.
	(RSK-08:EPS-019) Maintenance of AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers.	AMOSC Participating Member Contract is in place.
	(RSK-08:EPS-020) Maintain a list of aircraft charter companies that could potentially provide fauna observation services.	List of providers is available.
	Tracking buoys **(RSK-08:EPS-021)** Three satellite tracker buoys are available throughout the activity (one on the MODU and one each on the two support vessels).	Satellite tracker buoys are visually sighted.
	Satellite imagery **(RSK-08:EPS-022)** Contract in place with AMOSC to enable access and analysis of satellite imagery.	AMOSC Participating Member Contract is in place.
	OSTM **(RSK-08:EPS-023)** Contract in place with AMOSC to enable OSTM services throughout activity	AMOSC Participating Member Contract is in place.
	(RSK-08:EPS-024) Access to additional OSTM capability to ensure redundancy.	Membership in place with OSRL.
	(RSK-08:EPS-025) Obtain monthly capability reports from OSMP service provider starting 3 months prior to the start of drilling.	Capability reports.

Response		
Oil characterisation is undertaken rapidly to inform ongoing response.	**(RSK-08:EPS-026)** Minimum requirements mobilised in accordance with Section 3.4 of the OPEP.	Incident logs.
	(RSK-08:EPS-027) Oil samples to be sent immediately for laboratory ecotoxicity testing.	Incident logs.
	(RSK-08:EPS-028) The 90, 95 and 99% species protection triggers levels will be derived from ecotoxicity testing results (minimum five species' tests) within 24 hours of receiving all results.	Incident logs.
	Vessel and aerial surveillance **(RSK-08:EPS-029)** Minimum first strike resource requirements mobilised in accordance with Section 3.4 of the OPEP.	Incident logs.
	(RSK-08:EPS-030) Daily observation reports submitted to DIMT until termination criteria are met.	Incident logs.
	(RSK-08:EPS-031) Vessels and aircraft comply with Part 8 of the EPBC Regulations 2000 (to minimise the risk of collision with marine fauna).	Completed vessel and aircraft statements of conformance is available.
	(RSK-08:EPS-032) Following initiation, two passes per day of the spill area are flown by observation aircraft.	Incident logs.
	(RSK-08:EPS-033) Trained aerial observers are supplied by Day 2 of response.	Incident logs.
	(RSK-08:EPS-034) Observers complete aerial surveillance observer log following completion of each flight.	Aerial observer logs.
	Tracking buoys **(RSK-08:EPS-035)** The tracking buoys are deployed.	Incident logs.
	Satellite imagery **(RSK-08:EPS-036)** Satellite data incorporated into common operating picture and provided to OSTM provider.	Incident logs and IAP.
	OSTM **(RSK-08:EPS-037)** AMOSC will be contacted and asked to initiate OSTM within two hours of notification of a Level 2 or 3 spill.	Incident logs.

Dispersant application		
Preparedness		
EOG retains access to dispersant application resources for the duration of the activity in order to ensure a prompt response.	**(RSK-08:EPS-038)** Access to dispersant stockpiles, vessel application booms, aircraft and personnel is maintained through contracts/agreements with AMOSC and OSRL.	Pre-drilling checks with AMOSC and OSRL verify that dispersant stockpiles, equipment and personnel remain available and ready for deployment.
Response		
Dispersant application is undertaken to reduce the probability or severity of contact with shoreline protection priorities.	**(RSK-08:EPS-039)** Dispersant application from the support vessels starts as soon as the DIMT Leader gives the go-ahead is provided.	Incident logs verify prompt application of dispersant.
	(RSK-08:EPS-040) Only OSCA-listed dispersants are used.	Incident logs.
	(RSK-08:EPS-041) An in-situ dispersant efficacy test is undertaken, and dispersant is only applied if the test is deemed successful.	Incident logs.
	(RSK-08:EPS-042) Dispersant is applied only during daylight hours (in order to determine dispersion effectiveness).	Incident logs.
	(RSK-08:EPS-043) Dispersant is only applied to dispersible oil (i.e., oil that has not emulsified), with the window of opportunity for dispersant application to be determined based on field testing.	Incident logs.
	(RSK-08:EPS-044) Dispersant is not applied within the JBG AMP or the North Kimberley Marine Park, or within 10 km from these park boundaries or in waters less than 20 m deep.	Incident logs.
Containment and recovery		
Response		
Maximise oil recovery to reduce the probability or severity of contact with shoreline protection priorities.	**(RSK-08:EPS-045)** Containment and recovery shall only be undertaken under the supervision of an AMOSC Core Group member.	Incident logs.
	(RSK-08:EPS-046) Decanting shall only be undertaken following approval from the WA DoT, NT DIPL and/or AMSA and is only undertaken during daylight hours, to the apex of the containment boom, and following a minimum residence time of 30 minutes.	Incident logs.

Shoreline protection and deflection		
Response		
Maximise shoreline deflection activities to reduce the probability and/or severity of contact with shoreline protection priorities.	**(RSK-08:EPS-047)** DIMT to confirm protection priorities in consultation with WA DoT and NT DIPL (Marine Safety Branch).	IAP. Incident logs.
	(RSK-08:EPS-048) IAP Shoreline Protection and Deflection Sub-plan developed to provide oversight and management of shoreline protection and deflection operation.	IAP Shoreline Protection and Deflection Sub-plan available.
	(RSK-08:EPS-049) Unless directed otherwise by the designated Control Agency (i.e., WA DoT and/or NT DIPL) a shoreline/nearshore habitat/bathymetry assessment is conducted prior to nearshore activities.	IAP records.
	(RSK-08:EPS-050) Shallow draft vessels are used for shoreline and nearshore operations unless directed otherwise by the designated Control Agency (i.e., WA DoT and/or NT DIPL).	Vessel specification documentation contained in IAP.
Shoreline clean-up and assessment (SCAT)		
Preparedness		
Implement shoreline clean-up and assessment activities to remove stranded hydrocarbons in order to reduce shoreline ecological impacts.	**(RSK-08:EPS-051)** Shoreline Tactical Response Plans (TRPs) are prepared ahead of drilling, factoring in shoreline type, habitats, access and ecological, cultural heritage and socio-economic sensitivities.	Shoreline TRPs.
	(RSK-08:EPS-052) Shoreline TRPs are reviewed and updated based on satellite data and OSTM and are used to provide intelligence on shorelines at greatest risk of oiling. These shorelines are prioritised for response.	Shoreline TRPs. Satellite data. OSTM report/s.
Response		
	(RSK-08:EPS-0573 Shoreline clean-up strategies will be implemented under the direction of the WA DoT and/or NT DIPL.	Incident logs.
	(RSK-08:EPS-054) EOG will make available AMOSC Core Group Responders and equipment for shoreline clean-up team positions to the Control Agency.	Incident logs.
	(RSK-08:EPS-055) SCAT crews are inducted into the TRPs so that environmental, cultural heritage and socio-economic sensitivities are known and can be appropriately managed.	Induction records. Incident logs.

	(RSK-08:EPS-056) Unless directed otherwise by the Control Agency, a Heritage Advisor is consulted if shoreline operations overlap with areas of cultural significance.	Incident logs.
	(RSK-08:EPS-057) The establishment of forward staging areas on shorelines is undertaken only under the direction of or in consultation with the WA DoT, NT DIPL.	Documented in IAP and Incident Log.
	(RSK-08:EPS-058) SCAT response continues until termination criteria are met, as outlined within the SCAT Plan.	Incident logs.
OWR		
Preparedness		
Prevent or reduce impacts from oiling to fauna.	**(RSK-08:EPS-059)** EOG will make available personnel and resources to OWR agencies, as requested, to mobilise and maintain an OWR response.	Incident logs verify finances and/or resources are provided by EOG to the OWR agencies.
	(RSK-08:EPS-060) An IAP Wildlife Response Sub-plan is developed to provide oversight and management of OWR operations.	IAP Wildlife Response Sub-plan is available prior to OWR operations commencing.
Response		
Humanely treat, house and release oiled fauna wherever possible. Euthanise fauna where treatment and release is not a humane option.	**(RSK-08:EPS-061)** Integration of state-based OWR liaison representatives in the DIMT is undertaken prior to the spill reaching state waters to facilitate planning and implementation of OWR response.	Incident logs verify integration of state-based agency OWR personnel into the DIMT prior to the spill reaching state waters.
	(RSK-08:EPS-062) In accordance with the IAP Wildlife Response Sub-plan, deploy personnel and equipment (where safe to do so) in areas of highest environmental value based on monitoring and evaluation results and NEBAs.	Incident logs verify that personnel and equipment is mobilised to most relevant locations.
	(RSK-08:EPS-063) Capture and treatment of oiled wildlife is undertaken only by personnel trained to do so.	Wildlife capture and treatment personnel qualifications and training matrix. Incident logs noting names of wildlife capture and treatment personnel.
	(RSK-08:EPS-064) OWR response continues until termination criteria are met, as outlined within the IAP Wildlife Response Sub-plan.	Incident logs.

Waste management		
Preparedness		
Waste from oil spill recovery activities will be managed to minimise additional environmental impacts and allow	**(RSK-08:EPS-065)** Waste TRPs are prepared ahead of drilling, factoring in shoreline type and safe access.	Shoreline TRPs.
	(RSK-08:EPS-066) Waste TRPs are reviewed and updated based on SCAT response, satellite data and OSTM and are used to provide intelligence on shorelines at greatest risk of oiling. These shorelines are prioritised for response.	Shoreline TRPs. Satellite data. OSTM report/s.
	(RSK-08:EPS-067) Personnel and equipment are deployed (if safe to do so, depending on shoreline type) to areas of very high sensitivity at least 72 hours prior to predicted first stranding at environmentally sensitive locations.	Incident logs.
	(RSK-08:EPS-068) Environmental risk assessments are conducted prior to waste management work commencing to identify risks and suitable controls.	Completed risk assessments are available.
	(RSK-08:EPS-069) Wastes are treated and/or disposed of in accordance with the Waste TRP, which is developed based on regulatory requirements.	Waste transport, disposal and/or destruction certificates verify regulatory compliance.
	(RSK-08:EPS-070) Waste management response continues until termination criteria are met, as outlined within the Waste TRP.	Incident logs.

Risk Assessment (residual)			
Response strategy	Likelihood	Consequence	Risk rating
Relief well drilling	Remote	Minor	Negligible
Monitor and evaluate	Remote	Negligible	Negligible
Dispersant application	Remote	Moderate	Low
Containment and recovery	Remote	Minor	Negligible
Shoreline protection and deflection	Remote	Minor	Negligible
Shoreline clean-up	Remote	Moderate	Low
OWR	Remote	Moderate	Low
Waste management	Remote	Minor	Negligible
Receptor	Likelihood	Consequence	Risk rating
Fauna disturbance	Remote	Minor	Negligible
Fauna injury	Remote	Minor	Negligible

<table>
<tr><td colspan="2">Fauna death</td><td>Remote</td><td>Minor</td><td>Negligible</td></tr>
<tr><td colspan="5">The risk of spill response activities to the identified receptors is assessed as negligible to low because:
• The control measures adopted are effective in reducing the risk to ALARP.</td></tr>
<tr><th colspan="5">Demonstration of ALARP</th></tr>
<tr><td colspan="5">A detailed demonstration of ALARP is presented in Appendix 7. This also considers the availability, functionality, reliability, survivability and independence/capability of each control measure.</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 9 describes the EP implementation strategy to be employed for this activity, which is largely reliant on the implementation of AGR’s HSE Management System during the activity.</td></tr>
<tr><td>Engagement</td><td>Relevant persons</td><td colspan="3">There have been no concerns raised from relevant persons regarding spill response activities.</td></tr>
<tr><td>Legislative context</td><td colspan="4">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="4">Industry practice</td><td colspan="4">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 colspan="3">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-08: all EPS).</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td colspan="3">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 colspan="3">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>
</table>

	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Sections 76-79 (Spill response planning): A spill response plan should be prepared **(RSK-08: all EPS)**.
	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.
	Response-specific guidance	
	Monitor and evaluate	In-water surveillance of oil spills at sea (IPIECA/IOGP, 2016).
		Aerial observations of oil spills at sea (IPIECA/OGP, 2015)
		At-sea monitoring of surface dispersant effectiveness (IPIECA/OGP, 2014).

		An assessment of surface surveillance capabilities for oil spill response using airborne remote sensing (Polar Imaging, 2014).
		Aerial Observations of Marine Oil Spills (ITOPF, 2011b)
	Dispersant application	Oil spill response: Should you spray dispersant (IPIECA/IOGP, 2022).
		Dispersants: surface application. Good practice guidelines for incident management and emergency response personnel (IPIECA/IOGP, 2015).
		Dispersant logistics and supply planning (IPIECA, OGP, 2013).
	Containment and recovery Shoreline protection and deflections	The use of decanting during offshore oil spill recovery operations (IPIECA, OGP, 2013).
		Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments (NOAA, 2001).
	SCAT	A guide to oiled shoreline assessment (SCAT) surveys (IPIECA/IOGP, 2014).
		A guide to oiled shoreline clean-up techniques (IPIECA, 2016).
		Characteristic Coastal Habitats: Choosing Spill Response Alternatives (NOAA, 2013).
	OWR	Key principles for the protection, care and rehabilitation of oiled wildlife (IPIECA, IOGP, 2017)
		Wildlife response preparedness (IPIECA/IOGP, 2016).
		A guide to oiled wildlife response planning (IPIECA, 2004).
	Waste management	Oil spill waste minimisation and management (IPIECA, IOGP, 2014).
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.
	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.
	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	
	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 Environment Policy; • The residual risk ratings are negligible; • An Implementation Strategy (described in Chapter 9) 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 Beehive-1 OPEP and OSMP 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.

9. 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 Chapters 7 and 8 are adequately implemented.

9.1. Activity Organisational Structure

Figure 9.1 illustrates the organisational chart for the activity and the relationship between EOG, AGR (as the drilling project manager), the MODU contractor and consultants for the activity.

EOG has overall responsibility for the management of the activity to ensure that:

- Design and execution of the activity is undertaken 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 MODU contractor will have the day-to-day control and management of the MODU through the Offshore Installation Manager (OIM) and the support vessels through the respective Vessel Masters. The OIM and Vessel Masters have overriding authority and responsibility to make decisions with respect to environment protection and pollution prevention and to request assistance as may be necessary.

Specific environmental roles and responsibilities are outlined in Table 9.1. These will be communicated to all personnel involved in the activity. As the Titleholder, EOG has entered into an agreement with AGR to provide the following ongoing services through this phase:

- Integrated Management System (IMS) (i.e., health, safety and environment) and support (resource) services; and
- Incident management capabilities associated with this activity.

9.2. Roles and Responsibilities

The environmental roles and responsibilities of key project team members are summarised in Table 9.1.

Day-to-day implementation of the activity (and the EP) will occur on the MODU under the leadership of the OIM, and for the support vessels under the leadership of the Vessel Masters. The AGR Project Manager will have oversight of the performance of the activity against the project plans, including this EP, and will initiate reviews and audits as required.

