VERMILION
Oil & Gas
Australia Pty. Ltd.

VERMILION OIL & GAS AUSTRALIA

WELL CONSTRUCTION ENVIRONMENT PLAN

WPA-7000-YH-0001

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12	24.01.2020	Environmental Advisor	Well Construction Manager HSE Manager	Managing Director

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Revision history

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Abbreviations and acronyms

° API	degrees American Petroleum Institute (index)
°C	degrees Celsius
AEMI	Australian Emergency Management Institute
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHS	Australian Hydrographic Service
AHTS	Anchor Handling Transport Supply
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
APASA	Asia-Pacific Applied Science Associates
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
AusSAR	Australian Search and Rescue
BBG	Bowman Bishaw Gorham
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals 1979
BOP	Blowout Preventer
CALM Buoy	Catenary Anchor Leg Mooring Buoy
CAMBA	China-Australia Migratory Bird Agreement
CDN	Canadian dollars
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFC	Chlorofluorocarbon
CGS	Concrete Gravity Structure
CHARM	Chemical Hazard and Risk Management
cm	centimetre
cP	centiPoise
cSt	centistoke
D, mD	darcy, millidarcy (measure of permeability)
dB	decibel
DEWHA	Department of Environment, Water, Heritage and the Arts

DER	Department of Environment Regulation
DEH	Department of Environment and Heritage
DMP	Department of Mines and Petroleum
DoE	Department of the Environment (formerly DSEWPaC)
DoF	Department of Fisheries
DoT	Department of Transport
DP	Dynamic Positioning
DPA	Dampier Port Authority
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EMBA	Environment that may be Affected (formally referred to as ZPI)
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPIP Act	*Environment Protection Impact of Proposals Act 1974*
EPS	Environmental Performance Standard
ERP	Emergency Response Plan
ESD	Emergency Shutdown
FCA	Field Change Approval
FIT	Formation Integrity Test
g/mL	grams per millilitre
GHG	Greenhouse Gas
GOR	Gas oil ratio
ha	hectare
HAZID	Hazard Identification
HAZOP	Hazardous Operations
HQ	Hazard Quotient
HSE	Health, Safety and Environment
HSES	Health Safety, Environment and Security
HSE MS	Health, Safety and Environment Management System
HVAC	Heating, Ventilation and Air Conditioning
Hz, kHz	hertz, kilohertz
IADC	International Association of Drilling Contractors
IALA	International Association of Lighthouse Authorities

IAP	Incident Action Plan
IAPP	International Air Pollution Prevention Certificate
IBC	Intermediate Bulk Container
ICT	Incident Command Team
IOPP	International Oil Pollution Prevention certificate
IUCN	International Union for Conservation of Nature
IWCF	International Well Control Forum
JAMBA	Japan-Australia Migratory Bird Agreement
JSA	Job Safety Analysis
KCl	potassium chloride
KEF	Key Ecological Feature
kg	kilogram
km, km/hr	kilometre, kilometre per hour
kPa	kilopascals
KPI	Key Performance Indicator
L	litre
LNG	Liquefied Natural Gas
LOT	Leak Off Test
m, m^3, mm	metre, cubic metre, millimetre
MAE	Major Accident Event
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973/78
MNES	Matters of National Environmental Significance
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MOU	Memorandum of Understanding
MSDS	Material Data Safety Sheet
MWD	Measurement While Drilling
NatPlan	AMSA's National Plan to Combat Pollution of the Sea by Oil
NES	National Environmental Significance
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NIMPIS	National Introduced Marine Pest Information System
nm	nautical mile
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NPI	National Pollutant Inventory

NWS	North-West Shelf
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone depleting substances
OIW	Oil in water
OPEP	Oil Pollution Emergency Plan
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPGGSA	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPP	Oil Pollution Plan
OPRC 90	Convention on Oil Pollution Preparedness, Response and Cooperation 1990
OSCA	Oil Spill Control Agents
OSCP	Wandoo Platform (Well Construction) Oil Spill Contingency Plan
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OSRL	Oil Spill Response Ltd
OSTM	Oil Spill Trajectory Modelling
P(SL)A	*Petroleum (Submerged Lands) Act 1982*
PAH	Polycyclic Aromatic Hydrocarbon
PEC:PNEC	Predicted Environmental Concentration: Predicted No Effect Concentration
PLONOR	Pose Little or No Risk
PMS	Preventative Maintenance System
PMSD	Protected Matters Search Database
POB	Persons on Board
PPE	Personal Protective Equipment
ppm	parts per million
PSZ	Petroleum Safety Zone
QA/QC	Quality Assurance/Quality Control
QHSE	Quality, Health, Safety and Environment
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROV	Remote Operated Vehicles
RSDV	Riser Shut Down Valve
scf/bbl	Standard cubic feet per barrel
SDS	Safety Data Sheet
SIMA	Spill Impact Mitigation Assessment
SIMOPS	Simultaneous operations

SKM	Sinclair Knight Merz
SMART	Specific, Measurable, Achievable, Realistic, Time-oriented
SMPEP	Shipboard Marine Pollution Emergency Plan
SOLAS	Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SOUV	Statement of Outstanding Universal Value
SSSV	Sub Surface Safety Valve
t	tonne
TD	total depth
TPH	Total Petroleum Hydrocarbon
TVDRT	Total Vertical Depth Rotary Table
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change 1992
UNCLOS	United Nations Convention on the Law of the Sea 1982
VOGA	Vermilion Oil & Gas Australia Pty Ltd
WA	Western Australia
WAF	Water Accommodated Fraction
WAFIC	Western Australian Fishing Industry Council
WCMS	Well Construction Management System
WCSM	Well Construction Standards Manual
WestPlan	WA Marine Pollution Contingency Plan
WHA	World Heritage Area
WNA	Wandoo A
WNB	Wandoo B
WPF	Wandoo Production Facilities
ZPI	Zone of Potential Impact (now referred to as EMBA)

1 Introduction

1.1 Background

Vermilion Oil & Gas Australia Pty Ltd (VOGA) periodically conducts well construction operations in Operational Area WA-14L using a Mobile Offshore Drilling Unit (MODU). Well construction operations planned over the next five years involve the drilling and, possibly, completing of new wells, the re-entering, side-tracking and recompleting of existing wells and plugging back laterals, abandoning wells and slot recoveries.

The frequency of campaigns will vary depending on a range of operational and commercial factors. Each campaign will likely take between 30 to 100 days to complete. The reservoir targeted during the campaigns will be the M.australis within the Wandoo Field. The work scope, MODU and Anchor Handling Transport Supply (AHTS) vessel activities are summarised in Section 2.

As MODU availability is unable to be predicted for the five-year period of operation of this Environment Plan (EP), well construction activities have been assessed on the basis that they may occur at any time during the calendar year.

WA-14L is located in Commonwealth waters in the Carnarvon Basin off the northwest coast of Western Australia (WA), approximately 80km northwest of Dampier and 110km northeast of Barrow Island (see Figure 2-2).

1.2 Environment Plan Summary

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

Table 1-1: Summary of material requirements for an EP

Material Requirement	Section of EP containing material requirement
The location of the activity	Section 2.2
A description of the receiving environment	Section 4
A description of the activity	Section 2
Details of the environmental impacts and risks	Section 6
The control measures for the activity	Section 6
The arrangements for ongoing monitoring of the titleholder's environmental performance	Section 7.4 Section 7.10 Section 8

Material Requirement	Section of EP containing material requirement
Response arrangements in the oil pollution emergency plan	Section 7.8.2 Section 7.9 Oil Pollution Emergency Plan (WAN-2000-RD-0001.02) included with EP submission
Consultation already undertaken and plans for ongoing consultation	Section 9
Details of the titleholders nominated liaison person for the activity	Section 1.3

1.3 The Proponent

VOGA is the titleholder of production licence WA-14L, which contains the Wandoo Production Facilities (WPF). VOGA is a wholly owned subsidiary of Vermilion Energy Inc., a Canadian-based oil and gas exploration and production company. VOGA acquired operatorship of the permit at the beginning of 2005 after purchasing the share of the permit from the previous operator, ExxonMobil.

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1.4 Scope and purpose of the Environment Plan

The purpose of this EP is to document the potential environmental impacts and risks and planned mitigation and management measures associated with well construction activities within Australian Commonwealth waters adjacent to existing Wandoo Facilities in production licence WA-14L in the Wandoo Field approximately 80 km north north-west of Dampier, Western Australia.

The activities covered in this EP include MODU-based well construction activities[1]:

- Mobilisation and position of a Mobile Offshore Drilling Unit (MODU) within the Operational area of the well construction activity (as described in Section 3.3);
- well interventions and side-tracks;
- construction of new wells;
- abandonment of existing laterals and well bores; and
- slot recoveries.

Activities excluded from the scope of this EP are:

- Exploration drilling activities;
- Mobilisation of a MODU from either international waters or an alternate location in Australian territorial waters, given this remains the responsibility of the MODU Operator and is managed under the *Navigation Act 2012* as administered by the Australian Maritime Safety Authority (AMSA);
- Vessel operations within Port Boundaries or State waters given they are managed under the Shipping and Pilotage Act 1967 (WA) as administered by the relevant Port Authority under the Port Authorities Act 1999 (WA);
- Vessel operations within Commonwealth waters outside of the Operational area given they are managed under the Navigation Act 2012 as administered by the Australian Maritime Safety Authority (AMSA); and
- Aviation activities given they are managed under the Civil Aviation Act 1988 and Civil Aviation Regulation 1998 as administered by the Australian Civil Aviation Safety Authority (CASA).

The EP details the arrangements in place for ensuring that the potential environmental impacts and risks associated with well construction activities are reduced to As Low As Reasonably Practicable (ALARP) and are of an acceptable level.

This EP has been prepared in accordance with the requirements of the Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R).

The implementation strategy contained in this EP will ensure that the well construction campaigns carried out over the next five years comply with all statutory requirements and the requirements of the VOGA Health, Safety and Environment Management System (HSE MS). The EP has been prepared to address campaign activities for the next five years. To ensure its

[1] This EP excludes non-platform based drilling activities, e.g. exploration wells, which would be addressed as required under a separate or revised EP.

continued suitability, a review of this EP will be undertaken after each well construction campaign. Any significant departure from the activity, environment, risks, control measures, etc. detailed in the EP, will be identified and assessed. If required, the EP will be revised and resubmitted in accordance with Regulation 17 of the OPGGS(E)R. Table 5-1 illustrates how this EP addresses each of the key requirements for the content of an EP ensuring fulfilment of Divisions 2.2A and 2.3 of the OPGGS(E)R.

1.5 Corporate environmental performance philosophy

VOGA is committed to minimising the adverse environmental impacts of its operations and to meeting all regulatory requirements associated with those operations. As stated in the Company Health, Safety and Environment (HSE) Policy, VOGA will:

- accept responsibility and accountability for providing leadership, visible commitment, direction and resources to meet HSE performance targets;
- maintain a strong HSE MS to identify and manage risks;
- integrate HSE into business objectives;
- make a positive contribution to the protection of the environment in which it operates;
- respond promptly and effectively to emergencies;
- focus on continual improvement in HSE performance; and
- communicate openly and fairly on a timely basis with fellow employees and contractors, the public, governments, management and other stakeholders.

A copy of the VOGA HSE Policy is included in VOGA Health, Safety and Environment (HSE) Policy.

1.6 Applicable legislation and codes

1.6.1 Overview

This section details the requirements that apply to the activity including relevant legislation, codes, other approvals and conditions. The Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGSA) controls exploration and production activities. The OPGGS(E)R stipulates the requirements for EPs to ensure that petroleum activities are carried out in an acceptable manner. VOGA carries out a review of applicable legislation each year.

The Operational Area lies within Commonwealth waters. Commonwealth legislation and other requirements relevant to the activity area including relevant international conventions are described in Table 1-2.

This EP considers the impacts to matters of national environmental significance (MNES) protected under Part 3 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Table 1-3 summarises relevant species conservation advices and recovery plans used by the Department of Environment and Energy (DotEE).

Table 1-2: Relevant Commonwealth Legislation

Legislation	Scope	Related International Conventions	Administering Authority
Australian Maritime Safety Authority Act 1990	This Act facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are affected through AMSA who administers the National Plan for Maritime Environmental Emergencies (NatPlan). **Application to activity**: AMSA is the designated Control Agency for oil spills from vessels in Commonwealth waters. *These arrangements are detailed in the OPEP.*	International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 Articles 198 and 221 of the United Nations Convention on the Law of the Sea 1982	Australian Maritime Safety Authority (AMSA)
Australian Ballast Water Management Requirements (DAWR, 2017)	The Australian Ballast Water Management Requirements set out the obligations on vessel operators with regards to the management of ballast water and ballast tank sediment when operating within Australian seas. **Application to activity**: Provides requirements on how vessel operators should manage ballast water when operating within Australian seas to comply with the *Biosecurity Act 2015*. Section *7.17 details these requirements in relation to the management of ballast water.*	International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted in principle in 2004 and in force on 8 September 2017)	Department of Agriculture and Water Resources
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act replaced the *Quarantine Act 1908* in 2015 and is the primary legislation for the management of the risk of diseases and pests that may cause harm to human, animal or plant health, the environment and the economy. The objects of this Act are to provide for: (a) managing biosecurity risks; human disease; risks related to ballast water; biosecurity emergencies and human biosecurity emergencies;	International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted in principle in 2004 and in force on 8 September 2017)	Department of Agriculture and Water Resources

Legislation	Scope	Related International Conventions	Administering Authority
	(b) to give effect to Australia's international rights and obligations, including under the International Health Regulations, the Sanitary and Phytosanitary Agreement and the Biodiversity Convention. **Application to activity**: The Biosecurity Act and regulations apply to 'Australian territory' which is the airspace over and the coastal seas out to 12 Nm from the coastline. For the activity the Act regulates vessels entering Australian territory regarding ballast water and hull fouling. *Biosecurity risks associated with the activity are detailed in Section 6.17*		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	This Act applies to actions that have, will have or are likely to have a significant impact on matters of national environmental or cultural significance. The Act protects Matters of National Environmental Significance (MNES) and provides for a Commonwealth environmental assessment and approval process for actions. There are eight MNES, these being: • World heritage properties; • Ramsar wetlands; • Listed Threatened species and communities; • Listed Migratory species under international agreements; • Nuclear actions; • Commonwealth marine environment; • Great Barrier Reef Marine Park; and • Water trigger for coal seam gas and coal mining developments. **Application to activity**: Petroleum activities are excluded from within the boundaries of a World Heritage Area (Sub regulation 10A(f)). *The activity is not within a World Heritage Area.* The EP must describe matters protected under Part 3 of the EPBC Act and assess any impacts and risks to these.	1992 Convention on Biological Diversity and 1992 Agenda 21 Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 Agreement between the Government and Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 Agreement between the Government and Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 Agreement between the Government of Australia and the Government of the Republic of Korea on The Protection of Migratory Birds 2006	Department of the Environment and Energy (DotEE)

Legislation	Scope	Related International Conventions	Administering Authority
	Section 4 describes matters protected under Part 3 of the EPBC Act. The EP must assess any actual or potential impacts or risks to MNES from the activity. *Section 7 provides an assessment of the impacts and risks from the activity to matters protected under Part 3 of the EPBC Act.*	Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 (Ramsar) International Convention for the Regulation of Whaling 1946 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979	
Environment Protection and Biodiversity Conservation Regulations 2000	Part 8 of the regulations provide distances and actions to be taken when interacting with cetaceans. **Application to activity**: The interaction requirements are applicable to the activity in the event that a cetacean is sighted. *Section 6.15 details how these requirements will be applied.*	-	DotEE
Environmental Reform (Consequential Provisions) Act 1999	This Act allowed the transition of legislation from the Environment Protection Impact of Proposals Act (1974) (EPIP Act) to the EPBC Act. The Environmental Reform (Consequential Provisions) Act clarifies that projects approved under the EPIP Act are exempt from being assessed under the EPBC Act. The Wandoo Full Field Development was approved under the EPIP Act.	-	DotEE
Fisheries Management Act 1991	This Act provides for the protection of Australia's offshore commercial fish resources from 3nm to the extent of the Australian Fishing Zone (200nm). There are no fisheries within the Operational Area however there are several within the EMBA.	Fishermen in Commonwealth-managed fisheries will be informed by VOGA (via AMSA) of program activity as required by legislation.	Australian Fisheries Management Authority (AFMA)
National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry 2009	The guidance document provides recommendations for the management of biofouling risks by the petroleum industry. **Application to activity**: Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species. *Sections 6.17 details the requirements applicable to vessel activities.*	Certain sections of MARPOL International Convention for the Safety of Life at Sea 1974 Convention on the International Regulations for Preventing Collisions at Sea (COLREG) 1972	Department of Agriculture

Legislation	Scope	Related International Conventions	Administering Authority
National Greenhouse and Energy Reporting Act 2007 (NGER Act) National Greenhouse and Energy Reporting Regulations 2008	This Act introduces a single national reporting framework for the reporting and dissemination of information about the greenhouse gas emissions, greenhouse gas projects, and energy use and production of corporations. Under the NGER Act, businesses who are very large emitters of greenhouse gases will be required by law to measure and report their emissions to the government. National Pollutant Inventory reporting is covered by this Act.	United Nations Framework Convention on Climate Change (UNFCCC) 1992 Vienna Convention for the Protection of the Ozone Layer 1985 and the Montreal Protocol on Substances that Deplete the Ozone Layer 1987	DoEE/Clean Energy Regulator
Navigation Act 2012	This Act regulates ship-related activities and invokes certain requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) relating to equipment and construction of ships. Several Marine Orders (MO) are enacted under this Act relating to offshore petroleum activities, including: • MO 21: Safety of navigation and emergency arrangements. • MO 30: Prevention of collisions. • MO 31: Vessel surveys and certification. **Application to activity**: The relevant vessels (according to class) will adhere to the relevant MO with regard to navigation and preventing collisions in Commonwealth waters. *Sections 6.15 details the requirements applicable to vessel activities.*	Certain sections of MARPOL International Convention for the Safety of Life at Sea 1974 COLREG 1972 United Nations Convention on the Law of the Sea 1982 (UNCLOS)	AMSA
Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) OPGGS(E)R	The Act addresses all licensing, health, safety, environmental and royalty issues for offshore petroleum exploration and development operations extending beyond the three-nautical mile limit. Part 2 of the OPGGS(E)R specifies that an EP must be prepared for any petroleum activity and that activities are undertaken in an ecologically sustainable manner and in accordance with an accepted EP. **Application to activity**: The OPGGS Act provides the regulatory framework for all offshore petroleum exploration and production activities in Commonwealth waters, to ensure that these activities are carried out:		NOPSEMA

Legislation	Scope	Related International Conventions	Administering Authority
	• Consistent with the principles of ecologically sustainable development as set out in section 3A of the EPBC Act. • So that environmental impacts and risks of the activity are reduced to as low as reasonably practicable (ALARP). • So that environmental impacts and risks of the activity are of an acceptable level. *Demonstration that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities are ALARP and acceptable is provided in Section 7.*		
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	This Act regulates Australian regulated vessels with respect to ship-related operational activities and invokes certain requirements of the MARPOL Convention relating to discharge of noxious liquid substances, sewage, garbage, air pollution etc. **Application to activity**: All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act. Several MOs are enacted under this Act relating to offshore petroleum activities, including: • MO 91: Marine Pollution Prevention – Oil. • MO 93: Marine Pollution Prevention – Noxious Liquid Substances. • MO 94: Marine Pollution Prevention – Packaged Harmful Substances. • MO 95: Marine Pollution Prevention – Garbage. • MO 96: Marine Pollution Prevention – Sewage. • MO 97: Marine Pollution Prevention – Air Pollution. *Sections 6.7, 6.10 and 6.13 details the requirements applicable to vessel and MODU activities.*	Various parts of MARPOL Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (also known as the London Protocol)	AMSA
Protection of the Sea (Harmful Antifouling Systems) Act 2006	Under this Act, it is an offence for a person to engage in negligent conduct that results in a harmful anti-fouling compound being applied to or present on a ship.	International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001	AMSA

Legislation	Scope	Related International Conventions	Administering Authority
	The Act also provides that Australian ships must hold 'anti-fouling certificates', provided they meet certain criteria. **Application to activity**: All ships involved in offshore petroleum activities in Australian waters are required to abide to the requirements under this Act. The MO 98: Marine Pollution Prevention – Anti-fouling Systems is enacted under this Act. *Sections 6.17 details the requirements applicable to vessel activities.*		
Underwater Cultural Heritage Act 2018	Protects the heritage values of shipwrecks, sunken aircraft and relics (older than 75 years) in Australian Territorial waters from the low water mark to the outer edge of the continental shelf (excluding the State's internal waterways). The Act allows for protection through the designation of protection zones. Activities / conduct prohibited within each zone will be specified. **Application to activity**: In the event of removal, damage or interference to shipwrecks, sunken aircraft or relics declared to be historic under the legislation, activity is proposed with declared protection zones, or there is the discovery of shipwrecks or relics. *Section 4.5.1 identifies no shipwrecks within the Operational Area but an extensive number of shipwrecks within the EMBA*	Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972	DotEE

Table 1-3: Recovery plans and species conservation advices relevant to the Wandoo Well Construction Environment Plan

Relevant Plan/Advice	Applicable Threats or Management Advice
National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (DSEWPaC, 2011)	The recovery plan is a co-ordinated conservation strategy for albatrosses and giant petrels listed as threatened. • **Marine pollution**: evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. • **Marine debris**: evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Sternula nereis nereis* (Fairy Tern) (TSSC, 2011)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy tern. • **Marine pollution:** evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Calidris canutus* (Red Knot)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the red knot. **Threats:** • **Marine pollution**: evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Calidris tenuirostris* (Great knot)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the great knot. **Threats:** • **Habitat loss and degradation:** prevent destruction of key breeding and migratory staging sites. • **Marine pollution:** evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Calidris frruginea* (Curlew sandpiper)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the curlew sandpiper. • **Habitat loss and degradation:** maintain undisturbed feeding and roosting habitat at sites on the north-west coast used during migration for the species
Approved Conservation Advice for *Charadrius mongolus* (Lesser sand plover)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the lesser sand plover. **Threats:** • Habitat loss and degradation from pollution, changes to water regimes and invasive plants