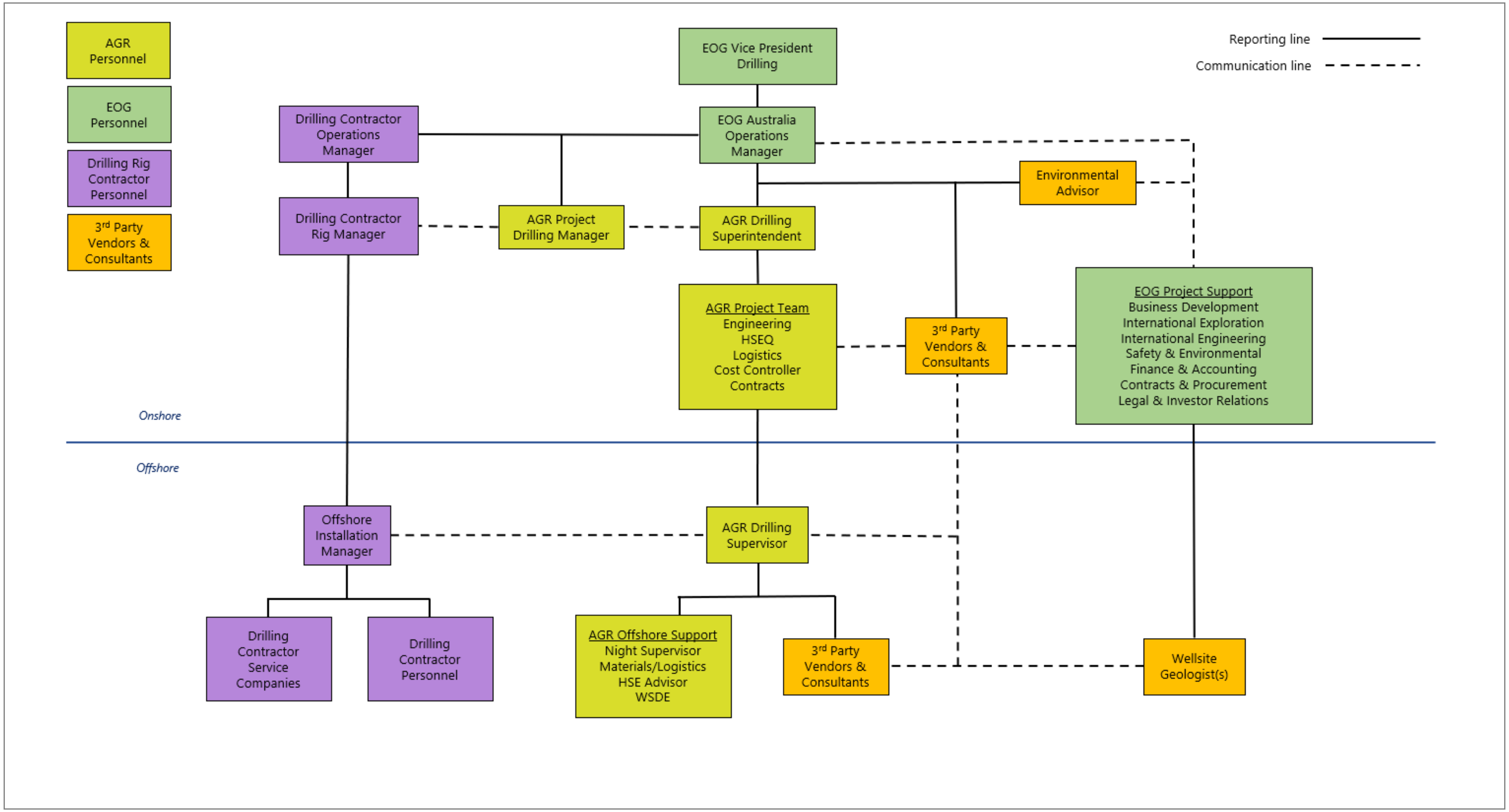


Figure 9.1. Activity organisation chart

Table 9.1. Environmental roles and responsibilities for the activity

Role	Environmental responsibilities
Onshore	
EOG	
EOG Vice President Drilling	• Ensures EOG's drilling standards are met. • Approves this EP for submission to NOPSEMA.
Vice President (Safety & Environment)	• Ensures EOG's Safety and Environmental Policy is applied to the activity.
EOG Australia Operations Manager	• Overall project manager for the activities. • Works with the EOG team, as well as all contractors, to execute a safe and successful project. • Ensures EOG is adequately resourced to undertake the activities. • Ensures AGR and Aventus are adequately resourced to support the activities. • 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. • Reviews the Drilling EP, OPEP and OSMP. • Confirms all required plans, audits and reviews are undertaken in accordance with the requirements of the EP and other regulatory documents. • Reviews and approves incident reports and submits them to regulators. • Ensures all notifications are prepared and submitted in a timely fashion. • Reviews major changes to operations. • Reviews and submits the end-of-activity notification for submission to NOPSEMA. • Reviews and submits the Environmental Performance Report to NOPSEMA. • Approves submissions to NOPSEMA.
Project support	• Provides direction on stakeholder consultation. • Attends stakeholder meetings as required.
Specialists	
AGR Project Manager	• Facilitates clear communications between EOG and MODU contractor. • Ensures the support vessels are appropriately inspected, certified and fit for purpose. • Ensures compliance with the EP. • Ensures effective emergency response arrangements are in place with the MODU. • Ensures all AGR, MODU and third-party contractor personnel are inducted and are aware of their activity-specific environmental responsibilities. • Ensures all required plans, audits and reviews are undertaken in accordance with the regulatory requirements and as required by the EP. • Conducts incident investigations. • Provides daily feedback on operations progress to the EOG Operations Director. • Reports all incidents to the EOG Operations Director.
AGR Drilling Superintendent	• Executes operations and is the key interface point between AGR and MODU management onshore during operations. • Ensures AGR's drilling operations perform to the highest required standards of HSEQ as defined by the AGR organisation, government regulators and clients.

Role	Environmental responsibilities
	• Promotes a proactive HSEQ culture within AGR operations and attendance at project HSE meetings • Ensures full and complete HSEQ compliance with EOG requirements and government regulations. • Leads onboard HSEQ incident investigations. • In the event of an emergency, assumes the role of Drilling Incident Management Team (DIMT) Leader and activates the EOG Drilling Program Bridging ERP to ensure the necessary onshore support is managed appropriately.
AGR HSEQ Manager	• Provides frontline HSEQ support and direction to management and all personnel for the project. • Ensures AGR complies with all applicable legislative, industry and corporate governance requirements. • Encourages the implementation of industry best practice and implements AGR's management systems to achieve exemplary HSE performance. • Manages the preparation of the HSE regulatory approvals documents (e.g., SCR and WOMP). • Provides technical input to risk analysis and evaluation techniques. • Arranges for review of the MODU and vessel contractors' HSE management systems upon contract award. • Reports recordable and reportable incidents to EOG. • Assists with review, investigation and reporting of HSE incidents.
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 EP compliance inspections/audits. • 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	
MODU	
MODU Offshore Installation Manager (OIM)	• Responsible for the daily control and management of the MODU, has over-riding authority and responsibility to make decisions regarding environment protection and pollution prevention. • Responsible for all vessel activities within the PSZ around the MODU. • Oversees all work activities and work programs ensuring work is undertaken in accordance with procedures, work instructions and in compliance with the MODU HSE Case and HSE Case Addendum. • Assumes role of MODU Emergency Response Team (ERT) Leader. • Ensures all offshore personnel understand their obligations with respect to the management of HSE risks. • Ensures the MODU training matrix is fully implemented by all MODU crew. • Ensures MODU HSE inductions are conducted.

Role	Environmental responsibilities
	• Ensures waste disposal complies with MARPOL requirements. • Monitors closeout of non-conformances, corrective actions and audit recommendations. • Reports all incidents, near-misses and dangerous occurrences to the AGR DSV in accordance with the incident reporting system.
AGR Drilling Supervisor (DSV)	• Acts as AGR's and EOG's Onboard Representative during the activity and ensures that commitments made in the EP are met. • Represents AGR and EOG onboard the MODU in all matters that affect EOG's commitment to HSE performance and ensures that the HSEQ and technical expectations are met. • Ensures inductions, auditing and reporting requirements are met. • Shares any design changes with the MODU OIM and rest of the onboard project team. • Encourages the principle of stop-work authority for safety. All personnel are encouraged to call a Time Out For Safety (TOFS) and to stop operations if there is a risk or any reasonable doubt about safety. • Ensures that the operation is halted in a safe manner to protect personnel, equipment and the environment prior to providing clarification and, if necessary, performing a risk assessment to identify mitigating plans in order to resume safe operations. • Participates in HSE meetings and will be a member of the investigation team activated as the result of an accident or incident. Advises the AGR Drilling Superintendent of any incidents. • Complies with all MODU rules, regulations, policies and procedures as defined within the Vessel HSE Case Addendum and MODU ERP. • Undertakes a technical review of the activity. • Liaises with the AGR Drilling Supervisor to ensure compliance with drilling program requirements.
AGR HSE Coordinator	• Supports the DSV to ensure the execution of all HSE commitments under the HSE Plan, HSE Case Addendum, WOMP and EP. • Assists and advises on MODU risk assessments. • Participates in the MODU behavioural-based safety programs. • Conducts or participates in incident investigations as required. • Conducts HSE inspections. • Provides HSE technical support to the program and works with the MODU HSE Officer.
All MODU personnel	• Undertake work activities with reasonable care and in accordance with EP commitments to ensure no adverse impacts to the environment. • Report all new hazards, incidents, near-misses and dangerous occurrences to immediate supervisor as soon as possible. • Participate in the development of work procedures through the job safety analysis (JSA) process. • Attend all necessary toolbox talks, HSE inductions and HSE meetings. • Participate in workplace inspections. • Maintain high house-keeping standards.
Support vessels	
Vessel Master	• Complies 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.

Role	Environmental responsibilities
	• 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 DSV, recording the details and taking initial actions with the Vessel Master to render the situation safe. • Keeps watch for megafauna and avoids direct interactions.
Vessel crew	• Undertake work activities with reasonable care and in accordance with EP commitments to ensure no adverse impacts to the environment. • Report all new hazards, incidents, near-misses and dangerous occurrences to immediate supervisor as soon as possible. • Participate in the development of work procedures through the JSA process. • Attend all necessary toolbox talks, HSE inductions and HSE meetings. • Participate in workplace inspections. • Maintain high house-keeping standards.

9.3. 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.

9.3.1. EOG

EOG has in place an Australian Projects HSE Management Plan (996161-2022-Beehive#1-HSEPlan) 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 includes descriptions of 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;
- 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 MODU and vessel contractors will be required to have an HSE management system or plan that meets the requirements of the EOG Safety and Environmental Policy and the EOG Australian Projects HSE Management Plan.

9.3.2. AGR

AGR’s management system is accredited with ISO 9001:2015 and ISO 14001:2015 and governs all of the group business as documented in the AGR Management System Manual (AGR-HSEQ-M-01).

AGR uses a standardised management system process to ensure that project activities are planned and managed efficiently and with due consideration to good oilfield practice, local and international standards as they relate to well design, operations planning, construction and then subsequent suspension or abandonment operations. This process is known as the WDP (see also Section 2.3). The AGR WDP is a central component of the AGR Management System and is being used by EOG for this activity.

The AGR WDP is supported by the AGR Well Standard (UK-WDP-S01), which details the standards that apply to all operations planned and conducted by AGR. These are the minimum standards to be applied to all wells within AGR unless standards stipulated by local legislation are more onerous. All well operations are planned and performed in compliance with applicable legislation, regulations and industry guidelines.

All wells are designed, constructed and operated to maintain well life cycle integrity and to ensure prevention of major accidents in line with the AGR Corporate Major Accident Prevention Policy (CMAPP, UK-HSEQ-S01).

Safety and Environmentally Critical Elements (SECE) can be defined as installation and well equipment and systems (including software) whose purpose is to prevent, limit or control the effects of a major accident or environmental event, or whose failure could cause or increase the risk of a major accident or environmental event.

Within respect to well construction, AGR has identified the following SECE within its control and measures to assure its fitness for purpose:

- Drilling Fluids;
- Casing;
- Cement Fluids;
- Wellheads;
- Blow Out Preventer and drill-string internal BOP;

- Rig Selection and Intake;
- Manage Shallow Gas Potential;
- Weather and sea state conditions; and
- Well Suspension or Abandonment.

Additional detail regarding the WDP will be provided in the WOMP.

During the activity, AGR will identify any new or increased environmental impacts and risks (that are not addressed in this EP) and communicate these to the EOG Project as soon as they are identified as part of the MoC (see Section 9.8) and risk management processes.

There are daily meetings, daily drilling reports (DDRs), weekly meetings and weekly reports between the AGR and EOG management teams that keep all management personnel appraised of project issues (technical or HSE) as they arise.

9.4. Training and Awareness

9.4.1. Recruitment and Training

EOG contractor competency

Contractor management is detailed in the EOG Australian Projects HSE Management Plan. During its contractor selection process, EOG will conduct an HSE qualification to ensure that the MODU and support vessel contractors have procedures in place to ensure the correct selection, placement, training and ongoing assessment of employees (or this may be delegated to AGR using their contractor competency assessment process).

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.

AGR personnel competency

AGR's Wells Competency Management System (AP-WDP-M16) describes how it manages the competence of individuals and teams to carry on their work and associated risks. This includes staff, consultants, associates and third-party suppliers.

Importantly, this system specifies the roles and responsibilities and qualifications and training requirements for safety and environmentally critical positions (SECP) including the DSV, HSE Manager, Principal Engineer, Senior Completions Engineer and so forth. Position-specific competence matrices are available for these roles and are used to guide and record assessments of skills.

AGR's Operations Supervision Manual (AP-WDP-M13) provides detailed guidance for all AGR Well Management Supervisors (i.e., DSVs) to ensure that drilling is undertaken in accordance with AGR standards and policies. It specifies that people in the role of DSV have a Subsea Supervisor International Well Control Certificate, offshore survival training, industry safety training, oil spill training and offshore medical training at a minimum. This manual provides the minimum standards required to ensure well control is maintained, and provides specifications for optimising drilling parameters, adequate bulk and drilling fluids, coring operations, casing/wellhead operations, cementing, formation strength tests, wireline logging, well testing and completions, and well abandonment.

9.4.2. 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 operational area and spill EMBA;
- Overview of the key control measures to be implemented;
- 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.

EOG will prepare the induction and the AGR DSV 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 MODU and support vessel contractors will conduct their own company and vessel-specific inductions independently of the activity-specific HSE induction.

9.4.3. Oil Spill Response Training

Quarterly training of MODU and support vessel crews in SMPEP procedures is a MARPOL requirement for vessels over 400 GRT (Annex 1, Regulation 37).

During its contractor audit process, EOG will assess the vessel contractor's implementation of their SMPEPs (or equivalent, relevant to class).

An office-based desktop spill response exercise of the Beehive-1 OPEP and bridging ERP will be conducted, involving key personnel from EOG, AGR, MODU and specialist third-party contractor personnel prior to or at the start of the activity.

9.4.4. 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., crane lifts).

Environmental issues will also be addressed in daily operations meetings and weekly HSE meetings, where department leads will participate with the AGR DSV 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 in respective company data servers.

9.4.5. Communications

The OIM, AGR DSV and AGR HSE Coordinator are jointly 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 9.2 outlines the key meetings proposed to take place onshore and offshore during the activity.

Table 9.2. Activity communication meetings

Meeting	Frequency	Attendees
Onshore		
EOG Project Management	Daily	EOG Australia Operations Manager, AGR Project Manager, AGR Drilling Superintendent, AGR DSV, AGR HSEQ Manager, AGR HSE Coordinator, vessel masters (if necessary)
Offshore		
Operations	Daily	OIM, Department heads, AGR DSV, AGR HSE Coordinator, vessel masters (if necessary)
Pre-start safety meeting	Daily, prior to each shift	All personnel on shift
Toolbox	Before each task	All personnel involved in the task
HSE	Weekly	All personnel
TOFS	As required, based on safety issues	All personnel

9.5. Environmental Emergencies and Preparedness

In the event of an emergency of any type, the MODU OIM (for the MODU) and Masters (for the support vessels) will assume overall onsite command and act as the ERT Leader. All personnel aboard the MODU and vessels will be required to act under the ERT Leader's directions.

The AGR DSV will maintain communications with the AGR Drilling Superintendent, who will become the overall DIMT Leader and activate the DIMT. The DIMT Leader will communicate with the EOG Australia Operations Manager who will implement the EOG Crisis Management Plan (CMP) if required, with support from the AGR DIMT as required.

9.5.1. Adverse Weather Protocols

It is the duty of the MODU OIM and the support vessel masters to act as 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 MODU OIM and support vessel masters are responsible for the following:

- Ensuring the safety of all personnel onboard;
- Monitoring all available weather forecasts and predictions;
- Initiating the safety management systems, HSE procedures and/or ERPs;

- Keeping the AGR DSV fully informed of the prevailing situation and intended actions 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 MODU and support 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 operational area in the lead up to and for the duration of the activity.

9.5.2. Vessel Emergencies and Oil Spills

Activity-specific oil spill related emergency response procedures are included in the Beehive-1 OPEP, Bridging ERP, RWP and MODU and support vessel SMPEPs. The Beehive-1 Bridging ERP contains instructions for the MODU and support vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification and emergency contact information that is specific to Beehive-1.

Vessel-specific SMPEPs 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 MODU and support vessel crews in the event of a marine oil spill. 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 Beehive-1 OPEP will be implemented in the event of a Level 2 or Level 3 hydrocarbon spill that requires response resources beyond those immediately available to the MODU and support vessels. Oil spill emergency response for this activity is detailed in the Beehive-1 OPEP.

9.5.3. Emergency Response Training

The readiness and competency of EOG, AGR, the MODU and support vessel contractors to respond to incidents and emergencies will be tested by conducting a desktop emergency response exercise as close immediately prior to or soon after the activity commences.

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 DIMT and ERT 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, MODU and support vessel contractors); 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.

MODU-specific training

The MODU OIM is responsible for ensuring that personnel fulfilling emergency response roles are competent in crisis and emergency procedures related to the protection of HSE and integrity. The level of training and associated competency demonstration is dependent on individual roles in a crisis or emergency situation in accordance with the MODU's personnel training and qualifications matrix. This includes identification and development of approved competency and non-competency-based courses, and ensuring training is undertaken to schedule and records are maintained.

9.6. 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 20 km from the Blacktip unmanned wellhead platform and 12 km from the Blacktip gas export pipeline at its closest point, operated by Eni Australia. At this distance, it is not expected that SIMOPs will be an issue. EOG will remain in contact with Eni Australia so that SIMOPs issues can be addressed if and as required.

9.7. Incident Management

9.7.1. 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 Aventus and submitted by EOG to NOPSEMA by the 15th of each month. These are reported using the NOPSEMA template *Monthly environmental incident reports* (N-03000-FM0928). Table 9.3 summarises the recordable incident reporting requirements.

Table 9.3. 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

9.7.2. 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 Chapters 7 & 8) as having an inherent or residual impact consequence of 'moderate' or greater. Impacts and risks with these ratings are:

- Introduction of IMS;
- MDO spill; and
- LoWC.

Table 9.4 presents the reportable incident reporting requirements.

Table 9.4. 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
	Level 2 or 3 vessel spills that threaten WA or NT waters	• WA – (08) 9480 9924 • NT – 1800 064 567

Timing	Requirements	Contact
	For Level 2 or 3 hydrocarbon spills in Commonwealth waters.	As above, plus: • AMSA – 1800 641 792
	Oiled wildlife	• WA – (08) 9219 9108 • WA DBCA marine emergencies – (08) 9474 9055 • 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 fauna (e.g., vessel collision)	• 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

9.7.3. Incident Investigation

Any non-compliance with the EPS outlined in this EP will be investigated by EOG 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 MODU, support vessel and onshore project personnel for review. Tracking the recommendations and close-out actions arising from incident investigations will be managed via either the MODU, support vessel, AGR or EOG management systems, depending on the location and nature of the incident.

Investigation outcomes will be communicated to the project team via daily operations meetings and to the MODU and support vessel crew during daily toolbox meetings and at weekly HSE meetings.

9.7.4. Routine Recording and Reporting

Routine reporting of HSE matters will be provided via the meetings listed in Table 9.2. The DDR will report on HSE matters, including environmental issues, incidents and near-misses.

9.8. Management of Change

9.8.1. EOG

EOG's Australian Projects HSE Management Plan outlines 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 (see Section 9.9.3).

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 will 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 in the MoC register.

9.8.2. AGR

AGR undertakes MoC under their WDP, known as 'Management of Risk and Control of Change'. This change management process applies to all changes and deviations for well-related activities after the approval of the Beehive-1 Well Basis of Design (BOD) document, until the well is handed over to the EOG. This includes planning and operations including drilling, well interventions or workovers, or any other work designed and executed by AGR.

Deviations from the BOD may become necessary due to uncertainties in the subsurface environment or problems encountered during the course of operations. It is the purpose of the MoC procedures to provide a tool that facilitates agreement of change with EOG. This is achieved by determining and agreeing the value and impact of a change and subsequently documenting the approval process accepting the change. Changes in functionality or well integrity are also documented in an auditable format.

Changes are classified as minor, significant or major and are described below.

Minor Change

A minor change is a change to an approved plan, work program (or a procedure referenced in it) that has no safety, environmental or well integrity implication, adds less than $100,000 to the cost of the operation and has no impact on the operation's objectives (e.g., an additional wiper trip).

Minor changes to the project will be discussed and agreed at the daily operations meeting. All project changes will be confirmed by email from the AGR Drilling Superintendent, or designate, to the AGR DSV.

When operations are being conducted, the AGR Drilling Superintendent must provide approval. All minor changes must be confirmed via email and approved by the AGR Drilling Superintendent.

Significant Change

A significant change is defined as a change to an approved plan or work program that does not impact the operation's objectives but could have a direct safety, environmental or well integrity implication (i.e., increase in risk profile above that of the originally planned program) and/or increase the cost of the operation by more than $100,000 but less than $250,000.

Significant changes to the plan or program, or significant operations not included in the programme, will be discussed, risk assessed and agreed by the onshore and offshore teams and confirmed in writing with an approved Program Supplement/Amendment. This will be issued prior to commencing the change in programme. The AGR Drilling Superintendent will discuss the proposed change with the EOG Australian Operations Manager and the MODU OIM. The Supplement/ Amendment is developed by the Project Well Engineer and approved by the AGR Drilling Superintendent, or his delegate and the EOG Australia Operations Manager.

All changes are assessed to ensure any new impacts or risks, or significant change in risk level, are identified and whether or not the change influences environmental aspects of the project or an EP revision is triggered.

Major Change

A major deviation from plan is one that results in a deviation from the well program, and has a direct safety, environmental or well integrity implication (i.e., an increase in risk profile above that of the originally planned program), an EP revision being triggered, the design of the well changing and/or will result in the well Authority for Expenditure (AFE) being exceeded.

Changes affecting the Final Well Status require an approved Program Supplement/Amendment to be issued. The AGR Drilling Superintendent will discuss the proposed change with the EOG Australia Operations Manager and the MODU OIM. The Supplement/Amendment is developed by the Project Well Engineer and approved by the EOG Australia Operations Manager and the AGR Drilling Superintendent, or his delegate.

Exceptionally, if conditions demand an immediate response to safeguard the well or the MODU, then the AGR DSV is authorised to implement any necessary changes to the Program with the agreement of the MODU OIM. Contact with the AGR Drilling Superintendent or his delegate should be made as soon as reasonably practicable. A Programme Supplement should be prepared the next working day.

9.9. 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 (and AGR and Aventus) for a minimum of five years. These records will be made available to NOPSEMA in electronic or printed form upon request.

9.10. Assurance, Reporting and Review

9.10.1. 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 MODU and support vessel contractors are responsible for collecting this data and reporting it to the AGR DSV. This is facilitated by completing a daily environmental monitoring register that will be provided by EOG to the contractors, which captures the commitments made in Table 9.5 below.

Table 9.5. Summary of environmental monitoring requirements

Aspect	Monitoring parameter	Frequency	Record
Impacts			
Underwater sound	Megafauna observations	During VSP	Megafauna observation register
Atmospheric emissions	Fuel consumption	Tallied at end of activity from DDRs	DDRs
Drill cuttings and muds	Chemicals used in the mud system	Daily	DDR Daily mud report
	Volume of muds discharged overboard		
	Observations of the separation treatment system.	Continuous during activity	DDR Daily mud report
Cement	Real-time ROV observations	During conductor cementing operations	DDR
	Chemical additive use	As required	Daily cement report
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
Dropped objects	Type, location, quantity.	Each event	Incident report DDR

Aspect	Monitoring parameter	Frequency	Record
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 while in operational area	Incident report DDR
Hydrocarbon or chemical spill	Volume, type	Each event	Incident report DDR
MDO spill	Operational monitoring in line with the OPEP and scientific monitoring in line with the OSMP (depending on spill volume)	As required	Incident reports
LoWC	BOP function testing	Every 7 days	BOP testing reports
	BOP pressure testing	Every 21 days	
	Well casing pressure testing	After installation	Well casing pressure test reports

9.10.2. Routine Reporting and Notifications

Regulation 11A of the OPGGS(E) specifies 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 9.6 outlines the routine reporting obligations that EOG will undertake with external organisations.

Table 9.6. External routine reporting obligations

Requirement	Timing	Contact details	OPGGS(E) regulation
Pre-activity			
Notify the DoD of the activity commencement date.	5 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.	3 weeks prior to activity starting.	datacentre@hydro.gov.au	11A
Notify all other stakeholders in the stakeholder register with the activity commencement date.	2 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

Requirement	Timing	Contact details	OPGGS(E) regulation
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
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

9.10.3. Environment Plan Review

EOG 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 impacts and/or spill EMBA to determine whether there are newly-listed threatened species or ecological communities in the EMBAs.
  - 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.

The EOG Australia Operations Manager will seek advice 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 EOG 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 9.7.

Table 9.7. 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 Chapters 7 or 8.
- **Increased** impact or risk – one with greater extent, severity, duration or uncertainty than is detailed in Chapters 7 or 8.
- **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 Chapters 7 and 8.
  - The change affects the ability to achieve the EPO and EPS contained in Chapters 7 and 8.

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 Chapters 7 and 8; 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 9.7.

Minor revisions to the EP will not be submitted to NOPSEMA for assessment.

9.10.4. 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 to the AGR DSV and support vessel management 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 Australia Operations Manager in writing and at appropriate meetings.

Table 9.8. 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	During drilling	Once	In person on board the MODU	A suitably experienced auditor will assess compliance against each EPS through interviews, observations and review of databases and records.
Ongoing inspections	During activity	Weekly	In person on board	Checklists to be completed by the AGR HSE Coordinator.

9.10.5. Regulatory Inspections

Under Part 5 of the OPGGS Act, NOPSEMA inspectors have the authority to enter EOG premises, including the MODU, to undertake monitoring or investigation against this EP.

EOG will cooperate fully with the regulator during such investigations.

9.10.6. 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 Chapters 7 and 8. The information in the report will be based on the information collected during routine communications, inspections and audits, as outlined in this chapter.

9.10.7. Monitoring and Review

The MODU and support vessel contractors will have specific contractual compliance obligations associated with implementing the EP and other project plans. AGR, on behalf of EOG, will monitor the contractors 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 (if any) of the Beehive project.

9.11. Summary of Implementation Strategy Commitments

Table 9.9 summarises the commitments provided throughout the Implementation Strategy by assigning EPO, EPS and measurement criteria to each commitment.

Table 9.9. Summary of EP implementation strategy commitments

Section	EPO	EPS	Measurement criteria
9.4.1	Project personnel are trained and competent to fulfil their duties.	The Australian Projects HSE Management 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.
9.4.2	Project personnel are familiar with their HSE responsibilities.	All personnel working on the MODU and support vessels are inducted into the activity-specific HSE requirements.	Vessel crews and visitor lists, along with induction familiarisation checklists are readily available, verifying that all personnel working on and visiting the MODU and support vessels are inducted.
9.4.2, 9.4.3 & 9.4.6	Project personnel are familiar with operations HSE issues.	Regular HSE communications take place between offshore and office-based personnel.	HSE meeting records are available and verify regularity of communications.
9.5.2	Emergency response responsibilities are clearly defined.	The Australian Projects HSE Management Plan, OPEP, RWP and Bridging ERP outline emergency responsibilities for project personnel.	The emergency responsibilities are communicated to project personnel prior to the activity commencing.
9.5.2	Offshore and onshore project personnel are familiar with their emergency response responsibilities.	All relevant MODU-, vessel- and office-based personnel participate in emergency response (e.g., ERP and OPEP) training, drills and exercises.	Training records verify that emergency response exercises were undertaken.
9.7.1 & 9.7.2	Incident reports are issued to the regulators as required.	Recordable incidents reports are issued monthly to NOPSEMA as per Table 9.4.	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 9.5.	
9.7.3	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.
9.8	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 processes.	MoC records are available in the MoC register.

Section	EPO	EPS	Measurement criteria
9.9	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, AGR and Aventus.	EP documents are readily accessible.
9.10.1	Emissions and discharges are recorded.	Emissions and discharges from the MODU and support vessels, in line with Table 9.5, are recorded.	Monitoring records are available and align with the requirements in Table 9.5.
9.10.2	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 9.6.	Notification records verify issue.
9.10.3	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.
9.10.3	This EP is reviewed and updated on an as-required basis.	This EP is reviewed and updated based on the triggers presented in Section 9.10.3 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 are required, the EP is updated and re-issued to the regulators.	A record of EP revision is included in the document control page of this EP.
			Correspondence is available to verify the re-issue of the EP to NOPSEMA.
9.10.4	EP compliance inspections and audits are undertaken for the activity.	EP compliance is assessed during the activity by competent personnel.	Environmental inspection reports, completed checklists and audit report are available and verify compliance with this EP.
9.10.6	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.
9.10.7	An EP commitments register is established.	EP commitments register is in place and used throughout the campaign to track compliance with EPS.	EP commitments register verifies it is in use.