Relevant Plan/Advice	Applicable Threats or Management Advice
Approved Conservation Advice for *Ptodroma mollis* (soft-plumaged petrel)	Conservation advice provides management actions that can be undertaken to ensure the conservation of Aboott's booby. **Threats:** None applicable
Approved Conservation Advice for *Papasula abbotti* (Abbott's booby)	Conservation advice provides management actions that can be undertaken to ensure the conservation of Aboott's booby. **Threats:** • Loss of breeding habitat on Christmas Island.
Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australian lesser noddy. **Threats:** • **Marine pollution:** evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Wildlife Conservation Plan for Migratory Shorebirds – 2015 (DoE, 2015)	• None identified.
Approved Conservation Advice for *Rhincodon typus* (whale shark)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the whale shark **Threats:** • **Habitat loss and degradation from pollution, changes to water reigimes and invasive plants**
Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013)	The overarching objective of this recovery plan is to assist the recovery of the white shark in the wild throughout its range in Australian waters. **Threats**: • None identified.
Recovery Plan for the Grey Nurse Shark (*Carcharias Taurus)* west coast population (DoE 2014)	The recovery plan considers the conservation requirements of the grey nurse shark across its range and identifies the actions to be taken to ensure the species long-term viability.
Approved Conservation Advice for *Pristis zijsron* (green sawfish)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the green sawfish. **Threats:**

Relevant Plan/Advice	Applicable Threats or Management Advice
Sawfish and River Sharks Multispecies Recovery Plan: (*Pristis, Pristis zijsron, Pristis clavata, Glyphis glyphis* and *Glyphis garricki*)	• **Habitat loss and degradation**
Approved Conservation Advice for *Pristis clavata* (dwarf sawfish) Sawfish and River Sharks Multispecies Recovery Plan: (*Pristis pristis, Pristis zijsron, Pristis clavata, Glyphis glyphis* and *Glyphis garricki*)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the dwarf sawfish. **Threats:** • **Habitat loss and degradation**
Approved Conservation Advice for short-nosed sea snake (*Aipysurus apraefrontalis*)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the short-nosed sea snake. **Threats:** • **Degradation of reef habitat**: no anthropogenic disturbance in areas where the Short-nosed Sea Snake occurs.
Recovery Plan for Marine Turtles in Australia, 2017-2027 (DEE, 2017)	The long-term recovery objective for marine turtles is to minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act Threatened species list. **Threats:** • Chemical and terrestrial discharge. • Marine debris. • Light pollution. • Habitat modification. • Vessel strike. • Noise interference. • Vessel disturbance.
Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle)	See above for Recovery Plan for Marine Turtles in Australia, 2017-2027.

Relevant Plan/Advice	Applicable Threats or Management Advice
Conservation Management Plan for the Blue Whale, 2015-2025 (DoE, 2015)	The long-term recovery objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list. **Threats:** • Noise interference: evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented. • Vessel disturbance: evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the sei whale. **Threats:** • Noise interference: evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • Vessel disturbance: evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Megaptera novaeangliae* (Humpback Whale) (TSSC, 2015)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the humpback whale. **Threats:** • Noise interference: evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • Vessel disturbance: evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Conservation Management Plan for the Southern Right Whale 2011-2021 (DSEWPaC, 2012)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Southern right whale. **Threats:** • Noise interference: evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • Vessel disturbance: evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the fin whale. **Threats:** • Noise interference: evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • Vessel disturbance: evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.

Relevant Plan/Advice	Applicable Threats or Management Advice
Recovery plan for the Australian Sea Lion (*Neophoca cinereal*)	The long-term recovery objective for the Australian sea lion is to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list. **Threats:** • Noise interference: evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented. • Vessel disturbance: evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.

1.6.2 Western Australian legislation

Whilst the scope of this activity is limited to the Operational area within Australian Commonwealth waters, there are a number of State legislative requirements relevant to potential oil spill response activities in State jurisdiction.

Table 1-4 summarises the principal Western Australian legislative requirements relevant to spill response activities in State jurisdiction.

1.6.3 Codes of Practice

The Australian Petroleum Production and Exploration Association (APPEA) Code of Environmental Practice is the most relevant Code of Practice for well construction and intervention operations. Specific requirements of the APPEA Code of Environmental Practice include:

- compliance with applicable laws, regulations, standards and guidelines and, in their absence, adopting the most practical means to prevent or minimise adverse environmental impacts;
- ensuring that waste management practices minimise the potential impact on the environment. Practices are based on the prevention, minimisation, recycling, treatment and safe disposal of wastes;
- providing adequate training to enable employees and contractors to adopt environmentally responsible work practices;
- developing emergency plans and procedures so that incidents can be responded to in a timely and effective manner; and
- developing and maintaining management systems to identify, control and monitor risks.

VOGA is an APPEA member and, when undertaking its projects and activities, adheres to the provisions of its Code of Environmental Practice.

Additionally, the International Finance Corporation (IFC) Environmental, Health, and Safety (EHS) Guidelines (June 2015) are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).

Both the APPEA Code of Environmental Practice and the IFC Environmental, Health, and Safety Guidelines were key references in preparing for the environmental risk assessment process associated with this EP and in the development of the performance outcomes contained within it.

Table 1-4: Relevant Western Australian Legislation

Legislation	Scope	Application to Activity	Administering Authority
Biodiversity Conservation Act 2016	Provides for the conservation and protection of biodiversity and biodiversity components and the ecologically sustainable use of biodiversity components in Western Australia	Biodiversity Conservation Regulations 2018 sets out separation distances for whale sharks and other marine fauna.	Department of Biodiversity, Conservation and Attractions (DBCA)
Environmental Protection Act 1986	Provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment	This Act regulates wastes discharged into the environment	Department of Water and Environmental Regulation (DWER)
Conservation and Land Management Act 1984	This Act provides for the use, protection and management of public lands, including parks and forests. It includes water, flora and fauna on these lands.	The Act may be triggered in the event of a spill that impacts upon a public conservation reserve	DBCA
Fish Resources Management Act 1996	Regulates the management of and utilisation and conservation of fish and their habitat.	Liaison with commercial fishermen. Requires management of IMS risks.	Department of Primary Industries and Regional Development (DPIRD)
Local Government Act 1985	This Act is concerned with the administration of municipalities. It vests local authorities with responsibility for handling domestic and trade wastes, sewage disposal and protection of water sources (channels, pools, dams, etc.) from pollution.	Waste will be disposed of at an onshore facility	Local Government Authority
Marine and Harbours Act 1981	Provides for the advancement of efficient and safe shipping and effective boating and port administration	This Act contains regulations to control the refuelling of ships and boats; administered by the Department of Fisheries.	Department of Fisheries (DoF)
Maritime Archaeology Act 1973	Provides for the preservation of the remains of ships lost before 1900	May be triggered in the event of impacts to a known or previously un-located shipwreck	WA Museum
Pollution of Waters by Oil and Noxious Substances Act 1987	Provides for the protection of the sea from pollution by oil and other noxious substances. Gives effect to MARPOL in state waters.	Triggered in the event of vessels operating in state waters	Department of Transport (DoT) Relevant Port Authority
Western Australian Marine Act 1982	Regulates navigation and shipping	Triggered in the event of vessels operating in state waters	DoT

2 Description of Activity

2.1 Overview

The Wandoo Field was discovered in 1991. Extraction of crude oil commenced in 1993 from a single unmanned monopod wellhead platform (Wandoo A) supporting a helideck and five production wells. The Wandoo B production platform and a Concrete Gravity Structure (CGS) with associated processing facilities, was installed in 1997 and connected to Wandoo A by a subsea pipeline. The oil produced from Wandoo A (WNA) is piped to the Wandoo B (WNB) platform. After treatment, the oil is stored in the CGS and then, when sufficient volumes are available, offloaded through flexible pipelines to a Catenary Anchor Leg Mooring Buoy (CALM Buoy) located 1.2km north of the WNB platform (refer Figure 2-1). A floating hose is used to transfer the oil from the CALM Buoy to export tankers situated at a mooring facility. Export tankers are chartered on a spot basis to offload the oil.

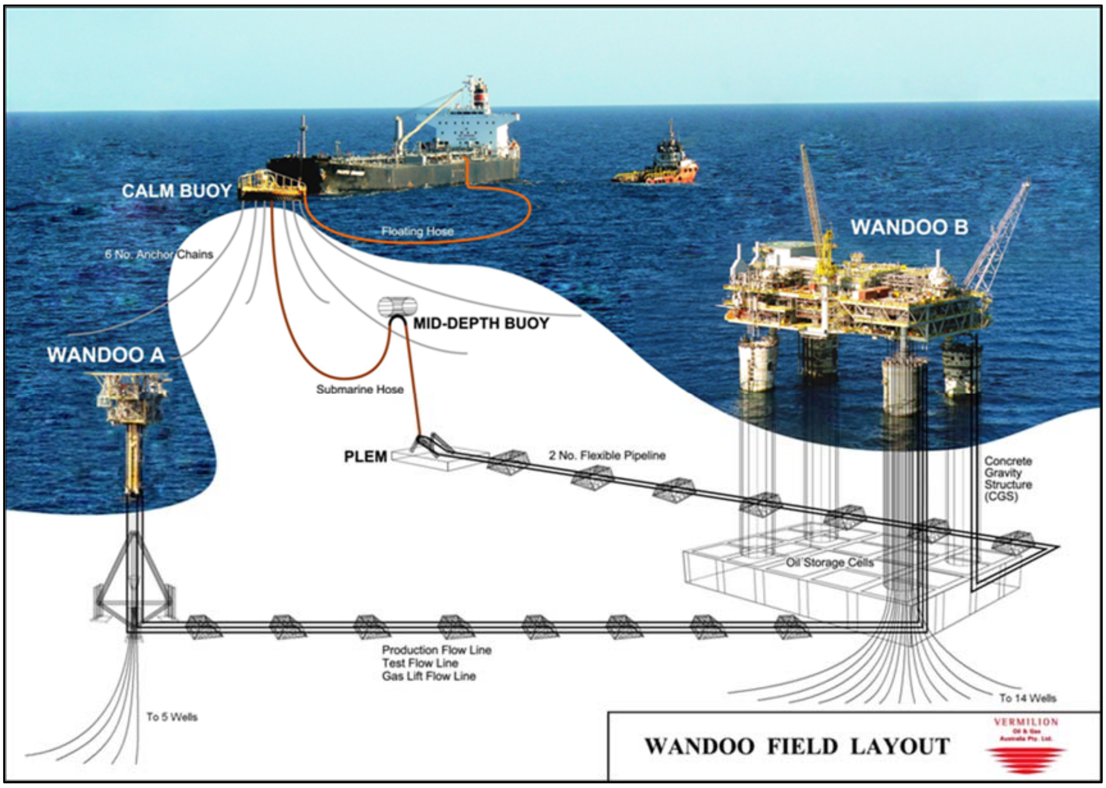


Figure 2-1: The Wandoo Oil Production Facilities

The scope of the well construction operations planned for the Wandoo Field over the next five years includes:

- well interventions and side-tracks;
- construction of new wells;
- abandonment of existing laterals and well bores; and
- slot recoveries.