10. References

ABC. 2000. Kiwi shellfish smother Australian seabeds. A WWW article accessed at httcp://www.abc.net.au/science/articles/2000/11/06/207775.htm. ABC Science.

ABC News. 2014. 'Clean-up underway after tar balls wash up on Ninety Mile Beach.' ABC News Online. Article posted 18 March 2014. Australian Broadcasting Corporation.

ABS. 2020. 2016 Census Quick Stats. A WWW database accessed at https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/036. Australian Bureau of Statistics. Canberra.

AFMA. 2021. Prawns. Australian Fisheries Management Authority. Available from: https://www.afma.gov.au/fisheries-management/species/prawns.

Allen, G.R. 1982. A Field Guide to Inland Fishes of Western Australia. Perth, Western Australia: University of Western Australia Press.

AMOSC. 2019. Northern Territory Oiled Wildlife Response Plan, version 2.0, February 2019. Australian Marine Oil Spill Centre.

AMSA. 2019. Australian Government Coordination Arrangements for Maritime Environmental Emergencies. Australian Maritime Safety Authority. Canberra.

AMSA. 2015. Technical guidelines for preparing contingency plans or marine and coastal facilities. Australian Maritime Safety Authority. Canberra.

AMSA. 1998. The Effects of Maritime Oil Spills on Wildlife Including Non-Avian Marine Life. Australian Maritime Safety Authority. Canberra.

ANZECC/ARMCANZ. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 4. Prepared by the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand.

Apache Energy. 2008. Van Gogh Oil Field Development Draft Public Environment Report. Prepared by Apache Energy Ltd. Perth.

API. 2001. Effects of Oil and Chemically Dispersed Oil in the Environment. API Publication Number 4693. May 2001. Prepared under contract by Boyd, J.N., Kucklick, J.H., Scholz, D.K., Walker, A.H. Pond, R.G. and Bostrom, A. American Petroleum Institute.

APPEA. 2008. Code of Environmental Practice. Australian Petroleum Production and Exploration Association.

APPEA. 2004. Seismic and the Marine Environment. Australian Petroleum Production and Exploration Association. Canberra.

AQIS. 2011. Australian Ballast Water Management Requirements. Version 5. Australian Quarantine Inspection Service, Department of Agriculture, Fisheries and Forestry. Canberra.

Au, W., Popper, A. and Ray, A. 2000. Hearing by Whales and Dolphins. Springer New York.

Baker, C., Potter, A., Tran, M. & Heap, A.D. 2008. Geomorphology and Sedimentology of the Northwest Marine Region of Australia. Geoscience Australia, Record 2008/07. Geoscience Australia, Canberra. 220 pp.

Bannister, J., Kemper, C. and Warnecke R. 1996. The Action Plan for Australian Cetaceans. The Director of National Parks and Wildlife Biodiversity Group. Environment Australia. Canberra.

Barkaszi, M.J., M. Butler, R. Compton, A. Unietis, and B. Bennet. 2012. Seismic survey mitigation measures and marine mammal observer reports. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-015.

Barrett, N., Buxton, C. and Edgar, G. 2009. Changes in invertebrate and macroalgal populations in Tasmanian marine reserves in the decade following protection. *Journal of Experimental Marine Biology and Ecology* (370): 104–119.

Barry, S. B., Cucknell, A. C. and Clark, N. 2012. 'A direct comparison of bottlenose dolphin and common dolphin behaviour during seismic surveys when air guns are and air not being utilised.' In: The effects of noise on aquatic life. Edited by A. N. Popper and A. Hawkins.

Bartol, S.M. and Ketten, D.R. 2006. Turtle and tuna hearing. In: Swimmer, Y. and Brill, R (eds). December 2006. NOAA Technical Memorandum NMFS-PIFSC-7. 98-103.

Bartol, S.M., Musick, J.A. and Lenhardt, M.L. 1999. Auditory evoked potentials of the loggerhead sea turtle (Caretta caretta). Copeia: 836-840.

Berry, P.F. 1986. Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, Northwestern Australia. Records of the Western Australian Museum. No 25: 27–35. Western Australian Museum, Perth.

Bik, H., Halanych, K., Sharma, J. and Thomas, W. 2012. Dramatic shifts in benthic microbial eukaryote communities following the Deepwater Horizon oil spill*. PLOS One* 7(6): e38550.

Black, K., Brand, G., Grynberg, H., Gwyther, D., Hammond, L., Mourtikas, S., Richardson, B. and Wardrop, J. 1994. Production facilities. In Environmental implications of offshore oil and gas development in Australia – the findings of an independent scientific review. Edited by J.M. Swan, J.M. Neff and P.C. Young. Australian Petroleum Exploration Association. Sydney.

Blackwell, S.B., C.S. Nations, T.L. McDonald, A.M. Thode, D. Mathias, K.H. Kim, C.R. Greene, Jr., and A.M. Macrander. 2015. Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds. PLoS ONE 10(6): e0125720. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0125720.

Blumer, M. 1971. Scientific aspects of the oil spill problem. *Environmental Affairs* (1):54–73.

BoM. 2022. Tropical Cyclone Climatology. Available at: http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/climatology. Accessed 19 January 2022.

BoM. 2021a.Climatology of Tropical Cyclones in Western Australia. Bureau of Meteorology. Available from: http://www.bom.gov.au/cyclone/climatology/wa.shtml.

BoM. 2021b. Climate statistics for Australian locations – Monthly climate statistics. Available from: http://www.bom.gov.au/climate/averages/tables/cw_014948.shtml

BP. 2015. Gulf of Mexico Environmental Recovery and Restoration. Five year Report. March 2015. BP Exploration and Production Inc. London.

BP. 2014. Abundance and Safety of Gulf Seafood. Seafood Background White Paper. BP Exploration and Production Inc. London.

BP. 2014b. Dispersant White Paper. BP. London. A WWW document accessed at https://www.thestateofthegulf.com/media/1366/dispersant-background-paper-9314.pdf. BP. London.

BP. 2013. BP Response to 60 Minutes Australia re: "Crude Solution". 9 September 2013. A WWW document accessed at: https://www.thestateofthegulf.com/the-whole-story/for-the-record/bp-response-to-60-minutes-australia-re-crude-solution/. BP. London.

Brewer, D., Lyne, V., Skewes, T. and Rothlisberg, P. 2007. Trophic Systems of the North West Marine Region. Prepared for the Department of the Environment, Water, Heritage and the Arts by CSIRO Marine and Atmospheric Research, Cleveland, Queensland.

Brusati, E. and Grosholz, E. 2007. Effect of native and invasive cordgrass on *Macoma petalum* density, growth and isotopic signatures. *Estuarine Coastal and Shelf Science* (71): 517–522.

Burger, A. 1993. Estimating the mortality of seabirds following oil spills: effects of spill volume. *Mar. Poll. Bull*. (26):140–143.

Carls, M., Holland. L., Larsen, M., Collier, T., Scholz, N. and Incardona, J. 2008. Fish embryos are damaged by dissolved PAHs, not oil particles. *Aquatic Toxicology* (88):121–127.

Carroll, A., Przeslawski, R., Duncan, A., Gunning, M. and Bruce, B. 2017. A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. *Mar. Poll. Bull*. 114 9-24.

Castellote, M., Clark, C.W. and Lammers, M.O. 2012. Acoustic and behavioural changes by fin whales (*Balaenaptera physalus*) in response to shipping and airgun noise. Bio. Cons. 147: 115-122.

Castro, J.I., Woodley, C.M. and Brudek, R.L., 1999. A preliminary evaluation of the status of shark species. FAO Fisheries Technical Paper 380. FAO, Rome.

Cato, D.H., Noad, M.J., Dunlop, R.A., McCauley, R.D., Gales, N.J., Kent, C.P.S., Kniest, H., Paton, D., Jenner, K.C.S. 2013. A study of the behavioural response of whales to the noise of seismic air guns: Design, methods and progress. Acoustics Australia 41(1): 88-97.

Cerchio, S., Yamada, T.K. and Brownell, R.L. 2019. Global distribution of Omura's whales (*Balaenoptera omurai*) and assessment of range-wide threats. *Front. Mar. Sci*. 6:67.

Challenger, G. and Mauseth, G. 2011. Chapter 32 – Seafood safety and oil spills. In Oil Spill Science and Technology. Edited by M. Fingas.

Chevron Australia. 2010. Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project. Chevron Australia Pty Ltd, Perth, Western Australia, July 2010.

Cholewiak, D., Clark, C., Ponirakis, D., Frankel, A., Hatch, L., Risch, D. 2018. Communicating amidst the noise: modelling the aggregate influence of ambient and vessel noise on baleen whale communication space in a national marine sanctuary. *Endanger. Species Res*. 36, 59–75

Christian, J.R., Mathieu, A., Buchanan, R.A., 2004. Chronic Effects of Seismic Energy on Snow Crab (*Chionoecetes opilio*). Environmental Funds Project No. 158. Fisheries and Oceans Canada. Calgary.

Christian, J.R., Mathieu, A., Thomson, D.H., White, D., Buchanan, R.A. 2003. Effect of seismic energy on snow crab (*Chionoecetes opilio*). Environmental Research Funds Report No 144. Calgary.

Cintron, G., Lugo, A., Marinez, R., Cintron, B., Encarnacion, L. 1981. Impact of oil in the tropical marine environment. Prepared by Division of Marine Research, Department of Natural Resources. Puerto Rico.

Clark, R.B. 1984. Impact of oil pollution on seabirds. *Environmental Pollution* 33: 1–22.

CoA. 2006. A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Commonwealth of Australia. Department of the Environment and Heritage. Canberra.

Committee on Oil in the Sea. 2003. Oil in the Sea III: Inputs, Fates and Effects. Washington, D.C. The National Academies Press.

Compagno, L.J.V., 1984. FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. FAO Fisheries Synopsis No. 125, Volume 4, Part 1.

Condie, S., Andrewartha, J., Mansbridge, J. and Waring, J. 2006. Modelling circulation and connectivity on Australia's North West Shelf. North West Shelf Joint Environmental Management Study: Technical Report No. 6. CSIRO Marine and Atmospheric Research, Hobart, Tasmania.

Connell, D., Miller, G. and Farrington, J. 1981. Petroleum hydrocarbons in aquatic ecosystems—behaviour and effects of sublethal concentrations: Part 2. *Critical Reviews in Environmental Science and Technology*. 11(2): 105-162.

Cox, B., Dux, A., Quist, M. and Guy, C. 2012. Use of a Seismic Air Gun to Reduce Survival of Nonnative Lake Trout Embryos: A Tool for Conservation? North American Journal of Fisheries Management (32):2, 292–298.

CSIRO. 2022. Ocean currents Diagrams. Available at: https://research.csiro.au/ncmi-idc/information/ocean-circulation/ocean-current-diagrams. Accessed 19 January 2022.

Cunningham, K., and Mountain, D. 2014. Simulated masking of right whalesounds by shipping noise: incorporating a model of the auditory periphery. *J. Acoust. Soc. Am*. 135, 1632–1640

Currie, D.R. and Isaacs, L.R. 2005. Impact of exploratory offshore drilling on benthic communities in the Minerva gas field, Port Campbell, Australia. Mar. Env. Res. (59) 217-233.

Curtin University. 2010. Report on Necropsies from a Timor Sea Horned Sea Snake. Curtin University, Perth.

Curtin University. 2009. Report on Biopsy Collections from Specimens Collected from the Surrounds of the West Atlas Oil Leak – Sea Snake Specimen. Curtin University, Perth.

D'Anastasi, B., Simpfendorfer, C. & Van Herwerden, L. 2013. *Anoxypristis cuspidata*. The IUCN Red List of Threatened Species 2013.

DAFF. 2021. Marine Pests Interactive Map. A WWW database accessed at http://www.marinepests.gov.au/Pages/ marinepest-map.aspx. Department of Agriculture, Fisheries and Forestry. Canberra.

DAFF. 2009. The National Biofouling Management Guidance for the Petroleum Production and Exploration Industry. Department of Agriculture, Fisheries and Forestry. Canberra.

DAWE. 2022a. EPBC Act Protected Matters Search Tool. A WWW database accessed at http://www.environment.gov.au/epbc/pmst/. Department of Agriculture, Water and the Environment. Canberra.

DAWE, 2022b. Directory of Important Wetlands in Australia - Information sheets. Accessed on 30 March 2022 via https://www.awe.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands

DAWE. 2020a. The Australian Ballast Water Management Requirements (v8). Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021a. EPBC Act Protected Matters Search Tool. A WWW database accessed at http://www.environment.gov.au/epbc/pmst/. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021b. Species Profile and Threats (SPRAT) Database. A WWW database accessed at http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021c. National Conservation Values Atlas. A WWW database accessed at https://www.environment.gov.au/topics/marine/marine-bioregional-plans/conservation-values-atlas. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021d. Australia's World Heritage List. A WWW database accessed at http://www.environment.gov.au/heritage/places/world-heritage-list. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021e. Australia's National Heritage List. A WWW database accessed at http://www.environment.gov.au/heritage/places/national-heritage-list. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021f. Directory of Important Wetlands in Australia. A WWW database accessed at https://www.environment.gov.au/water/wetlands/australian-wetlandsdatabase/directory-important-wetlands. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021g. Australia's Commonwealth Heritage List. A WWW database accessed at http://www.environment.gov.au/topics/heritage/heritage-places/ commonwealth-heritage-list. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2021h. Directory of Important Wetlands in Australia. A WWW database accessed at https://www.environment.gov.au/water/wetlands/australian-wetlandsdatabase/directory-important-wetlands. Department of Agriculture, Water and the Environment. Canberra.

DAWR. 2020. Australian Ballast Water Management Requirements. Department of Agriculture and Water Resources. Canberra.

DAWR. 2018. National Strategic Plan for Marine Pests in Australia. Department of Agriculture and Water Resources. Canberra.

Day, R., Fitzgibbon, Q., McCauley, R. and Semmens, J. 2021. Examining the potential impacts of seismic surveys on Octopus and larval stages of Southern Rock Lobster - PART A: Southern Rock Lobster. The Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania. FRDC project 2019-051. 2021.

Day, R., Fitzgibbon, Q., McCauley, R., Hartmann, K. and Semmens, J. 2020. Lobsters with pre-existing damage to their mechanosensory statocyst organs do not incur further damage from exposure to seismic air gun signals. Environmental Pollution (267).

Day, R., McCauley, R., Fitzgibbon, Q., Hartmann, K. and Semmens, J. 2019. Seismic air guns damage rock lobster mechanosensory organs and impair righting reflex. Proc. R. Soc. B 286 (1907).

Day, R., McCauley, R., Fitzgibbon, Q., Hartmann, K. and Semmens, J. 2017. Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop *Pecten fumatus*. Proceedings of the National Academy of Sciences Oct 2017, 114 (40) E8537-E8546.