Timing is based on MODU availability and not restricted to any specific months or seasons. Assessment in this EP have considered all relevant seasonal conditions and factors that may influence the activity and associated environmental impact.

The primary purpose of these activities will be to add new production intervals to access undrained oil in the Wandoo reservoir. A secondary aim will be to continue the evaluation of the Field boundaries to determine the extent of the Wandoo reservoir in the areas of the Field which the new trajectories will access. This evaluation process will provide critical information for the updating of VOGA's Geological and Reservoir Models for the Field, allowing both future development and production processes to be optimised.

Drilling of a new well from a recovered slot on WNA or WNB is undertaken if an existing well is first abandoned and the slot recovered for use in a new well (Section 2.4.3). In addition, the existing wells at Wandoo are also candidates for conversion into multi-lateral wells (Section 2.4.4), along with well interventions and well abandonment (Section 2.4.5 and 2.4.6 respectively).

The use of MODUs is described in Section 2.6.1, and supporting activities within the operational area such as AHTS support vessels and helicopters are described in Sections 2.6.2 and 2.6.3. Section 3.2 describes the emissions, waste and discharge streams. Section 2.5 details the spill response activities in the unlikely event of an hydrocarbon release during the well construction activity. A summary of the key parameters of the activity are detailed in Table 2-1.

Table 2-1: Key parameters of well construction activities

Operational Area	WA-14L
Reservoir	*M. australis* Sandstone
Type of well	Production
Oil type	Medium density crude
Well depth	Up to 6,000m
Workover duration	~30 days for each well
Campaign frequency	Every two to three years
Campaign duration	50-100 days
MODU type	Jack-up Drilling Rig
Helicopter flights into operational area	2-7 return flights per week
Vessel transit into operational area	Daily

2.2 Location

The Wandoo Field is located approximately 80km northwest of the port of Dampier. Geographical coordinates of the various facilities at Wandoo are given in Table 2-2. The location of the Wandoo Field and existing Petroleum Safety Zone (PSZ) is shown in Figure 2-2.

Table 2-2: Coordinates of Wandoo facilities

Facility	Latitude	Longitude
Wandoo A	20°08' 20" S	116°25' 17.5" E
Wandoo B	20°07' 43" S	116°26' 04" E
Anchorage	20°05' 00" S	116°23' 48" E
CALM Buoy	20°07' 02" S	116°26' 02" E

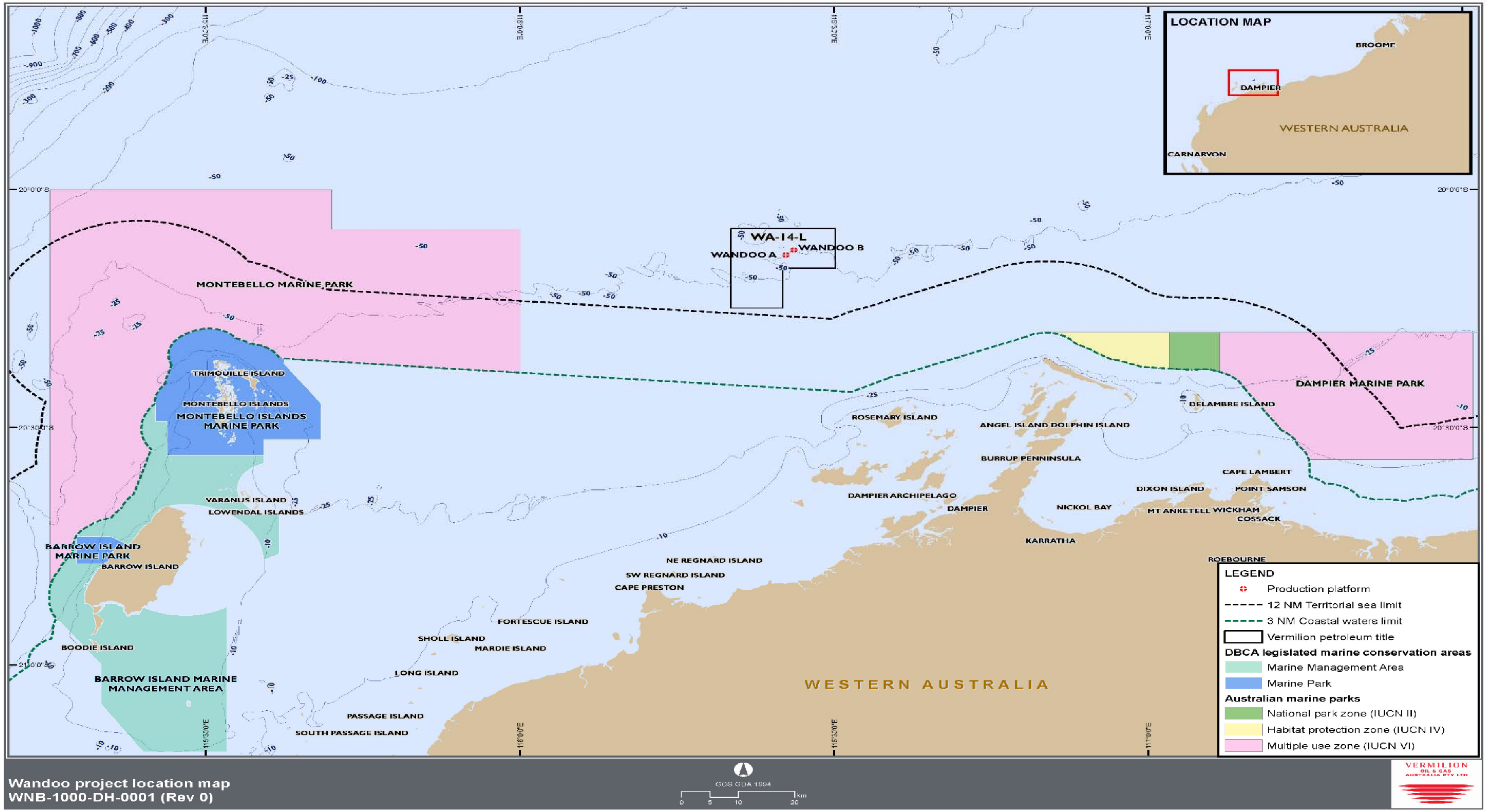


Figure 2-2: The Location of the Wandoo Field

2.2.1 Reservoir oil characterisation

Wandoo crude, having lost the majority of its lighter fractions due to microbial biodegradation in the reservoir, is a 19.4° API crude, and is similar to other medium crude produced on the North-West Shelf (NWS). It has a low pour point, virtually no paraffin wax and low asphaltene content. Modelling undertaken by RPS for the Wandoo B16 well (RPS, 2019) shows that for Wandoo Crude, approximately 1.7% (by mass) of volatile hydrocarbons will evaporate within the first 12 hours. A further 10.2% of the oil is characterised as the semi-volatile hydrocarbon compounds and will evaporate within the first 24 hours while an additional 33.1% represent the low volatiles and will typically evaporate over several days. A relatively high proportion (55%) of hydrocarbon compounds is persistent which are unlikely to evaporate and will decay over time.

A summary of reservoir oil specification is contained in Table 2-3 and Table 2-4.

Table 2-3 Physical properties for Wandoo Crude.

Properties	Wandoo Crude
Density (kg/m^3)	0.937 (at 16 °C)
API	19.4
Dynamic viscosity (cP)	161 (at 25 °C)
Pour point (°C)	-24
Hydrocarbon property category	Group IV
Hydrocarbon property classification	Persistent

Table 2-4 Boiling point ranges for Wandoo Crude.

Characteristic Oil Type	Volatiles (%)	Semi-volatiles (%)	Low Volatiles (%)	Residual (%)
Boiling point (°C)	< 180	180-265	265-380	> 380
	Non persistent			Persistent
Wandoo Crude	1.7	10.2	33.1	55

2.3 Geology and reservoir characteristics

The seabed at Wandoo is approximately 50m below mean sea level. The lithological sequence of interest in the Wandoo Oil Field:

- **Sea floor to 300m Total Vertical Depth Rotary Table (TVDRT) – Tertiary age**: The upper 300m is highly uncompacted calcareous mudstone. No hydrocarbon indications have been seen on any wells drilled in the Field. No evidence of porosity in samples or logs;
- **300 to 480m TVDRT – Cretaceous age "Santonian"**: Claystone and calcareous claystone. These rocks are non-porous and form the main sealing formation in the area. Traces of siderite and sandstone occur in a few wells in the Field. No hydrocarbon indications have been seen on any wells drilled in the Field. No porosity or hydrocarbon shows observed;
- **480 to 540m TVDRT – Cretaceous age "Cenomanian"**: Claystone with minor silty claystone interbeds. No hydrocarbon indications have been seen on any wells drilled in the Field. No porosity or hydrocarbon shows observed;

- **540 to 580m TVDRT – Cretaceous age "Albian"**: Claystone with minor silty claystone interbeds. No hydrocarbon indications have been seen on any wells drilled in the Field. No porosity or hydrocarbon shows observed;
- **580 to 750 m TVDRT - Cretaceous - Barremian to Valanginian (Muderong Shale Formation)**: 100% glauconitic claystone. It has calcareous cement with abundant interspersed glauconitic fine peletal glauconite. No porosity with minor patchy oil stains on cuttings is observed; and
- **620 to 690m TVDRT – Cretaceous age "M. *australis* Sandstone"**: A fine to medium-grained glauconitic sandstone (greensand) that is the main producing formation of the Wandoo Field.

Currently, the only producing reservoir in the Operational Area is the *M. australis* Sandstone. The *M. australis* Sandstone is subdivided into an upper unit (the A sand) and lower unit (the B sand). The A sand is a fine-grained highly glauconitic sandstone (greensand) with a porosity of approximately 30% and permeability ranging from 50 to 3000 millidarcy (mD) with reservoir characteristics that improve markedly with depth. The A sand is subdivided into three units, the uppermost being the A1 and the lowermost the A3. The B sand is a relatively clean, fine to medium-grained, quartzose sandstone of exceptional reservoir characteristics with porosities ranging from 35% to 40% and permeability ranging from 5 to 15 darcy (D). The B sand is also subdivided into a number of units based on reservoir quality (B1, B2, etc.).

Both the A and B sands are effectively unconsolidated. An important feature of the A sand is the presence of laterally discontinuous and co-relatable siderite beds. These siderite beds are primarily concentrated in the A2 unit. Due to the unconsolidated nature of the sand and its high glauconite content, drill cuttings from the reservoir do not consist of rock chips and fragments that would otherwise be expected if a harder substrate or more consolidated substrata was drilled. Consequently, cuttings from this reservoir consist essentially of loose grains of sand and dispersed clays rather than rock fragments.