Day, R., McCauley, R., Fitzgibbon, Q. and Semmens, J. 2016a. Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries. FRDC Report 2012/008. University of Tasmania. Hobart.

Day, R., McCauley, R., Fitzgibbon, Q. and Semmens, J. 2016b. Seismic air gun exposure during early stage embryonic development does not negatively affect spiny lobster *Jasus edwardii* larvae (Decapoda:Palinuridae), Scientific Reports 6, Article Number: 22733.

DEH. 2005. PB23 – Christmas Island Province. 2005 National Marine Bioregionalisation of Australia. Department of the Environment and Heritage. Hobart, TAS.

DEWHA. 2008a. EPBC Act Policy Statement 2.1-Interaction between offshore seismic exploration and whales, Department of Environment, Water, Heritage & the Arts, Canberra.

DEWHA. 2008b. The Northwest Marine Bioregional Plan Bioregional Profile: A description of the ecosystem, conservation values and uses of the Northwest Marine Region. Department of Environment, Water, Heritage and the Arts. Canberra.`

DEWHA. 2008c. The North Marine Bioregional Plan Bioregional Profile: A description of the ecosystem, conservation values and uses of the North Marine Region. Department of Environment, Water, Heritage and the Arts. Canberra.

DEWHA. 2007. Characterisation of the marine environment of the north marine region: outcomes of an expert workshop convened in Darwin, Northern Territory, 2-3 April 2007. Department of Environment, Water, Heritage and the Arts. Canberra http://www.environment.gov.au/resource/characterisation-marine-environment-north-marine-region-outcomes-expert-workshop-2-3-april

Di Lorio, L. and Clark. W. 2010. Exposure to seismic survey alters blue whale acoustic communication. Biology Letters 6(1): 51-54.

DNP. 2018a. North Marine Parks Network Management Plan 2018. Director of National Parks. Canberra.

DNP. 2018b. Northwest Marine Parks Network Management Plan 2018. Director of National Parks. Canberra.

Department of Natural Resources, Environment, the Arts and Sport. 2009. Sites of Conservation Significance: the Tiwi Islands. Northern Territory Government. Accessed on 10 February 2022 via: https://nt.gov.au/environment/environment-data-maps/important-biodiversity-conservation-sites/conservation-significance-list

DNP. 2014. Christmas Island National Park Management Plan 2014 - 2024, Director of National Parks. Canberra, ACT.x

DoA and DoE. 2015. Anti-fouling and in-water cleaning guidelines. Department of Agricultre and Department of the Environment. Canberra.

DoD. 2021. Where is Unexploded Ordnance – Interactive Map. A WWW database accessed in May 2021 at https://www.whereisuxo.org.au. Department of Defence. Canberra.

DoE. 2013. EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance. Department of Environment. Canberra.

DoE. 2015a. Conservation Management Plan for the Blue Whale. A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999. Department of the Environment. Canberra.

DoE. 2015b. Conservation Advice *Numenius madagascariensis* eastern curlew. Department of the Environment. Canberra.

DoE. 2015c. Sawfish and River Sharks – Multispecies Recovery Plan. Department of the Environment. Canberra.

DoEE. 2020. National Light Pollution Guidelines for Wildlife. Department of Energy and the Environment.

DoEE. 2019a. SPRAT Profile http://www.environment.gov.au/cgi-bin/sprat/public/sprat.

DoEE. 2019b. Draft Conservation Plan for Seabirds. Department of Energy and the Environment. Canberra.

DoEE. 2018. Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans 2018. Department of the Environment and Energy. Canberra.

DoEE. 2017a. National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna. Department of the Environment and Energy. Canberra.

DoEE. 2017b. Australian National Guidelines for Whale and Dolphin Watching. Department of the Environment and Energy. Canberra.

DoEE. 2017c. Recovery Plan for Marine Turtles in Australia. Department of the Environment and Energy. Canberra.

DoEE. 2017d. EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species. Department of Energy and the Environment. Canberra.

DoEH. 2005. Ten seabird species issues paper – Part B; Conservation issues for specific species/ groups (continued). Department of the Environment and Heritage. Canberra.

DoF. 2013. Guidance Statement on Undertaking Seismic Surveys in Western Australian Waters. Fisheries Occasional Publication No. 112, 2013. Government of Western Australia. Department of Fisheries.

Done, T.J., Williams, D. McB., Speare, P., Turak, E., Davidson, J., DeVantier, L.M., Newman, S.J., and Hutchins, J.B. 1994. Surveys of Coral and Fish Communities at Scott Reef and Rowley Shoals. Australian Institute of Marine Science. Townsville, Australia.

DoT. 2014. Northern Territory Oil Spill Contingency Plan (Version 5.0, May 2014). Department of Transport. Darwin, Northern Territory.

DoT. 2015. Western Australian Oil Spill Contingency Plan (Version 1, January 2015). Department of Transport. Perth, Western Australia.

Double, M., Andrews-Goff, V., Jenner, K., Jenner, M., Laverick, S., Branch, T. & Gales N. 2014. Migratory movements of pygmy blue whales (*Balaenoptera musculus brevicauda*) between Australia and Indonesia as revealed by satellite telemetry. *PLOS one*, 9(4).

DPIR. 2021. Northern Territory Commercial Fisheries. Department of Primary Industry and Resources. Darwin.

DPIR. 2019. Status of key Northern Territory fish stocks report 2017. Fishery report no. 121. Department of Primary Industry and Resources. Darwin.

DPIR. 2018. NT Fisheries. Management Arrangements for the Northern Territory Offshore Net and Line Fishery. Department of Primary Industry and Resources. Darwin.

DPaW. 2013. Lalang-garram/Camden Sound Marine Park Management Plan 73, 2013 – 2023. Department of Parks and Wildlife, Perth.

DPaW. 2016b. Advice received in relation to Clearing Permit Application CPS 7153/1 - Threatened and Priority Flora. September 2016. Department of Parks and Wildlife, Western Australia.

DPW. 2016. North Kimberley Marine Park Joint Management Plan 2016 Uunguu, Balanggarra, Miriuwung Gajerrong, and Wilinggin Management Areas, Number Plan 89. Department of Parks and Wildlife, Perth.

DPW and AMOSC. 2014. Western Australian Oiled Wildlife Response Plan. Department of Parks and Wildlife and Australian Marine Oil Spill Centre. Perth. Western Australia.

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

DSEWPC. 2012a. Marine bioregional plan for the North Marine Region. Department of Sustainability, Environment, Water, Population and Communities. Canberra.

DSEWPC. 2012b. Marine bioregional plan for the North Marine Region. Department of Sustainability, Environment, Water, Population and Communities. Canberra.

DSEWPC. 2011. National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016. Department of Sustainability, Environment, Water, Population and Communities. Australian Antarctic Division. Canberra.

Dunlop, R.A. 2016. The effect of vessel noise on humpback whale, Megaptera novaeangliae, communication behaviour. *Animal Behaviour* (111): 13–21.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Slade, R. Paton, D., and Cato, D.H. 2018. A behavioural dose-response model for migrating humpback whales and seismic air gun noise. *Mar. Poll. Bull*. (133): 506–516.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Slade, R. Paton, D., and Cato, D.H. 2017. The behavioural response of migrating humpback whales to a full seismic air gun array. *Proceedings of the Royal Society B*. (284): 20171901.

Dunlop, R.A., Noad., M.J., McCauley, R.D., Kniest, E., Slade, R., Paton, D. and Cato, D.H. 2016. Response of humpback whales (Megaptera novaeangliae) to ramp-up of a small experimental air gun array. *Mar. Poll. Bull*. 103(1–2): 72-83.

Dunlop, R.A., Noad., M.J., McCauley, R.D., Kniest, E., Slade, R., Paton, D. and Cato, D.H. 2015. The behavioural response of humpback whales (Megaptera novaeangliae) to a 20 cubic inch air gun. *Aquatic Mammals* 41(4): 412.

Engelhardt, F. 1983. Petroleum Effects on Marine Mammals. *Aquatic Toxicology* (4):199–217.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R. 2015. Communication masking in marine mammals: A review and research strategy. *Mar. Poll. Bull*. 103(1-2): 15–38.

ERM. 2011. GDF SUEZ – Marine Baseline Survey and Ecological Assessment. Report prepared for GDF SUEZ LNG. Perth, Western Australia.

European Commission. 2019. Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production. Luxembourg: Publications Office of the European Union.

Falkner, I., Whiteway, T., Przeslawski, R. and Heap, A.D. 2009. Review of ten key ecological features (KEFs) in the North-west Marine Region. Record 2009/13. Geoscience Australia, Canberra.

Felder, D., Thoma, B., Schmidt, W., Sauvage, T., Self-Krayesky, S., Christoserdov, A., Bracken-Grissom, H. and Fredericq, S. 2014. Seaweeds and Decapod Crustaceans on Gulf Deep Banks after the Macondo Oil Spill. *Bioscience* (64): 808–819.

Finneran, J. 2016. Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise. Technical Report.

Fletcher, W., Mumme, M. and Webster F. (eds). 2017. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher, W. and Santoro, K. 2015. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15: The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher, W.J. and Santoro, K. 2009. State of the fisheries report 2008/09. Western Australian Department of Fisheries, Perth.

Fossette, S., Ferreira, L., Whiting, S., King, J., Pendoley, K., Shimada, T., Speirs, M., Tucker, A., Wilson, P. and Thums, M. Movements and distribution of hawksbill turtles in the Eastern Indian Ocean. *Global Ecology and Conservation*. 29. https://doi.org/10.1016/j.gecco.2021.e01713.

French, D. Schuttenberg, H. and Isaji, T. 1999. Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light In: Proceedings of the 22nd Artic and Marine Oil Spill Program (AMOP), Technical Seminar, June 1999. Alberta, Canada.

French-McCay, D. 2002. Development and application of an oil toxicity and exposure model, OilToxEx. *Environmental Toxicology and Chemistry* (21):2080-2094.

French-McCay, D.P. 2003. Development and application of damage assessment modelling: example assessment for the North Cape oil spill. *Mar. Poll. Bull*. 47(9):9–12.

French-McCay, D. 2009. State-of-the-art and research needs for oil spill impact assessment modelling. Proceedings of the 32nd Arctic and Marine Oil Spill Program Technical Seminar. Environment Canada, Ottawa.

Gabriele, C., Ponirakis, D., Clark, C., Womble, J., and Vanselow, P. 2018. Underwater acoustic ecology metrics in an Alaska marine protected area reveal marine mammal communication masking and management alternatives. *Front. Mar. Sci*. 5:270.

Gagnon, M. and Rawson, C. 2011. Montara Well Release, Monitoring Study S4A – Assessment of Effects on Timor Sea Fish. Curtin University, Perth, Australia.

Gala, W. 2001. Predicting the Aquatic Toxicity of Crude Oils. *International Oil Spill Conference Proceedings* (2):935–940.

Galaiduk, R., Huang, Z., Miller, K., Nanson, R., Przeslawski, R. and Nichol, S. 2018. An eco-narrative of Joseph Bonaparte Gulf Marine Park: North marine region. Report to the National Envionmental Science Program, Marine Biodiversity Hub. 21pp.

Garnett, S.T., Szabo, J.K., and Dutson, G. 2011. The Action Plan for Australian Birds 2010. CSIRO Publishing, Collingwood, Australia.

Garnett, S. and Crowley, G. 2000. The action plan for Australian birds 2000, Department of the Environment and Heritage, Canberra, ACT.

Gaughan, D. and Santoro, K. (eds). 2021. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gaughan, D. and Santoro, K. (eds). 2020. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2018/19: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia

Gaughan, D., Molony, B. and Santoro, K. (eds). 2019. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2017/18: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gaughan, D. and Santoro, K. (eds). 2018. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gausland, I. 2000. Impact of seismic surveys on marine life. SPE International Conference on Health, Safety and the Environment in Oil and Gas Exploration and Production. 26-28 June, 2000.

Geoscience Australia. 2022. Bonaparte Basin. Accessed online on 5 April 2022 via https://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/offshore-northwest-australia/bonaparte

Geraci, J. and St. Aubin, D. 1988. Synthesis of Effects of Oil on Marine Mammals. Report to US Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study. Ventura, California.

Gilmour J.P., Travers M.J., Underwood J.N., Markey K.L., Ninio R., Cecarelli D., Hoey A.S., Case M., O'Leary R. and Radford, B. 2012. Long-term monitoring of shallow water coral and fish communities at Scott Reef. Australian Institute of Marine Science (AIMS) report for Woodside Energy Ltd. Browse LNG Development Contract no. 4600001754, 170 pp.

Gippsland Times. 2014. Beach oil spill. Report by Julianne Langshaw, March 17, 2014. Gippsland Times and Maffra Spectator. Victoria.

Godwin, E.M., Noad, M.J., Kniest, E. and Dunlop, R.A. 2016. Comparing multiple sampling platforms for measuring the behavior of humpback whales (*Megaptera novaeangliae*). Marine Mammal Science 32(1): 268-286. http://dx.doi.org/10.1111/mms.12262.

Gohlke, J.M. 2011. A Review of Seafood Safety after the Deepwater Horizon Blowout. *Environmental Health Perspectives* 119(8):1062–1069.

Gomez, C., Lawson, J., Wright, A., Buren, A., Tollit, D. and Lesage, V. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. *Canadian Journal of Zoology* 94(12): 801–819.

Gotz, T., Hastie, G., Hatch, L., Raustein, O, Southall, B., Tasker, M, Thomsen, F. 2009. Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR Commission. London.

Green, B. and Gardner, C. 2009. Surviving a sea-change: survival of southern rock lobster (*Jasus edwardsii*) translocated to a site of fast growth. *ICES Journal of Marine Science* (**66**): 656–664.

Hallegraeff, G.M. and Jeffrey, S.W. 1984. Tropical phytoplankton species and pigments of continental shelf waters of north and north-west Australia. Marine Ecology Progress Series, 20: 59-74.

Hart, A., Murphy, D. and Green, K. 2015. Beche-de-mer Fishery Status Report. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15: The State of the Fisheries, Fletcher, W. J. & Santoro, K. (eds.), Department of Fisheries, Western Australia, pp. 39-48.

Hawkins, A.D. and Popper, A.N. 2016. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science: 17.

Hazel, J., Lawler, I. and Hamann, M., 2009. Diving at the shallow end: Green turtle behaviour in nearshore foraging habitat. Journal of Experimental Marine Biology and Ecology, vol. 371, pp. 84-92.

Heck Jr., K., Hays, G. and Orth, R.J. 2003. Critical evaluation of the nursery role hypothesis for seagrass meadows. *Marine Ecology Progress Series.* 253, 123–136.

Heyward, A., Wakeford, M., Cappo, M., Olsen, Y., Radford, B., Colquhoun, J., Case, M. and Stowar, M. Submerged Shoals 2017 – Final Report. Prepared for Shell/INPEX Applied Research Program. Australian Institute of Marine Science.

Heyward, A., Moore, C., Radford, B. and Colquhoun, J. 2010. Monitoring Program for the Montara Well Release Timor Sea: Final Report on the Nature of Barracouta and Vulcan Shoals. Report prepared by the Australian Institute of Marine Science for PTTEP Australasia (Ashmore Cartier) Pty Ltd.

Heyward A., Colquhoun J., Cripps E., McCorry D., Stowar M., Radford B., Miller K., Miller I, and Battershill C. 2018. No evidence of damage to the soft tissue or skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. Mar. Poll. Bull. (129): 8–13.

Hinwood, J.B., Potts, A.E., Dennis, L.R., Carey, J.M., Houridis, H., Bell, R.J., Thomson, J.R., Boudreau, P. and Ayling, A.M. 1994. 'Drilling Activities'. In: Environmental Implications of Offshore Oil and Gas Developments in Australia – the Findings of an Independent Scientific Review. Edited by Swan J.M., Neff J.M. and Young P.C. Australian Petroleum Exploration Association. Sydney.

Holdway, D. 2002. The acute and chronic effects of wastes associated with offshore oil and gas production on temperate and tropical marine ecological processes. *Mar. Poll. Bull*. (**44**): 185–203.

Holloway, P.E., Pelinovsky, E., Talipova, T. and Barnes, B. 1997. A Nonlinear Model of Internal Tide Transformation on the Australian North West Shelf. Journal of Physical Oceanography 27: 871–896.

Holloway, P. E., Humphries, S. E., Atkinson, M., and Imberger, J. 1985. Mechanisms for nitrogen supply to the Australian North West Shelf. Australian Journal of Marine and Freshwater Research 36: 753–764.

Holloway, P.E. 1983. Internal Tides on the Australian North-West Shelf: A Preliminary Investigation. Journal of Physical Oceanography Vol 13: 1357 – 1370.

Hook, S., Batley, G., Holloway, M., Irving, P. and Ross, A. 2016. Oil Spill Monitoring Handbook. CSIRO Publishing. Melbourne.

Hotchkin, C. and Parks, S. 2013. The Lombard effect and other noise-induced vocal modifications: insight from mammalian communication systems. Biological Reviews 88(4): 809-824.

Houde, E. D. 2002. Chapter 3. Mortality. In: *Fuiman, L. A. and R. G. Werner* (eds.), Fishery science: The unique contribution of early life stages. Blackwell Scientific Publishing, Oxford.

How, J.R., Webster, F.J., Travaille, K.L., Nardi, K., Harry, A.V. 2015. Western Australian Marine Stewardship Council Report Series No. 4: West Coast Deep Sea Crustacean Managed Fishery. Department of Fisheries, Western Australia. 172pp.

Humphreys, B. and J. Blyth. 1994. Subterranean Secrets. Landscope - W.A's Conservation, Forests and Wildlife Magazine. 9, No. 3:22-27.

Humphreys, W.F. and M.N. Feinberg. 1995. Food of the blind cave fishes of northwestern Australia. Records of the Western Australian Museum. 17:29-33.

Humphreys, W.F. 1999. The distribution of Australian cave fishes. Records of the Western Australian Museum. 19:469-472.

IAGC. 2013. Environmental manual for worldwide geophysical operations. International Association of Geophysical Contractors.

IMCA. 2015. Guidelines for the use of multibeam echosounders for offshore surveys. International Marine Contractors Association.

IMCA. 2017. Guidance on vessel USBL systems for use in offshore survey, positioning and DP operations. International Marine Contractors Association.

IMO. 2016. International Maritime Dangerous Goods Code. Amendment 38.16. International Maritime Organisation.

IMO. 2011. Guidelines for the control and management of ships' biofouling to minimise transfer of invasive aquatic species. International Maritime Organisation.

Inpex. 2010. Ichthys Gas Field Development. Draft Environmental Impact Statement. Inpex Browse Ltd. Perth.

IOGP-IPIECA, 2020. Environmental management in the upstream oil and gas industry. Report No. 254. August 2020. International Association of Oil & Gas Producers and IPIECA. London.

IOGP. 2017. Guidelines for the conduct of offshore drilling hazard site surveys. International Association of Oil and Gas Producers.

ITOPF. 2011. Effects of Oil Pollution on the Marine Environment. Technical Information Paper 13. The International Tanker Owners Pollution Federation Ltd. London.

Jenner, K., Jenner, M. and McCabe, K. 2001. Geographical and temporal movements of humpback whales in Western Australian waters. *APPEA Journal*, 2001: 749-765.

Jenssen, B. 1994. Effects of Oil Pollution, Chemically Treated Oil, and Cleaning on the Thermal Balance of Birds. *Env. Poll*. (86):207–215.

Jimenez-Arranz, G., Hedgeland, D., Cook, S., Banda, N., Johnston, P. and Oliver, E. 2019. Acoustic characterisation of a mobile offshore drilling unit. Proceedings of Meetings on Acoustics: 5th International Conference on the Effects of Noise on Aquatic Life, Den Haag, The Netherlands 7-12 July 2019.

Jones, D.S. 2004. Marine biodiversity of the Dampier Archipelago, Western Australia 1998-2002.

Jones, D. and Morgan, G. J. 1994. A field guide to crustaceans of Western Australia. Western Australian Museum.

Jung, J. 2011. Biomarker Responses in Pelagic and Benthic Fish Over One Year Following the Hebei Spirit Oil Spill (Taean, Korea). *Mar. Poll. Bull*. 62(8): 1859–1866.

Kalnay, E., Kanamitsu, R., Kistler, W., Collins, D., Deaven, L., Gandin, M., Iredell, S., Saha, G., White, J., Woollen, Y., Zhu, A., Leetmaa and Reynolds, R. 1996. The NCEP/NCAR 40-Year Reanalysis Project: Bulletin of the American. *Meteorological Society*, 77, 437–441.

Kathiresan, K. and Bingham, B. 2001. Biology of Mangroves and Mangrove Ecosystems. *Advances in Marine Biology*. 40. 81-251. 10.1016/S0065-2881(01)40003-4.

Kauss, P., Hutchinson, T., Soto, C., Hellebust, J. and Griffiths, M. 1973. The Toxicity of Crude Oil and its Components to Freshwater Algae. International Oil Spill Conference Proceedings: March 1973, Vol. 1973, No. 1, pp. 703-714.

Kennish, M.J. 1996. Practical Handbook of Estuarine and Marine Pollution. CRC Press. Florida.

Kenyon, R., Loneragan, N., Manson, F., Vance, D., Venables, W. 2004. Allopatric distribution of juvenile red-legged banana prawns (*Penaeus indicus* H. Milne Edwards, 1837) and juvenile white banana prawns (*Penaeus merguiensis* De Man, 1888), and inferred extensive migration, in the Joseph Bonaparte Gulf, Northwest Australia. *Journal of Experimental Marine Biology and Ecology* 309, 79–108.

Ketten, D.R. 1992. The cetacean ear: form, frequency, and evolution. In Thomas, J.A., R.A. Kastelein, and A.Y. Supin (eds.). Marine Mammal Sensory Systems. Plenum Press, New York. 53-75.

Ketten, D.R. and Bartol, S.M. 2005. Functional measures of sea turtle hearing. ONR project final report. Document Number ONR Award Number N00014-02-1-0510. Office of Naval Research (US).

Ketten, D.R., Merigo, C., Chiddick, E., Krum, H. and Melvin, E.F. 1999. Acoustic fatheads: parallel evolution of underwater sound reception mechanisms in dolphins, turtles, and sea birds. J. Acous. Soc. America 105(2): 1110.

Kistler, R., Kalnay, E., Collins, W., Saha, S., White, G., Wollen, J., Chelliah, M., Ebisuzaki, W., Kanamitsu, M., Kousky, V., Van Den Dol, H., Jenne, R. & Fioriono, M. (2001) The NCEP/NCAR 50-Year Reanalysis: Monthly Means CD-ROM and Documentation. Bulletin of the American. *Meteorological Society*, 82, pp 247-267.

Klimey, A. and Anderson, S. 1996. Residency patterns of White Sharks at the South Farrallone Islands, California. In: Great White Sharks: The biology of Carcharodon carcharias. Klimley, A. P. and Ainley, D. G. (eds.), Academic Press, New York USA. pp 365 - 373.

Klimley, A.P. and Myrberg, Jr A.A. 1979. Acoustic stimuli underlying withdrawal from a sound source by adult lemon sharks, Negaprion brevirostris (Poey). Bull. Mar. Sci. 29: 447–458.

Kloser, R.J., Keith, G. and Althaus, F. 2010. Key ecological features of the east and south-east marine regions: shelf incising canyons. Draft report to the Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra.

Kostyuchenko, L. 1973. Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. *Hydrobiological Journal* **9**: 45-48.

Laist, D., Knowlton, A., Mead, J., Collet, A. and Podesta, M. 2001. Collisions between Ships and Whales. *Mar. Mam. Sci*. 17(1): 35-75.

Lamendella, R., Strutt, S., Borglin, S., Chakraborty, R., Tas, N., Mason, O., Hultman, J., Prestat, Hazen, T. and Jansson, J. 2014. Assessment of the Deepwater Horizon oil spill impact on Gulf coast microbial communities. *Front. Microbiol*. 5: 130.

Last, P. and Stevens, J. 1994. Sharks and Rays of Australia. Collingwood, Victoria: CSIRO Publishing.

Last, P., Lyne, V., Yearsley, G., Gledhill, D., Gommon, M., Rees, T. and White, W. 2005. Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (> 40 m depth). Australian Government Department of the Environment and Heritage and CSIRO Marine Research, Australia.

Last, P. and Stevens, J. 2009. Sharks and Rays of Australia (Second Edition). Collingwood, Victoria: CSIRO Publishing.

Law, R. 1997. Hydrocarbons and PAH in Fish and Shellfish from Southwest Wales following the Sea Empress Oil Spill in 1996. *International Oil Spill Conference Proceedings 1997* (1): 205–211.

Lee, H.J., Shim, W.J., Lee, J. and Kim, G.B. 2011. Temporal and geographical trends in the genotoxic effects of marine sediments after accidental oil spill on the blood cells of striped beakperch (*Oplegnathus fasciatus*). *Mar. Poll. Bull*. 62:2264– 2268.

Lenhardt, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta). In: Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (eds.). 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum, NMFS-SEFSC-351, National Technical Information Service, Springfield, Virginia.

Lenhardt, M.L., Klinger, R. and Musick, J. 1985. Marine turtle middle-ear anatomy. J. Aud. Res. 25(1): 66-72.

Lewis, M. and Pryor, R. 2013. Toxicities of oils, dispersants and dispersed oils to algae and aquatic plants: Review and database value to resource sustainability. *Env. Poll*. **180**:345–367.

Lindquist, D., Shaw, R. and Hernandez, F. 2005. Distribution patterns of larval and juvenile fishes at offshore petroleum platforms in the north-central Gulf of Mexico. *Estuar. Coast. Shelf Sci*. 62(4):655–665.

Ling, S., Johnson, C., Frusher, D. and Ridgway, K. 2009. Overfishing reduces resilience of kelp beds to climate-driven catastrophic phase shift. Proceedings of the National Academy of Sciences Dec 2009, 106 (52) 22341-22345; DOI: 10.1073/pnas.0907529106.

Ling, S. & Johnson, C. 2012. Marine reserves reduce risk of climate-driven phase shift by restoring size and habitat specific trophic interactions. Ecological applications: a publication of the Ecological Society of America. 22. 1232-45. 10.2307/23213957.

Loneragan, N., Die, D., Kenyon, R., Taylor, B., Vance, D., Manson, F., Pendrey, B. & Venables, B. (2002). The growth, mortality, movements and nursery habitats of red-legged banana prawns (Penaeus indicus) in the Joseph Bonaparte Gulf. CSIRO Marine Research. Project FRDC 97/105. 142 pp.

Marchant, S. and P.J. Higgins. 1993. Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.

Marquenie, J., Donners, M., Poot, H., Steckel, W. and Wit, B. 2008. Adapting the spectral composition of artificial lighting to safeguard the environment. PCIC Europe Paper 535.

Marshall, A., Kashiwagi, T., Bennett, M., Deakos, M., Stevens, G., McGregor, F., Clark, T., Ishihara, H. and Sato, K. 2011a. *Manta alfredi*. The IUCN Red List of Threatened Species 2011.

Marshall, A., Bennett, M. B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., Stevens, G. and Kashiwagi, T.2011b. *Manta birostris*. The IUCN Red List of Threatened Species 2011.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the loggerhead turtle (Caretta caretta): A comparison of behavioral and auditory evoked potential audiograms. J. Exper. Biol. 215(17): 3001-3009.

Matishov, G. 1992. The reaction of bottom-fish larvae to airgun pulses in the context of the vulnerable Barents Sea ecosystem. Contr. Petro Piscis II '92 F-5, Bergen, Norway, 6-8 April, 1992.

Matsumoto, H., Bohnenstiehl, D., Tourandre, J., Dziak, R., Haxel, J. Lau, T., Fowler, M. and alo, S. 2014. Antarctic icebergs: a significant natural ocean sound source in the Southern Hemisphere. *Geochemistry, Geophysics, Geosystems*. **15**: 3448-3458.

Maxwell, A. J., Vincent, L. W. & Woods, E. P. 2004. The Audacious discovery, Timor Sea and the role of pre-stack depth migration seismic processing. In: Ellis, G. K., Baillie, P. W. & Munsoon, T. J. (eds.), Timor Sea Petroleum Geoscience, Proceedings of the Timor Sea Symposium, Darwin, Northern Territory, 19-20 June 2003, Northern Territory Geological Survey, Special Publication 1, 53-65.

Mees, G.F. 1962. The subterranean freshwater fauna of Yardie Creek Station, North West Cape, Western Australia. Journal of the Royal Society of Western Australia. 45, Part 1:24-32.

McCauley, R., Gavrilov, A., Jolliffe, R., Ward, C. and Gill, P. 2018. Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics. Deep-sea Research Part II: Tropical Studies in Oceanography 157: 154-168.

McCauley, R., Day, R., Swadling, K., Fitzgibbon, Q., Watson, R. and Semmens, J. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nat. Ecol. Evol. 1, 0195.

McCauley, R. and Kent, C. 2012. A lack of correlation between air gun signal pressure waveforms and fish hearing damage. Advances in Experimental Medicine and Biology 730:245–250.

McCauley, R. 2004. Underwater sea noise in the Otway Basin – drilling, seismic and blue whales. Report prepared by Centre for Marine Science and Technology, Curtin University, for Santos Ltd McIntyre, A.D. and Johnson, R. 1975. Effects of nutrient enrichment from sewage in the sea. In: ALH Gameson, ed. Discharge of sewage from sea outfalls. New York, Pergamon Press. pp.131–141.

McCauley, R., Fewtrell, J., Duncan, A., Jenner, C., Jenner M-N., Penrose, J. D., Prince, R. T., Adhitya, A., Murdoch, J. and McCabe, A. K. 2003a. 'Marine seismic surveys: analysis and propagation of source signals; and effects of exposure on humpback whales, sea turtles, fishes and squid.' In: Environmental Implications of Offshore Oil and Gas Developments in Australia: Further Research. Australian Petroleum Production and Exploration Association. Canberra.