Prior to the start of production, the Field had a 22.1m oil column overlain by an 18m gas column at the crest of the Field. The oil is heavily biodegraded and viscous (19.4 API gravity, 14.5 centiPoise (cP) viscosity, -24°C pour point) and has a low Gas Oil Ratio (GOR) (99 standard cubic feet per barrel (scf/bbl)). The sulphur and wax contents are also low. The Field is currently drained by 20 horizontal wells, with injection of excess gas being carried out through another horizontal well. All wells are drilled from two platforms (WNA and WNB).

2.4 Wandoo Field well construction operations

VOGA became the Licence Holder in 2005. Since that time VOGA has carried out multiple workovers and drilled four new wells and eight new side-track laterals into the reservoir. An outline of previous VOGA well construction campaigns is presented in Table 2-5 below.

Table 2-5: Previous VOGA well construction campaigns

Well	Date
Wandoo B13 drill and complete	2008
Wandoo B14 drill and complete	2008
Wandoo B8 ST1 re-enter, side-track and complete	2010
Wandoo B12 ST3 re-enter, side-track and complete	2010
Wandoo A6 H3 re-enter, side-track and complete	2010

Well	Date
Wandoo B5 ST1 re-enter, side-track and complete	2013
Wandoo B9 ST1 re-enter, side-track and complete	2013
Wandoo A5ST1 re-enter, side-track and complete	2015
Wandoo B4ST1 re-enter, side-track and complete	2016
Wandoo B11ST1 re-enter, side-track and complete	2016
Wandoo B15 drill and complete	2018/19
Wandoo B16 drill and complete	2018/19

The well construction operations planned for the Wandoo Field over the next five years includes:

- well interventions and side-tracks;
- construction of new wells;
- abandonment of existing laterals and well bores; and
- slot recoveries.

Due to MODU availability it is possible that well construction activities could occur at any time during the calendar year.

2.4.1 Moving a MODU onto location

The MODUs that will be used by VOGA in its Wandoo well construction campaigns will be jack-up drilling rigs. They have three legs fabricated in a lattice structure terminating with a spud-can or foot at the base. The spud-can is approximately 15m in diameter and terminates in a point. Each of the three MODU legs is individually controlled.

A MODU is typically towed between two locations using one or two vessels, with its legs well clear of the seabed. Mobilisation of the MODU from either international or Australian territorial waters remains the responsibility of the contracted MODU Operator. Once the MODU is in waters adjacent to the Operational area, the MODU is moved into the Wandoo Facility Petroleum Safety Zone (PSZ) under the direction of VOGA in accordance with the rig move plan. Once in the Operational area, the management of the MODU is within scope of this EP. As it nears the planned drilling location the tow speed will be slowed to allow the MODU to be positioned over the desired location, at which time the move is stopped and the legs are jacked down to contact the seabed. If the MODU is moved to a location alongside one of the Wandoo platforms it will be initially towed by one or two vessels until it is a few kilometres from the Field. At this time the tow will be halted and the vessels rearranged such that there is a vessel on each corner of the MODU. The MODU will then be moved into its final position under the control of the three vessels and then the legs jacked down to contact the seabed.

After confirming the integrity of the seabed, the MODU hull will be jacked up to working height. At the completion of operations, arrangements will be made for the MODU to move off location and, when ready, the hull will be jacked down into the water, and hull integrity tests are carried out while two vessels are connected to the hull (three vessels will be connected if the MODU is being moved to a location alongside another Wandoo facility). The legs will then be raised clear of the seabed and the tow vessels will move the MODU to its next location. At the desired location the legs will be lowered, and process repeated.

2.4.2 Drilling a development well from a new slot

Drilling and completing a new well may take up to 30 days, depending upon specific complexities. The basic sequence to drill a new development well is as follows:

- drill a sufficient diameter hole (to accommodate the conductor) to around 25m below the seabed;
- set a conductor about 25m below the seabed and cement it in place (if the well will be a producer);
- drill 445mm or 416 mm hole directionally to around 300m below sea level;
- set 340mm casing, cement it in place and install Blowout Preventers (BOPs);
- drill 311mm hole directionally building to 90° inclination in the *M. australis* sandstone reservoir (the depth will depend on specific well requirements);
- set 244mm casing, cementing it in place;
- drill 216mm hole horizontally in the reservoir;
- install sand exclusion screens;
- complete the well;
- plug the completion to allow safe removal of the BOPs;
- remove BOPs and install a production Xmas tree;
- remove suspension plugs; and
- formal handover of the well from Well Construction to Production.

2.4.3 Drilling a new well from a recovered slot

New wells are possible if a well is drilled near the existing facilities (refer to Section 2.4.2), or if an existing well is first abandoned and the slot recovered for use in a new well. Drilling and completing a new well may take up to 30 days, depending upon specific complexities.

The basic sequence to drill a new Wandoo development well from a recovered slot is as follows:

- formal handover of the well from Production to Well Construction;
- kill the existing well by displacing oil in the existing completion to completion brine;
- install BOPs on the existing wellhead;
- remove the existing completion tubing from the well;
- set and verify cement abandonment plugs in the well near the reservoir;
- displace the well to a corrosion inhibited kill density brine;
- mechanically cut and recover the 244mm casing below the selected kick-off point;
- set cement kick-off plug;
- drill 311mm hole directionally building to 90° inclination in the *M. australis* sandstone reservoir (the depth will depend on specific well requirements);
- set 244mm casing, cementing it in place;

- drill 216mm hole horizontally in the reservoir;
- install sand exclusion screens;
- complete the well;
- plug the completion to allow safe removal of the BOPs;
- remove BOPs and install a production Xmas tree;
- remove suspension plugs; and
- formal handover of the well from Well Construction to Production.

2.4.4 Conversion of existing wells and side-tracks

When the Wandoo wells were first drilled, they were drilled such that each well provided one production interval. It is now possible to drill multilateral wells in which more than one production interval is accessed with a single oil well at surface. The existing wells at Wandoo are candidates for conversion into multi-lateral wells. The duration of a single well side-track or the installation of a new production interval is approximately 20 to 25 days.

To convert an existing, single producing well bore into a multilateral well, the basic sequence is as follows:

- formal handover of the well from Production to Well Construction;
- kill the existing well by displacing oil in the existing completion to completion brine;
- install BOPs on the existing wellhead;
- remove the existing completion tubing from the well;
- install-tie back equipment to enable the original well bore to be retained;
- mill a window in the casing above the tie-back equipment;
- drill a new horizontal production interval;
- install sand exclusion screens in the new production interval;
- form a sealing junction at the milled window;
- run a new completion into the well;
- plug the well to allow safe removal of the BOPs;
- remove the BOPs and install a production Xmas tree;
- remove suspension plugs; and
- formal handover of the well from Well Construction to Production.

2.4.5 MODU based well interventions

Well interventions are workover-type well repairs or modifications and are designed to improve reservoir access or to rectify a problem in an existing well. The duration of a well intervention is highly dependent on what operation is required. The duration of a single well intervention will typically be about five to 15 days.

A typical sequence of operations is as follows:

- formal handover of the well from Production to Well Construction;
- kill the existing well by displacing oil in the existing completion to completion brine;
- install BOPs on the existing wellhead;
- remove the existing completion tubing from the well;
- carry out the planned change and install a new completion in the well;
- plug the completion to allow safe removal of the BOPs;
- remove BOPs and install a production Xmas tree;
- remove suspension plugs; and
- formal handover of the well from Well Construction to Production.

Note: rigless well intervention activities (i.e from the Wandoo Facility) are provided for within the Wandoo Facility Environment Plan (WPA-7000-YH-0007).

2.4.6 Well abandonments

Well abandonment is the process of sealing an unused well to ensure hydrocarbons cannot flow to the environment at some point in the future. At some point in field life each of the Wandoo wells will be plugged and abandoned. It may occur at the end of the economical field life, or it may be much sooner if a slot is required for a new well. Well abandonments will take about three to seven days to complete.

The basic sequence for Wandoo well abandonment is as follows:

- formal handover of the well from Production to Well Construction;
- kill the existing well by displacing oil in the existing completion to completion brine;
- install BOPs on the existing wellhead;
- remove the existing completion tubing from the well;
- set and verify cement abandonment plugs in the well near the reservoir;
- displace the well to a corrosion inhibited kill density brine;
- set and verify cement abandonment plugs close to the seabed;
- mechanically cut the 244mm casing below seabed;
- remove BOPs and wellhead;
- recover cut 244mm casing;
- cut and recover 340mm casing below seabed;
- set a surface cement plug across the 244mm and 340mm casing stubs; and
- cut the conductor below seabed and recover same.

2.5 Spill response activities

Although well construction activities are well understood and part of routine activities in the oil and gas industry, these activities carry an inherent risk of a loss of well control occurring. In order to mitigate impacts from a potential spill event resulting from well construction activities, VOGA has an array of potential spill response strategies that can be implemented in the event of a spill.

2.5.1 Source control

Source control is one of the first response strategies that should be considered when mounting a spill response. Source control minimises the volume of hydrocarbons lost to the environment by regaining control at the source of the spill. In many cases, source control can be as simple as turning off a valve but may also be as complex as drilling a relief well.

2.5.2 Monitoring and evaluation

Monitoring and evaluation is a technique used to understand the behaviour and likely trajectory of an oil spill to assist with selecting the most appropriate spill response strategy and to evaluate results during the response process. Several methods can be used to monitor and evaluate, including:

- surveillance from field infrastructure, MODU and vessels;
- aerial surveillance;
- satellite tracking buoys; and
- oil spill trajectory modelling.

2.5.3 Chemical dispersion

Chemical dispersion involves the application of chemical dispersant which accelerates the natural dispersion process, causing the oil to break down into small droplets, which are then rapidly dispersed into the water column and away from the ocean surface where it can be more easily biodegraded. The objective of dispersant use is to enhance the amount of oil that physically mixes into the water column, reducing the potential for a surface slick to contaminate shoreline habitats or come into contact with birds, marine mammals or other marine fauna that exist on the water surface or shoreline.

2.5.4 Containment and recovery

Booms and skimming equipment can be used to create physical barriers on the water surface to contain and recover the oil spill where information (including predictive spill fate modelling) indicates a likely threat to environmental, social and cultural sensitivities. This strategy is often used in the offshore environment in close proximity to the hydrocarbon source. Once contained, an attempt to recover the hydrocarbons from the surface waters can be undertaken.

2.5.5 Mechanical dispersion

Mechanical dispersion is the use of fire monitors, engine wash or other means to mechanically/physically disperse spilt oil into the water column, thereby increasing the speed with which weathering and biodegradation occurs. This strategy is a secondary strategy for all spill categories that could result from activities in the Operational Area.

2.5.6 Protection and deflection

The deployment of protection and deflection booms, along with a combination of sediment barriers and filter fences, can assist with minimising the potential impact and/or deflecting a slick away from sensitive areas towards those where collection can be more effective without impacting high value habitat areas.

2.5.7 Shoreline clean-up

Shoreline clean-up is the removal of oil from shorelines. Shorelines clean-up techniques that could be implemented in the event of an oil spill include:

- Natural recovery;
  - Physical cleaning/remove/disposal;
  - Manual clean-up
  - Vacuum systems
  - Use of sorbents.
- Physical cleaning/washing;
  - Low-pressure flushing
  - Steam cleaning
  - Sand blasting.
- Physical cleaning in-situ;
  - Surf washing/sediment reworking.
  - Treatment; and Bioremediation.

2.5.8 Oiled wildlife response

Oil Wildlife Response may consist of hazing, capture, recovery, assessment, cleaning and rehabilitation of oiled wildlife.

2.6 Wandoo Field support operations

2.6.1 Mobile offshore drilling units

MODUs used at Wandoo are jack-up barges with three independently controllable legs. The MODU is positioned as required using AHTS vessels and then the legs are jacked down to contact the seabed. Seawater is pumped onto the MODU to increase its mass and verify that the seabed has sufficient strength to support the MODU weight and operational loads. The MODU hull is then jacked up out of the ocean and elevated to a height that is well clear of waves that may occur during a storm or cyclone.

Example specifications for a MODU suitable for operating at Wandoo are provided in Table 2-6. The example MODUs are those typically used on the NWS, with minor variations in jack up size not considered to result in any material changes in environmental impact. The anticipated routine operational discharges from the MODU during well construction activities are detailed in Table 3-2.

Table 2-6: Example specifications for a MODU suitable for operating at Wandoo

Rig type:	Jack-up – Keppel FELS KFELS MOD V Super B Class or Friede & Goldman JU3000N designs or similar
Personnel on board:	Up to 150 persons
Rig dimensions (typical):	Length ~75 to 85m Breadth ~70m Depth ~8 to 10m Legs 3 in triangular format up to 150m long Leg Spacing Longitudinal centre ~40 to 45m, transverse centre ~45 to 47mm Spud-cans ~15m diameter x ~6m high
BOP system:	Manufactured and maintained to API standards and meeting VOGA well construction standards. Minimum specification 5,000psi working pressure with three rams and one annular preventer with redundant control systems. BOP control system does not vent fluid to the environment.
Fuel volumes on site:	Typical - ±850m^3
Fuel consumption:	Typical – 12 ~ 18m^3/day
Fuel transfer hose:	Typical – 3” to 4” flexible hose fitted with dry-break couplings
Cranes:	Typical – SeaTrax fitted with 36m boom; Main Block maximum load 50T at 10.5m radius and 15T at 36m radius; Whip Line 15T at 36m radius; hook load indicator; audible and visible alarms; automatic brake; crown saver limit switch
Method of crew change:	Helicopter from Dampier

2.6.2 AHTS support vessels

Two AHTS support vessels are typically contracted for the duration of each campaign. A third AHTS vessel of similar or lesser specifications may also be used during rig moves and to provide additional logistical support.

The general specifications for AHTS vessels suitable for supporting well construction operations at Wandoo are provided in Table 2-7.

Table 2-7: General specifications for AHTS vessels suitable for supporting well construction operations at Wandoo

Vessel type:	Dynamic positioned AHTS.
Personnel on board:	Up to 52 persons (max) – typical crew 15 persons
AHTS dimensions (typical):	Length ± 95m Breadth ± 25m Draft ± 8.7m
Main engines:	23,000 bhp
Fuel volumes on site:	Up to ±2,325m^3 (cargo fuel) ±290m^3 (fuel)
Fuel consumption:	Standby in field ± 6.0m^3/day Economical speed ± 13.0m^3/day Maximum speed ± 50m^3/day
One-way voyage to or from Dampier:	Economical speed ± 4½ hours Maximum speed ± 3½ hours

The AHTS vessels contracted to support the MODU operations will provide the following services under the scope of this EP:

- tow the MODU onto and off location, including positioning it within the Operational area;
- transfer of supplies to the MODU whilst on location in the Operational area (including food, water, bulk materials, hardware, drilling mud material and diesel fuel);
- on location support duties, including maintaining watch of surrounding AHTS activity;
- emergency response, including rescue; and
- on-site oil spill response support.

The AHTS vessels will also provide the following services during the campaigns:

- tow the MODU to and from waters adjacent to the Operational area;
- transport of supplies between Dampier and the Operational area
- oil spill response support within the Hydrocarbon Area (Section 2.5).

Vessel operations within Australian Commonwealth waters outside of the Operational area are managed under the Navigation Act 2012 as administered by the Australian Maritime Safety Authority (AMSA), and are therefore out of scope of this EP.

All AHTS vessels will be required, under contract, to comply with all State and Commonwealth legislation for the control of all sources of pollution and of discharges at sea and to comply with MARPOL 73/78.

Cargo will be transferred to or from the MODU using the MODU cranes. Bulk powdered mud products, liquid mud products and diesel will be transferred to the MODU using MODU supplied transfer hoses. Diesel fuel transfers from AHTS supply vessels to the MODU or the WNB platform will take place approximately once a week during the period spent on location. All refuelling operations and cargo transfer activities will be conducted in strict accordance with Company and industry requirements.

The anticipated routine operational discharges from the AHTS support vessels during well construction activities are detailed in Table 3-2.

2.6.3 Helicopter support

VOGA will contract specialist aviation service contractors to provide helicopter services to support well construction campaigns:

Helicopter services provide the following support services.

- personnel and minor cargo transfers between Karratha and the MODU;
- medivac;
- emergency evacuation of the MODU; and
- night standby duty, with the helicopter and flight crews capable of flying under instrument flight rules, i.e. capable of flying at night and during low cloud.

It is expected there will be approximately six to seven helicopter flights to the MODU each week during well construction activities.

Routine helicopter operations will be limited to daylight hours.

The Wandoo production operations helicopter will provide backup to the helicopter contracted for the MODU operations.

Helicopter refuelling on the MODU is not planned while it is jacked up on location in the Operational area.

Crew changes will occur via helicopter. Helicopter operations will be based out of the Karratha Airport. Personnel will travel between Perth and Karratha on commercial fixed wing aircraft.

Aviation activities are managed under the Civil Aviation Act 1988 and Civil Aviation Regulation 1998 as administered by the Australian Civil Aviation Safety Authority (CASA), and are therefore out of scope of this EP.

3 Description of Project Context

3.1 Potential Environmental Hazards

Based on the activities described in Section 2, the following potential environmental hazards have been identified for assessment and management:

- Planned and unplanned interactions with the environment resulting from moving a MODU onto location; drilling and well interventions; and spill response activities:
  - Physical presence of the MODU and AHTS vessels
  - Seabed disturbance from the MODU
  - Introduction of invasive marine species at the Operational area
- Emissions and discharges to the environment from routine MODU and AHTS vessels operations; drilling and well interventions; and spill response activities:
  - Noise
  - Atmospheric emissions
  - Artificial light
  - Discharge of cooling water/reject water
  - Deck drainage and bilge water discharge
  - Non-hazardous and hazardous waste
  - Discharge of sewage, grey water and putrescible wastes
- Drilling-specific discharges to the environment from drilling and well interventions:
  - Drill cuttings
  - Cement
  - Steel shavings
  - Well drilling and completions fluids
- Unplanned discharges to the environment during routine MODU and AHTS vessels operations; and drilling and well interventions:
  - Liquid hydrocarbon release from wells
  - Liquid hydrocarbon release from the MODU, export equipment or pipeline(s)
  - Diesel spill to sea from vessel collision
  - Ancillary hydrocarbons or chemical spills from the MODU or AHTS vessels
- Spill response specific interactions, discharges and emissions to the environment from the spill response activities.

The relationship between activities and environmental hazards is shown in Table 3-1.

Table 3-1: Relationship between Activities and Environmental Hazards

EP risk no.	Hazard	Activity									
					Spill response activities						
		Moving a MODU onto Location	Drilling and well interventions	Routine MODU and AHTS vessels Operations	Source Control	Monitoring and Evaluation	Chemical Dispersion	Containment and Recovery	Mechanical Dispersion	Shoreline Clean-up	Oiled Wildlife Response
EP-WC-R01	Liquid hydrocarbon release from wells		x								
EP-WC-R02	Liquid hydrocarbon release from the MODU, export equipment or pipeline(s)		x								
EP-WC-R03	Diesel spill to sea			x	x						
EP-WC-R04	Oil spill response strategy hazards				x	x	x	x	x	x	x
EP-WC-R05	Noise		x	x	x	x	x	x	x		
EP-WC-R06	Atmospheric emissions			x	x	x	x	x	x		
EP-WC-R07	Artificial light			x	x	x	x	x			
EP-WC-R08	Discharge of cooling water/reject water			x	x						
EP-WC-R09	Deck drainage and bilge water discharge			x	x	x	x	x	x		
EP-WC-R10	Non-hazardous and hazardous waste			x	x					x	x
EP-WC-R11	Discharge of drill cuttings, cement, steel shavings and well drilling and completions fluids		x		x						
EP-WC-R12	Discharge of sewage, grey water and putrescible wastes			x							
EP-WC-R13	Ancillary hydrocarbons or chemical spills		x	x	x	x	x	x			
EP-WC-R14	Physical presence of MODU and AHTS vessels	x		x	x	x	x	x	x	x	x
EP-WC-R15	Seabed disturbance	x	x		x						
EP-WC-R16	Introduction of invasive marine species	x			x	x		x		x	x

3.2 Basis of Assessment

Project specific data, industry experience, modelling and published studies are used to determine the temporal and spatial characteristics of environmental hazards. This forms the basis of the assessment.

The project data required to understand each activity and the potential hazards is provided in Table 3-2.

In many cases, activities and hazards are well understood, and typical of those undertaken throughout the industry. Published literature can therefore be used to support the understanding of the interaction between the activity and the existing environment. Some hazards, however, are specific to the project described in this EP, and further information is required to understand how such activities or hazards will affect the existing environment, therefore modelling and/or studies have been undertaken.

Table 3-2 also summarises the use of published literature and modelling studies in this EP.