McCauley, R., Fewtrell, J., Popper, A. 2003b.High intensity anthropogenic sound damages fish ears. J. Acoust. Soc. Am. 113, 638–642.

McCauley, R., Fewtrell, J., Duncan, A., Jenner, C., Jenner, M., Penrose, J., Prince, R., Adhitya, A., Murdoch, J. and McCabe, K. 2000a. 'Marine Seismic Surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid.' In: Environmental implications of offshore oil and gas development in Australia: Further research. Australian Petroleum Production and Exploration Association. Canberra.

McCauley, R., Fewtrell, J., Duncan, A., Jenner, C., Jenner, M., Penrose, J. 2000b. Marine seismic surveys 'A study of environmental implications. APPEA Journal, 40, 692'08.

McCauley, R. D. 1994. 'Seismic Survey.' In: Environmental Implications of Offshore Oil and Gas Developments in Australia – the Findings of an Independent Scientific Review. Swan J.M., Neff J.M. and Young P.C. (eds) Australian Petroleum Exploration Association. Sydney.

McClain, C.R. and Barry, J.P. 2010. Habitat heterogeneity, disturbance, and productivity work in concert to regulate biodiversity in deep submarine canyons. Ecology, 91(4): 964-976.

McLoughlin, R.J. and Young, P.C. 1985. Sedimentary provinces of the fishing grounds of the North West Shelf of Australia: grain-size frequency analysis of surficial sediments. Australian Journal of Marine and Freshwater Research, 36: 671-81.

McDonald, M.A., Hildebrand, J.A. and Webb, S.C. 1995. Blue and fin whales observed on a seafloor array in the Northeast Pacific. J. Acoust. Soc. Am. 98(2): 712–721.

McLeay, L., Sorokin, S., Rogers, P. and Ward, T. 2003. Benthic Protection Zone of the Great Australian Bight Marine Park: 1. Literature review. South Australian Research and Development Institute (Aquatic Sciences). Final report to: National Parks and Wildlife South Australia and the Commonwealth Department of the Environment and Heritage.

McPherson, C., Kowarski, K., Delarue, J., Whitt, C., MacDonnell, J. and Martin, B. 2016. Passive Acoustic Monitoring of Ambient Noise and Marine Mammals–Barossa Field. JASCO Document 00997, Version 1.0. Technical report by JASCO Applied Sciences for Jacobs.

Meekan, M. G., Wilson, S. G., Halford, A. and Retzel, A. 2001. A comparison of catches of fishes and invertebrates by two light trap designs, in tropical NW Australia. *Mar. Biol*. 139: 373 – 381.

Milicich, M., Meekan, M. and Doherty, P. 1992. Larval supply: a good predictor of recruitment in three species of reef fish (Pomacentridae). *Mar. Ecol. Prog. Ser*. 86: 153-166.

Minton, S. and Heatwole, H. 1975. Sea snakes from three reefs of the Sahul Shelf. In: Dunson, W. A., ed. The Biology of Sea Snakes. Page(s) 141-144. Baltimore: University Park Press.

Moein, S.E., Musick, J.A., Keinath, J.A., Barnard, D.E., Lenhardt, M.L. and George, R. 1995. Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges, in Sea Turtle Research Program: Summary Report. In: Hales, L.Z. (ed.). Report from U.S. Army Engineer Division, South Atlantic, Atlanta GA, and U.S. Naval Submarine Base, Kings Bay GA. Technical Report CERC-95. 90 pp.

Mollet, H., Cliff, G., Pratt, Jr. H. and Stevens, J. 2000. Reproductive biology of the female shortfin mako, *Isurus oxyrinchus* Rafinesque, 1820, with comments on the embryonic development of lamnoids. *Fishery Bulletin* 98(2): 299-318.

Mooney, T.A., Yamato, M. and Branstetter, B.K. 2012. Hearing in cetaceans: From natural history to experimental biology. Advances in Marine Biology 63: 197–246.

Moore, C., Cappo, M., Radford, B. and Heyward, A. 2017. Submerged oceanic shoals of north Western Australia are a major reservoir of marine biodiversity. *Coral Reefs*: **36**, 719-734.

Morris, C.J., Cote, D., Martin, B. and Kehler, D. 2017. Effects of 2D seismic on the snow crab fishery. Fisheries Research (2017). A WWW paper accessed at http://dx.doi.org/10.1016/j.fishres.2017.09.012.

Morrice, M., Gill, P., Hughes, J. and Levings, A. 2004. Summary of mitigation aerial surveys for the Santos Ltd EPP32 seismic survey, 2-13 December 2003. Report # WEG-SO 02/2004, Whale Ecology Group-Southern Ocean, Deakin University.

Myrberg, A. 2001. The acoustical biology of elasmobranchs. Environmental Biology of Fishes 60(3): 31- 45.

NCE. 2007. Treatments for reducing underwater sounds from oil and gas industry activities. Report prepared by Noise Control Engineering Inc. Report: 07- 001.

NERA. 2017. Environment Plan Reference Case: Planned Discharge of Sewage, Putrescible Waste and Grey Water. Department of Industry, Innovation and Science. Canberra.

Nichol, S., Howard, F., Kool, J., Stowar, M., Bouchet, P., Radke, L., Siwabessy, J., Przeslawski, R., Picard, K., Alvarez de Glasby, B., Colquhoun, J., Letessier, T. and Heyward, A. 2013. Oceanic Shoals Commonwealth Marine Reserve (Timor Sea) Biodiversity Survey: GA0339/SOL5650 – Post Survey Report. Record 2013/38. Geoscience Australia: Canberra.

NMFS. 2018. Revision to: Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. National Marine Fisheries Service. U.S. Department of Commerce. NOAA. NOAA Technical Memorandum NFMS-OPR-59.

NMFS. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. National Marine Fisheries Service.

NOAA. 2013. Deepwater Horizon Oil Spill: Assessment of Potential Impacts on the Deep Softbottom Benthos. Interim data summary report. NOAA Technical Memorandum NOS NCCOS 166. National Oceanic and Atmospheric Administration. Washington.

NOPSEMA. 2021. Environment plan decision making guideline (NOPSEMA Guideline GL1721, 2021). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidelines/A524696.pdf.

NOPSEMA. 2020a. Environment Plan Assessment Policy (NOPSEMA Policy N-04750-PL1347, Rev 8, March 2020). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Policies/A662608.18.19.pdf.

NOPSEMA. 2020b. Reducing marine pest biosecurity risks through good practice biofouling management (NOPSEMA Information Paper N-04750-IP1899, Rev 1, March 2020). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Environment-resources/A715054.pdf.

NOPSEMA. 2020c. Acoustic impact evaluation and management (NOPSEMA Information Paper, N-04750-IP1765). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Information-papers/A625748.pdf.

NOPSEMA. 2020d. Petroleum activities and Australian Marine Parks (NOPSEMA Guidance Note, N-04750-GN1785). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidance-notes/A620236.pdf.

NOPSEMA. 2020e. Operational and scientific monitoring programs (NOPSEMA Information Paper, N-04750-IP1349, October 2020). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/sites/default/files/documents/2021-03/A343826.pdf

NOPSEMA. 2019. Oil spill modelling (NOPSEMA Environment Bulletin, April 2019). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf.

NOPSEMA, 2018. Oil pollution risk management (NOPSEMA Guidance Note GN1488, Rev 2, February 2018). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidance-notes/A382148.pdf.

Northern Territory Government. 2019. Status of Key Northern Territory Fish Stocks Report 2017. Northern Territory Government Department of Primary Industry and Resources. Fishery Report No. 121.

Nowacek, D. & Southall, B. 2016. Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys. IUCN, Gland, Switzerland.

Nowacek, D., Johnson, M. and Tyack, P.L. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alarm stimuli. Proceedings of the Royal Society of London B 271: 227–231.

NRDA. 2012. April 2012 Status Update for the Deepwater Horizon Oil Spill. A WWW publication accessed at: http://www.gulfspillrestoration.noaa.gov. Natural Resource Damage Assessment.

NSF (U.S), U.S. Geological Survey, and National Oceanic and Atmospheric Administration (U.S.). 2011. Final Programmatic Environmental Impact Statement/Overseas. Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. National Science Foundation, Arlington, VA.

NT Government. 2020. Garig Gunak Barlu National Park factsheet and map. Accessed on 5 April 2022 via https://nt.gov.au/parks/find-a-park/garig-gunak-barlu-national-park

O'Brian, P. and Dixon, P. 1976. The effects of oils and oil components on algae: A review. *British Phycological Journal.* 11:115– 141.

Parks Australia. 2021. Indigenous rangers monitoring marine park health in Australia's Top End. Available at: https://parksaustralia.gov.au/marine/news/indigenous-rangers-monitoring-marine-park-health-in-australias-top-end/

Parry, G. and Gason, A. 2006. The Effect of Seismic Surveys on Catch Rates of Rock Lobsters in Western Victoria, Australia. Fisheries Research 79(2006): 272-284.

Patterson, H., Bromhead, D., Galeano, D., Larcombe, J., Woodhams, J. and Curtotti, R. 2021. Fishery status reports 2021. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Georgeson, L., Larcombe, J. and Curtotti, R. 2020. Fishery status reports 2020. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Larcombe, J. and Curtotti, R. 2019. Fishery status reports 2019. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Larcombe, J. and Curtotti, R. 2018. Fishery status reports 2018. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Larcombe, J. and Curtotti, R. 2017. Fishery status reports 2017. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Stobutski, I. and Curtotti, R. 2016. Fishery status reports 2016. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Parks, S.E., Clark, C.W. and Tyack, P.L. 2007. Short-and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication. J. Acous. Soc. of America 122(6): 3725-3731.

Parvin S., Nedwell, J. and Harland, E. 2007. Lethal and physical injury of marine mammals, and requirements for Passive Acoustic Monitoring. Subacoustech Report Reference: 565R0212, February 2007, Submitted to the UK DTI, 1 Victoria Street, London, SW1H 0ET. Published by the UK Department of Business, Enterprise and Regulatory Reform.

Payne, J., Andrews, C., Fancey, L., White, D. and Christian, J. 2008. Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003. Report Number 2008/060. Canadian Science Advisory Secretariat.

Peakall, D., Wells, P. and Mackay, D. 1987. A hazard assessment of chemically dispersed oil spills and seabirds. *Mar. Env. Res*. 22(2):91-106.

Pearce, C. and Duke, N. 2013. Shoreline ecological assessment aerial surveys. Report of Research. Montara Environmental Monitoring Program. James Cook University. Australia.

Pearce, A., Buchan, S., Chiffings, T., D'Adamo, N., Fandry, C., Fearns, P., Mills, D., Phillips, R. and Simpson, C. 2003. A review of the oceanography of the Dampier Archipelago, Western Australia. In: Wells, F. E., Walker, D. I. & Jones, D. S. (eds.). The marine flora and fauna of Dampier, Western Australia. Western Australian Museum, Perth, 13-50.

Pearson, W. H., Skalski, J.R. and Malme, C.I. 1992. Effects of Sounds from a Geophysical Survey Device on Behavior of Captive Rockfish (Sebastes spp.). Canadian Journal of Fisheries and Aquatic Sciences 49:1343–1356.

Pedretti, Y. and Paling, E. 2001. WA Mangrove Assessment Project 1999-2000. Marine and Freshwater Research Laboratory, Murdoch University, Perth, Western Australia.

Peel, D., Kelly, N., Smith, J. and Childerhouse, S. 2016. National Environmental Science Program Project C5 – Scoping of Potential Species for Ship Strike Risk Analysis, Pressures and impacts. CSIRO. Australia.

Perrin, W.F. 1998. Stenella longirostris. Mammalian Species 599: 1-7.

Piniak, W.E., Mann, D.A., Eckert, S.A. and Harms, C.A. 2011. Amphibious hearing in sea turtles. In: Hawkins, T. and Popper, A.N. (eds.). Proceedings of the 2nd International Conference on the Effects of Noise on Aquatic Life. August 15-20, 2010. Springer-Verlag. (In Press).

Piniak, W.E.D., Mann, D.A., Harms, C.A., Jones, T.T. and Eckert, S.A. 2016. Hearing in the Juvenile Green Sea Turtle (Chelonia mydas): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. PLOS ONE 11(10): e0159711.

Popper A.N., Halvorsen, M.B., Kane, E., Miller, D.D., Smith, M.E., Stein, P. and Wysocki, L.E. 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. J. Acoust. Soc. Am. 122: 623–635.

Popper, A. N., Gross, J.A., Carlson, T.J., Skalski, J., Young, J.V., Hawkins, A.D. and Zeddies, D. 2016. Effects of exposure to the sound from seismic airguns on pallid sturgeon and paddlefish. PLoS One 11:e0159486.

Popper, A.N. and Løkkeborg, S. 2008. Effects of anthropogenic sound on fish. Bioacoustics 17: 214-217.

Popper, A.N., Carlson, T., Gross, J.A., Hawkins, A.D., Zeddies, D.G. and Powell, L. 2015. Effects of Seismic Air Guns on Pallid Sturgeon and Paddlefish. Advances in Experimental Medicine and Biology 875:871-878.

Popper, A.N., Carlson, T.J., Gross, J.A., Hawkins, A.D., Zeddies, D., Powell, L. and Young, J. 2016. Effects of seismic air guns on pallid sturgeon and paddlefish. Advances in Experimental Medicine and Biology 875: 871-878. NLM.

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. SpringerBriefs in Oceanography, Volume ASA S3/SC1.4 TR-2014. ASA Press.

Przeslawski, R., Hurt, L., Forrest, A. and Carroll, A. 2016a. Potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin, FRDC Project No 2014/041. Geoscience Australia. Canberra.

Przeslawski, R., Bruce, B., Carroll, A., Anderson, R., Bradford, A., Durrant, A., Edmunds, M., Foster, S., Huang, Z., Hurt, L., Lansdell, M., Lee, K., Lees, C., Nichols, P. and Williams, S. 2016b. Marine Seismic Survey Impacts on Fish and Invertebrates. Final Report for the Gippsland Marine Environmental Monitoring Project. Record 2016/35. Geoscience Australia. Canberra.

Przeslawski, R., Daniell, J., Anderson, T., Barrie, J. V., Heap, A., Huges, M., Li, J., Potter, A., Radke, L., Siwabessy, J., Tran, M., Whiteway, T. and Nichol, S. 2011. Seabed Habitats and Hazards of the Joseph Bonaparte Gulf and Timor Sea, Northern Australia. Geoscience Australia.

PTTEP. 2013. Montara Environmental Monitoring Program. Report of Research. A WWW document accessed at: www.au.pttep.com/sustainable-development/environmentalmonitoring. PTTEP Australasia. Perth.

Purser, J. and Radford, A.N. 2011. Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (Gasterosteus aculeatus). PLoS ONE 6(2): e17478.

Putland, R., Merchant, N., Farcas, A., and Radford, C. 2018. Vessel noise cuts down communication space for vocalizing fish and marine mammals. *Glob. Change Biol*. **24**, 1708–1721

Ramachandran, S., Hodson, P., Khan, C. and Lee, K. 2004. Oil dispersant increases PAH uptake by fish exposed to crude oil. *Ecotoxicology and Environmental Safety* **59**:300– 308.