Table 3-2: Basis of Assessment

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
EP-WC-R01	Liquid hydrocarbon release from wells	Drilling and well intervention	Hydrocarbon characteristics	Wandoo Crude is comprised approximately of: • ~1.7% of volatile hydrocarbons that will evaporate within the first 12 hours. • ~10.2% of semi-volatile hydrocarbon compounds that will evaporate within the first 24 hours. • ~33.1% represent the low volatiles and will typically evaporate over several days. • ~55% is persistent which are unlikely to evaporate and will decay over time.	Wandoo Crude Oil Assay Report Number 2007-FED-032680
			Flow rates; Potential spill extent	Daily flow rates calculated to identify total release of 25,555 m^3 of Wandoo Crude over 43 days. Spill extent details provided in Section 3.2.1.	Society of Petroleum Engineers (SPE) Technical Report: Calculation of Worst-Case Discharge (WCD) (April, 2015): https://www.onepetro.org/general/SPE-174705-TR Technical Note –2019 Blowout Modelling Update (WNB-3000-RO-0007)
			Credible spill scenarios	Credible Scenario: Loss of Well Control, a surface release of 25,555 m^3 of Wandoo Crude over 43 days (tracked for 73 days).	Source Control Contingency Plan [VOG-5000-PD-0001] Oil Spill Response Capability Review [VOG-7000-RH-009_6] Technical Note –2019 Blowout Modelling Update (June 2019)
EP-WC-R02	Liquid hydrocarbon release from	Drilling and well intervention;	Hydrocarbon characteristics	MODU platform and export system contains Wandoo Crude – refer to hydrocarbon characteristics defined for EP-WC-R01.	Wandoo Crude Oil Assay Report Number 2007-FED-032680

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
	the MODU, export equipment or pipeline(s)	Spill response	Potential spill volumes and extent	The quantities of any potential spill and gas releases are minimised during the Rig move and positioning phases giving a potential total loss of up to 300m^3 of export pipeline, 0.16m^3 of oil from the WNA export line and/or 0.5m^3 of oil per conductor. For potential spill extent refer to EP-WC-R03.	Wandoo Facility Safety Case [WNB-1000-YH-0001]
			Credible spill scenarios	Credible Scenario: Collision between MODU or AHTS vessels and a platform, resulting in a loss of hydrocarbons (Wandoo Crude) from the platform or export system.	Wandoo Facility EP [WPA-7000-YH-0007] Wandoo Facility Safety Case [WNB-1000-YH-0001]
EP-WC-R03	Diesel spill to sea	Moving a MODU onto location; Routine support operations	Hydrocarbon characteristics	Diesel weathering characteristics	National Energy Resources Australia (NERA) Consequence Analysis of an Accidental Release of Diesel Reference Case (NERA, 2018).
			Potential spill volumes and extent	The anticipated total volume of diesel that may be stored, within multiple internal tanks, by the MODU and AHTS vessel are 824m^3 and 2,325m^3 respectively. The maximum volume of the single largest fuel tank (based upon 100% capacity) aboard an AHTS is generally <300m^3 and less for a MODU. For conservatism in impact assessment, the maximum spill extent of 150km in the NERA Reference Case was used which is based on a diesel spill volume of up to of 700m^3	AMSA Technical guidelines for preparing contingency plans for marine and coastal facilities (Commonwealth of Australia, January 2015): https://www.amsa.gov.au/sites/default/files/2015-04-np-gui012-contingency-planning.pdf Volumes based upon largest potential vessel in field: Maersk Master: https://www.maersksupplyservice.com/wp-content/uploads/2019/08/Maersk-Master-1.4-1.pdf National Energy Resources Australia (NERA) Consequence Analysis of an Accidental Release of Diesel Reference Case (NERA, 2018).

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
			Credible spill scenarios	Credible Scenario: Loss of diesel from MODU/AHTS vessel caused by collision with another vessel or the Facility.	Wandoo Facility EP [WPA-7000-YH-0007] Wandoo Facility Safety Case [WNB-1000-YH-0001]
EP-WC-R04	Oil spill response strategy hazards	Spill response	Determination of spill response activities	The following spill response activities have been determined as suitable for consideration: • source control; • monitor and evaluate; • chemical dispersion; • containment and recovery; • mechanical dispersion; • protection and deflection; • shoreline clean-up; and • oiled wildlife response.	Wandoo Field Oil Spill Contingency Plan - Oil Pollution Emergency Plan [WAN-2000-RD-0001.02] Refer to Section 2.5.
EP-WC-R05	Noise	Drilling and well intervention; Routine support operations; Spill response activities	Sound source levels	Estimated source level for: • MODU jackup rig: Source level - 137 dB re 1 µPa @ 1 m RMS (Marine Acoustics 2011). Frequency – 10 – 1000 Hz (Marine Acoustics 2011). • Vessels: Source level - ~192 dB re 1 µPa @ 1 m RMS (Genesis Oil and Gas Consultants 2011). Frequency - 20 to 300 Hz (Genesis Oil and Gas Consultants 2011). Equinor (2019) modelling of underwater sound propagation from the loudest sources of sound associated with the drilling activity (MODU thrusters – SPL of 196.7 238 dB re 1 µPa at 1 m	Equinor. 2019. Environment plan Appendix 6-1 Underwater sound modelling report Stromlo-1 exploration drilling program. Equinor Australia B.V. Perth, Australia. Marine Acoustics. 2011. Underwater Acoustic Measurement of the Spartan 151 Jack-up Drilling Rig in the Cook Inlet Beluga Whale Critical Habitat. Prepared for: Furie Operating Alaska, LLC. Fairweather Science LLC. 2018. Petition for Incidental Take Regulations for Oil and Gas Activities in Cook Inlet, Alaska. Genesis Oil and Gas Consultants. 2011. Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. 2011. Genesis Oil

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
				RMS) showed a range of conservative maximum distances at which the various biological effects levels are predicted to be exceeded. The greatest of these was the maximum distance over which the NMFS (2018) guideline for TTS effects on low-frequency cetaceans was exceeded at a maximum of 25 km from the MODU, due to the continuous emission of sound over 24 hours (Equinor 2019). Recognising there is uncertainty in the sensitivity of marine fauna, a conservative buffer is recommended and the maximum extent of underwater noise effects on marine fauna should be set at 40 km from the well location.	and Gas Consultants report for the Department of Energy and Climate Change.
EP-WC-R06	Atmospheric emissions	Routine support operations	Details of emissions	Modelling was undertaken for nitrogen dioxide (NO2) emissions from MODU power generation for an offshore drilling project (BP 2013). NO2 is the focus of the modelling because it is considered the main atmospheric pollutant of concern based on the larger predicted emission volumes as compared to other pollutants (SOx, CO and non-methane hydrocarbons) and its potential to impact upon the environment. Modelling indicates that on an hourly average, there is the potential for an increase in ambient NO2 concentrations of 0.0005 ppm within 10 km of the source and an increase of less than 0.00005 ppm in ambient NO2 concentrations more than 40 km away. The modelling also	BP. 2013. Shah Deniz 2 Project. Environmental & Socio-Economic Impact Assessment. BP Development Pty Ltd. MODU specifications based upon Noble Tom Prosser as representative large MODU: https://www.noblecorp.com/assets/pdfs/Rig-Details-Noble-Tom-Prosser.pdf

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
				indicates that the highest hourly averages of 0.00039 ppm were restricted to approximately 5 km from the MODU (BP 2013).	
EP-WC-R07	Artificial light	Routine support operations	Details of emissions	Monitoring by Woodside (2010) whilst drilling the Torosa South-1 well indicates that light density (navigational lighting) attenuated to below 1.00 lux and 0.03 lux at distances of 300 m and 1.4 km from a rig, respectively. Light densities of 1.0 and 0.03 lux are comparable to natural light densities experienced during deep twilight and during a quarter moon.	Environmental Resources Management. 2010. Browse Upstream LNG Development: Light Impact Assessment, Report produced for Woodside Energy Limited.
EP-WC-R08	Discharge of cooling water/reject water	Routine support operations	Volume and characteristics of discharge	Modelling of continuous wastewater discharges (including cooling water) undertaken by Woodside for its Torosa South-1 drilling program 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 ambient within 100 m (horizontally) of the discharge point, and 10 m vertically (Woodside 2014 cited in Woodside 2019).	Woodside Energy Ltd. 2019. Scarborough Offshore Project Proposal. June 2019. Woodside Energy, Perth WA.
EP-WC-R09	Deck drainage and bilge water discharge	Routine support operations	Volume and characteristics of discharge	Consist primarily of rainwater and deck wash-down water. Rainwater that collects on deck and deck wash-down water may contain small amounts of detergents, oil and grease, spilt chemicals, used machinery chemicals and dirt from the decks. Deck drainage water will be directed to a sump (or similar) which is connected to an oil-water separator. Once separated using oil in water (OIW) separator, the oil and grease will be stored in suitable	N/A

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
				containers ahead of transfer ashore for recycling. The treated water will be discharged to sea.	
EP-WC-R10	Non-hazardous and hazardous waste	Routine support operations	Volume and characteristics of discharge	General non-hazardous wastes include scrap materials, packaging, wood and paper and empty containers. Chemicals and other hazardous materials that will be stored on the MODU or AHTS vessels include: • drilling fluid additives such as biocides, corrosion inhibitors, viscosity, weighting and fluid loss control chemicals; • miscellaneous chemicals such as pipe dope, lubricating oils, cleaning and cooling agents; • oil filters and batteries; • contaminated Personal Protective Equipment (PPE) and rags; • paint, aerosol cans; and • acids/caustics and solvents.	N/A
EP-WC-R11	Discharge of drill cuttings, cement, steel shavings and well drilling and completions fluids	Drilling and well interventions	Drilling and completion fluids	There are five drilling and completions fluids planned for use at Wandoo: • Seawater with bentonite sweeps: used for drilling the tophole section(s), discharged to the seabed. Formulated from fresh water, bentonite clay, xanthium gum or guar gum and a small addition of sodium hydroxide. • KCL/PHPA/Glycol: used to drill the intermediate hole section after BOPs have	Well Construction Process Manual (VOG-5000-MN-0002)

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
				been installed. This fluid is recycled via the MODU shale shakers and solids control systems. • Drill-in fluid: used for drilling the Wandoo reservoir section. Formulated to minimise long-term damage to the formation and provide hole cleaning. • Solids free fluid: After drilling has been completed, the well is displaced to a polymer-based solids free completion fluid before sand exclusion screens are run. • Completion brine: After the completion has been run, the well bore is displaced with completion brine treated with a small amount of biocide to prevent souring of the reservoir. This is a filtered inhibited potassium chloride brine with a density of around 1.07sg. No SBM will be used.	
			Drill cuttings and fluids discharge – volume and characteristics	Refer above for cuttings and fluids	B15 End of Well Report – conservative cuttings and fluid discharge volumes are based on B15 well drilled in 2018-19
			Cement discharge – volume and characteristics	New wells will require casing strings to be run and cemented. The cementing process used for the installation of a conductor results in the return of minor volumes (less than 1m^3) of cement slurry to the seabed to ensure that the conductor is fully cemented. There will also be a minor amount of highly diluted cement washed to the MODU's	Well Construction Process Manual (VOG-5000-MN-0002) BP. 2013. Shah Deniz 2 Project. Environmental & Socio-Economic Impact Assessment. BP Development Pty Ltd.