Rawson, C., Gagnon, M.M. and Williams, H. 2011. Montara Well Release Olfactory Analysis of Timor Sea Fish Fillets. Curtin University, Perth, Western Australia, November 2011.

Reardon, M., Gerber, L. and Cavanagh, R. 2006. *Isurus paucus*. The IUCN Red List of Threatened Species 2006.

Reiser, C., Funk, D., Rodrigues, R. and Hannay, D. (eds.) 2011. Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort seas, July–October 2010: 90-day report. LGL Rep. P1171E–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC for Shell Offshore Inc, Houston, TX, Nat. Mar. Fish. Serv., Silver Spring, MD, and U.S. Fish and Wild. Serv., Anchorage, AK.

Richardson, A., Matear, R. and Lenton, A. 2017. Potential impacts on zooplankton of seismic surveys. CSIRO. Australia.

Richardson, W., Greene, C., Maime, C. and Thomson, D. 1995. Marine Mammals and Noise. Academic Press. California.

Ross, G.J.B. 2006. Review of the Conservation Status of Australia's Smaller Whales and Dolphins. Report to the Australian Department of the Environment and Heritage. Canberra.

Rothlisberg, P., Condie, S., Hayes, D., Griffiths, B., Edgar, S., and Dunn, J. 2005. Collation and Analysis of Oceanographic Datasets for National Marine Bioregionalisation: The Nothern Large Marine Domain: A report to the Australian Government, National Oceans Office.

Rowe, C., Mitchelmore, C. and Baker, J. 2009. Lack of Biological Effects of Water Accommodated Fractions of Chemically and Physically Dispersed Oil on Molecular, Physiological, and Behavioural Traits of Juvenile Snapping Turtles Following Embryonic Exposure. *Science of the Total Environment*. 407(20): 5344– 5355.

RPS. 2022a. Beehive-1 Exploration Drilling. Drill Cuttings and Muds Dispersion Modelling. Rev 1. 17 February 2022. Prepared by RPS for Aventus Consulting Pty Ltd.

RPS. 2022b. Beehive-1 Exploration Drilling. Crude Oil Spill Modelling. Rev 1. 18 January 2022. Prepared by RPS for Aventus Consulting Pty Ltd.

RPS. 2021. Beehive-1 Exploration Drilling. Marine Diesel Spill Modelling. Rev 1. 06 September 2021. Prepared by RPS for Aventus Consulting Pty Ltd.

Semeniuk, V. 1993. The Pilbara coast: a riverine coastal plain in a tropical arid setting, north-western Australia. *Sedimentary Geology*. 83(3-4):235-256.

Sepulveda, C., Kohin, S., Chan, C., Vetter, R. and Graham, J. 2004. Movement patterns, depth preferences, and stomach temperatures of free-swimming juvenile mako sharks in the Southern California Bight. *Marine Biology* 145: 191-199.

Shaw, R., Lindquist, D., Benfield, C., Farooqi, T., Plunket, J. 2002. Offshore petroleum platforms: functional significance for larval fish across longitudinal and latitudinal gradients. Prepared by the Coastal Fisheries Institute, Louisiana State University. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2002-077.

Shigenaka, G. 2011. Chapter 27 – Effects of Oil in the Environment. In: Oil Spill Science and Technology. Gulf Professional. Pp 985-1024.

Shigenaka, G. 2003. Oil and Sea Turtles: Biology, Planning, and Response. National Oceanographic and Atmospheric Administration, United States of America.

Simmonds, M., Dolman, S. and Weilgart, L. 2004. Oceans of Noise. Whale and Dolphin Conservation Society. Wiltshire.

Slotte, A., Hansen, K., Dalen, J. and Ona, E. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fish. Res. 67(2):143-150.

Smyth, D. 2007. Indigenous Protected Areas in Australia. Parks Vol 16 No 1, pp14-20. World Conservation Union, Switzerland.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene C. Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J. and Tyack, P. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals*. **33**(4): 411–521.

Southall, B.L., Nowaceck, D.P., Miller, P.J.O. and Tyack, P.L. 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. *Endangered Species Research* **31**: 293-315.

Stevens, J. D., Pillans, R. D. and Salini, J. P. 2005. Conservation assessment of *Glyphis glyphis* (speartooth shark), *Glyphis garricki* (northern river shark), *Pristis microdon* (freshwater sawfish) and *Pristis zijsron* (green sawfish). Report to Department of Environment and Heritage. Canberra, Australia. 84 pp.

Stevens, J.D., McAuley, R.B., Simpfendorfer, C.A. and Pillans, R.D. 2008. Spatial distribution and habitat utilisation of sawfish (*Pristis* spp.) in relation to fishing in northern Australia, report to the Australian Government Department of Environment and Heritage, Canberra.

Streever, B., Raborn, S., Kim, K., Hawkins, A. and Popper, A. 2016. Changes in fish catch rates in the presence of air gun sounds in Prudhoe Bay, Alaska. Arctic 69(4): 346-358.

Stone, C.J. and Tasker, M.L. 2006. The effects of seismic airguns on cetaceans in UK waters. J. Cet. Res. Man. 8(3): 255.

Tennessen, J. and Parks, S. 2016. Acoustic propagation modeling indicatesvocal compensation in noise improves communication range for North Atlantic right whales. *Endanger. Species Res*. 30, 225–237

Terhune, J., Stewart, R., and Ronald, K. 1979. Influence of vessel noises on underwater vocal activity of harp seals. *Can. J. Zool*. **57**, 1337–1338

Thomson, R., Sporcic, M., Foster, S., Haddon, M., Potter, A., Carroll, A., Przeslawski, R., Knuckey, I., Koopman, M. and Hartog J. 2014. Examining Fisheries Catches and Catch Rates for Potential Effects of Bass Strait Seismic Surveys. CSIRO and Geoscience Australia. Hobart and Canberra.

Thursby, G.B. and Steele, R. L. 2004. Toxicity of arsenite and arsenate to the marine macroalga *Champia parvula* (rhodophyta). *Environmental Toxicology and Chemistry*. (**3**):391-397.

Tiwi Land Council, 2013. Vernon Islands. Conservation Management Plans. Available at: https://tiwilandcouncil.com/documents/Uploads/Vernon%20Islands%20Conservation%20Management%20Plan%20May%202013lr.pdf

Tjeerdema, R., Bejarano, A.C. and Edge, S. No date. Biological Effects of Dispersants and Dispersed Oil on Surface and Deep Ocean Species. A WWW publication accessed at: http://crrc.unh.edu/sites/crrc.unh.edu/files/tjeerdemabejeranoedge.pdf. University of New Hampshire.

Tonks, M., Griffiths, S., Heales, D., Brewer, D. & Dell, Q. 2008. Species composition and temporal variation of prawn trawl bycatch in the Joseph Bonaparte Gulf, northwestern Australia. *Fisheries Research* 89: 276–293.

TSSC, 2018. Listing Advice: *Sphyrna lewini* (scalloped hammerhead). Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/85267-listing-advice-15032018.pdf. Accessed 22 February 2022.

TSSC. 2016. Conservation Advice *Limosa lapponica menzbieri* Bar-tailed godwit (northern Siberian). Threatened Species Scientific Committee. Canberra.

TSSC. 2015a. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale). Threatened Species Scientific Committee. Canberra.

TSSC. 2015b. Conservation Advice – *Balaenoptera borealis* (sei whale). Threatened Species Scientific Committee. Canberra.

TSSC. 2015c. Conservation Advice – *Balaenoptera physalus* (fin whale). Threatened Species Scientific Committee. Canberra.

TSSC. 2015d. Conservation Advice – *Rhincodon typus* (whale shark). Threatened Species Scientific Committee. Canberra.

TSSC. 2014a. Approved Conservation Advice for *Glyphis garricki* (northern river shark). Threatened Species Scientific Committee. Canberra.

TSSC. 2014b. Approved Conservation Advice for *Pristis pristis* (largetooth sawfish). Threatened Species Scientific Committee. Canberra.

TSSC. 2010. Listing Advice: *Thunnus maccoyii* (southern bluefin tuna). Available at: https://www.environment.gov.au/biodiversity/threatened/species/pubs/69402-listing-advice.pdf. Accessed 22 February 2022.

Tsvetnenko, Y. 1998. Derivation of Australian Tropical Marine Water Quality Criteria for Protection of Aquatic Life from Adverse Effects of Petroleum Hydrocarbons. Environmental Toxicology and Water Quality 13(4):273284.

Turnpenny, A. and Nedwell, J. 1994. The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. Fawley Aquatec Research Laboratories Ltd. Consultancy Report. FCR 089/94.

Tyack, P. 2008. Convergence of calls as animals form social bonds, active compensation for noisy communication channels, and the evolution of vocal learning in mammals. *Journal of Comparative Psychology*, 122(3), 319–331. https://doi.org/10.1037/a0013087.

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

Van Meter, R., Spotila, J. and Avery, H. 2006. Polycyclic Aromatic Hydrocarbons Affect Survival and Development of Common Snapping Turtle (*Chelydra serpentina*) Embryos and Hatchlings. *Env. Poll*. 142(3): 466–475.

Van Overbeek, J., & Blondeau, R. 1954. Mode of Action of Phytotoxic Oils. *Weeds*. **3**(1), 55-65.

Vetter, E.W. 1994. Hotspots of benthic production. Nature, 372(6501): 47.

Vinogradova, N.G. 1959. The zoogeographical distribution of the deep-water bottom fauna in the abyssal zone of the ocean. Deep-Sea Research, 5: 205-208.

Volkman, J., Miller, G., Revill, A. and Connell, D. 1994. 'Oil spills.' In: Environmental Implications of offshore oil and gas development in Australia - the findings of an independent scientific review. Edited by Swan, J.M., Neff, J.M. and Young, P.C. Australian Petroleum Exploration Association. Sydney.

Wale, M. A., Simpson, S. D and Radford, A. N. 2013. Noise negatively affects foraging and antipredator behaviour in shore crabs. Animal Behaviour. 86(1) 111–118.

Walker, D. and McComb, A. 1990. Salinity response of the seagrass *Amphibolis antarctica* (Labill) Sonder et Aschers: an experimental validation of field results. *Aquat Bot*. 36:359–366.

Walker, D., Wells, F. and Hanley R. J. 1996. Marine biological survey of the eastern Kimberley, Western Australia. Unpublished report by UWA, WAM and MARNT.

WAM, 2009. Marine Biodiversity Survey of Mermaid Reef (Rowley Shoals), Scott and Seringapatam Reef. Marine Survey Team, Aquatic Zoology, Western Australian Museum. Perth, Australia, Records of the Western Australian Museum Supplement No. 77.

Wardle, C., Carter, T., Urquhart, G., Johnstone, A., Ziolkowski, A., Hampson, G. and Mackie, D. 2001. Effects of seismic air guns on marine fish. *Continental Shelf Research*. 21: 1005–1027.

Wartzok, D. and Ketten, D.E. 1999. Marine Mammal Sensory Systems. In: Biology of Marine Mammals. Reynolds, J. and Rommel, S. (eds.). Smithsonian Institution Press, Washington DC. 117–175.

WDCS. 2006. Vessel collisions and cetaceans: What happens when they don't miss the boat. Whale and Dolphin Conservation Society. United Kingdom.

WDCS. 2004. Oceans of Noise. Whales and Dolphin Conservation Society. United Kingdom.

Webster, F.J., Wise, B.S., Fletcher, W.J. and Kemps, H. 2018. Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia. Fisheries Research Report No. 288 Department of Primary Industries and Regional Development, Western Australia.

Weir, C. 2007. Observations of marine turtles in relation to seismic airgun sound off Angola. Mar. Turt. Newsl. 116(2007):17–20.

Wever, E.G. 1978. The Reptile Ear: Its Structure and Function. Princeton University Press, Princeton, N.J.

Whitehead P.J., Tschirner K. 1992. Sex and age-related variation in foraging strategies of the Magpie Goose *Anseranas semipalmata*. Emu 92: 28-32.

Whiting, A., Thomson, A., Chaloupka, M. & Limpus, C. 2008. Seasonality, abundance and breeding biology of one of the largest populations of nesting flatback turtles, *Nator depressus*: Cape Domett, Western Australia. *Australian Journal of Zoology* 56: 297 – 303.

Whiting, S. Long, J.L. and Coyne, M. 2007. Migratory routes and foraging behaviour of olive ridley turtles *Lepidochelys olivacea* in northern Australia. Endangered Species Research, 3: 1-9.

Wiese, F., Montevecci, W., Davoren, G., Huettmann, H., Diamond, A. and Linke, J. 2001. Seabirds at risk around offshore oil platforms in the northwest Atlantic. *Mar. Poll. Bull*. 42:1285–1290.

Wilson, D.F. 2005. Arafura Sea biological survey report on RV Southern Surveyor expedition 05/2005. A National Oceans Office, Australian Museum and CSIRO project, Hobart.

Willis, K.L. 2016. Underwater Hearing in Turtles. In Popper, N.A. and A. Hawkins (eds.). The Effects of Noise on Aquatic Life II. Springer New York, New York, NY. 1229-1235.

Wilson, P., Thums, M. Pattiaratchi, C. Meekan, M., Pendoley, K., Fisher, R., and Whiting, S. 2018. Artificial light disrupts the nearshore dispersal of neonate flatback turtles (*Natator depressus*). *Marine Ecology Progress Series*. 600. 10.3354/meps12649.

Wilson, S., Depczynski, M., Fisher, R., Holmes, T., O'Leary, R. and Tinkler, P. 2010. Habitat associations of juvenile fish at Ningaloo Reef, Western Australia: The importance of coral and algae.*PloS ONE* **5**, Doi:10.1371/journal.pone.0015185.

Wood, J., Southall, B.L. and Tollit, D.J., 2012. PG&E offshore 3D Seismic Survey Project EIR-Marine Mammal Technical Draft Report. SMRU Ltd.

Woodside. 2011. Browse LNG Development. Draft Upstream Environmental Impact Assessment, EPBC Referral 2008/4111, November 2011. Woodside Energy Ltd. Perth.

Woodside. 2008. Browse LNG Development. Torosa South-1 Pilot Appraisal Well Environment Plan. Woodside Energy Ltd. Perth.

Woodside. 2004. Draft Environmental Impact Statement – Blacktip Project. Available from: https://ntepa.nt.gov.au/environmental-assessments/register/blacktip-gas/draft-environmental-impact-statement-eis.

Woodside. 2003. Environmental Impact Statement/Environment Effects Statement: Otway Gas Project. Woodside Energy Ltd. Perth.

World Bank Group. 2015. Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development. World Bank Group. Washington.

Young, M.A., Lerodiaconou, D., Edmunds, M., Hulands, L. and Schimel, A.C. G. 2016. Accounting for habitat and seafloor structure characteristics on southern rock lobster (Jasus edwardsii) assessment in a small marine reserve. Mar. Bio. 163: 1–13.

Yudhana, A., Sunardi, J.D., Abdullah, S. and Hassan, R.B.R. 2010. Turtle hearing capability based on ABR signal assessment. Telkomnika 8: 187-194.