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
				drainage system during the clean-up of the cement unit following cementing operations. Modelling of cement discharges from BP's Shah Deniz 2 offshore drilling project (BP 2013) provides a conservative assessment of the potential extent of cement exposure. The modelling considered cement discharged directly to the seabed of 200 T per well at a rate of 1.3 m^3/hour. Two hours after the start of discharge, plume concentrations were determined to be between 5 and 50 mg/L with the horizontal and vertical extents of the plume approximately 150 m and 10 m, respectively (BP 2013). Five hours after ceasing the discharge, modelling indicated that the plume had dispersed to concentrations below 5 mg/L (BP 2013).	
EP-WC-R12	Discharge of sewage, grey water and putrescible wastes	Routine support operations	POB on MODU / vessels	MODU = 150 POB AHTS vessels = up to 25 POB Based on these numbers, operation of the MODU and AHTS vessels will typically result in the generation of approximately 35m^3 per day of domestic discharges (based on 200L/day/person) including grey water, sewage and putrescible waste. For NERA reference case 2017:1001, the sewage and greywater discharge volume is limited to 150 m^3/day and is expected to remain within the nominal mixing zone boundary of 500 m around fixed facilities.	NERA – Environment Plan Reference Case - 2017:1001 - Sewage, grey-water and putrescible waste discharges

EP risk no.	Hazard	Source activities	Project data		Data source(s) used
EP-WC-R13	Ancillary hydrocarbons or chemical spills	Drilling and well interventions; Routine support operations; Spill response	Hydrocarbon/Chemical inventory onboard MODU and AHTS	The types of fluids on a MODU or vessel range from lubricating fluids to hydraulic, fuel and cooling fluids. The leaks may come from a failure of a mechanical component, fitting or hose. Any spills are likely to be small in nature with the largest credible event being the volume of a 205 L drum. For potential spill extent refer to EP-WC-R03.	MODU / vessel inventory checklist
EP-WC-R14	Physical presence of MODU and AHTS vessels	Moving a MODU onto location; Routine support operations; Spill response	Exclusion zone, locations, number of vessels, duration of exclusion	500 m PSZ currently applies to all Wandoo platforms and will apply to platform-based drilling associated with this activity. Duration of exclusion corresponds to the duration of the activity	Western Australian Government Gazette, Perth, Tuesday, 8 October 1996, No. 147. https://www.nopsema.gov.au/assets/Gazettal-notices/A269538.pdf Stakeholder consultation
EP-WC-R15	Seabed disturbance	Moving a MODU onto location; Routine support operations	Seabed footprint of MODU at each location, number of locations; Number of wells	The footings (known as 'spud-cans') on the bottom of the MODU legs cover an area of about 145 m^2 (based on approximately 2 m penetration of the seabed).	Refer to Section 2.6.1 for example MODU specifications
EP-WC-R16	Introduction of invasive marine species	Moving a MODU onto location; Routine support operations	Origin of MODU and AHTS vessels	Vessel managers should comply with relevant international, national and state obligations, legislation and guidelines before travelling into and within WA waters to keep the risk of transporting IMS to an acceptable (low) level (DPIRD 2015).	https://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biosecurity/Vessels-And-Ports/Pages/Legislation-Policies-And-Advice.aspxStakeholder consultation

3.2.1 Oil Spill Modelling

As identified in Table 3-2, oil spill modelling is required to determine the potential spatial and temporal extent of exposure associated with an unplanned release of reservoir hydrocarbons or diesel to the marine environment. Modelling undertaken for this EP is described in detail in the following sections.

3.2.1.1 *Unplanned Release of Reservoir Hydrocarbons*

OSTM was used to assess the potential environmental impacts of the worst-case crude oil and diesel oil spills associated with the well construction activities, based on the latest reservoir modelling information available to VOGA. Details regarding the oil spill modelling undertaken by RPS to support this EP are provided below and in Appendix 2.

A well blowout scenario was modelled in 2019 (RPS, 2019). The modelled scenario was based on a 25,555 m^3 surface release of Wandoo Crude over 43 days (tracked for 73 days) using summer, winter and transitional wind and current conditions. Modelling outputs were used to predict the probability and the number of days for specific hydrocarbon threshold concentrations to contact identified values and sensitivities.

To determine the potential benefit of applying dispersant across different seasons, the 100 simulations per season were remodelled under identical conditions, accounting for dispersants being applied for 10 hours during daylight, 48 hours after the initial release. Dispersant application was assumed to be limited to a 40 km by 40 km zone centred on the release location. A conservative dispersant to oil ratio of 1:20 and effectiveness of 50% was utilised.

Spill modelling was based on the parameters of the B16 production well. This well was determined to be representative of the worst-case flow and duration for the Wandoo Field under 2019 reservoir conditions; based on Wandoo reservoir physical conditions and measured properties along with dynamic reservoir simulation. Other well locations modelled by VOGA showed either no flow to the surface or lesser total volumes being released in the event of a blowout at these locations.

The B16 production well is also deemed a representative location within the overall development area, due to the distance separating the infrastructure (less than 2km). There would be minimal difference between oil spill trajectories if the release occurred at another location within the Development area, as the variation in metocean characteristics and relative proximity to the WA coastline and sensitive environments is insignificant across the Development area.

3.2.1.2 *Diesel spill scenario*

Potential impacts in the unlikely event of vessel to vessel collision resulting in a fuel tank rupture are described in the National Energy Resources Australia (NERA) Consequence Analysis of an Accidental Release of Diesel Reference Case (NERA, 2018). This is based on conservative modelling outputs. Refer to Section 6.4 for details.

3.3 Project Areas

Project Areas are the different areas, or zones, defined for this EP as areas of potential hazard or exposure to receptors. Some environmental hazards have been grouped within the same area, where the receptors affected, and the potential spatial boundary of the impacts are similar. Other environmental hazards, such as those associated with exposure from a hydrocarbon spill, have a specific project area defined.

The existing environment within each project area is described in Section 4. The nature and scale of the information provided in the description of the environment depends upon the potential environmental hazards which may occur within that project area, and their scope for exposure to affected receptors.

For this EP, the following Project Areas have been defined:

- Environment that may be Affected (EMBA) – the area within which a change in ambient environmental conditions could occur as a result of planned or unplanned activities (Figure 4-1). The EMBA is has been defined based on the outcomes of stochastic modelling (i.e. cumulative extent of a total of 100 model simulations per season) using low exposure values for each of the modelled oil components (1 g/m^2 floating, 10 ppb dissolved, 10 ppb entrained, 10 g/m^2 shoreline) which are threshold levels used to establish the range of socio-economic effects and establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers.
- Hydrocarbon Area – This area has been defined to include the worst-case extent of predicted hydrocarbon exposure from planned and unplanned activities at exposure values that may have ecological or social impacts. The Hydrocarbon Area has been defined based on the outcomes of stochastic modelling (i.e. cumulative extent of a total of 100 model simulations per season) using moderate exposure values for each of the modelled oil components (10 g/m^2 floating, 50 ppb dissolved, 100 ppb entrained, 100 g/m^2 shoreline) which are threshold levels anticipated to result in behavioural changes and sub-lethal and lethal effects to biota) and includes all probabilities of exposure.
- Operational Area – the area in which planned activities, as described in Section 2 of this EP, will occur. Defined as the area within the existing Petroleum Safety Zone (PSZ) within the Permit Area of WA-14-L (Figure 3-1) around the Wandoo facility during routine well construction activities, or within a 2 km radius of any potential relief well location during emergency conditions.

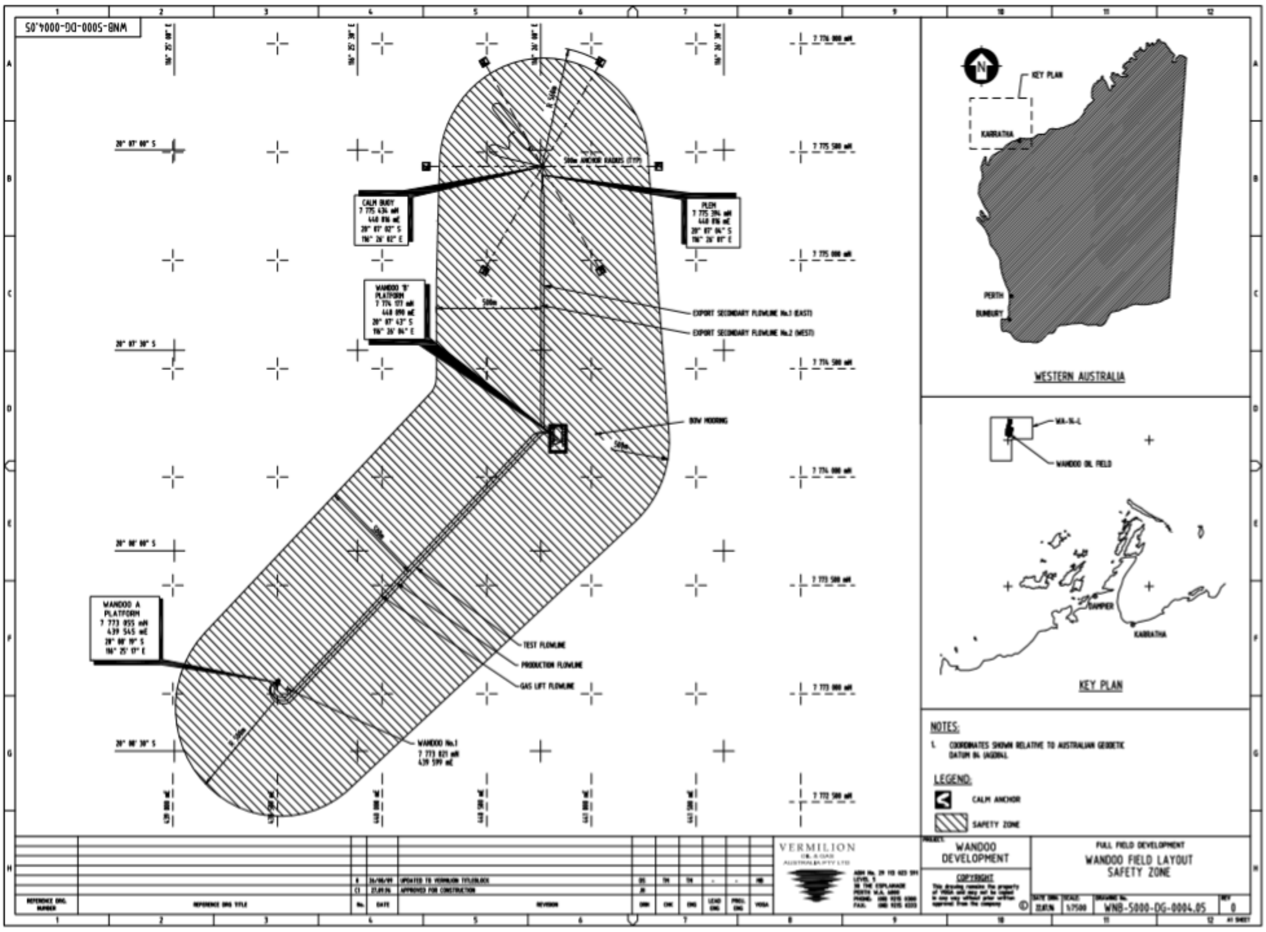


Figure 3-1: Operational Area of the well construction activity

Environmental hazards have the potential to result in impacts or risks to environmental receptors, if they are present within the spatial or temporal boundaries of the environmental hazard.

By using the Project Areas defined in Section 3.3, it is possible to identify receptors which may typically be impacted, depending on their behaviours. This process guides the nature and scale of details provided in the Description of the Existing Environment, ensuring that our understanding of receptors within the Existing Environment of each Project Areas is sufficient to undertake the impact assessment.

Table 3-3: Environmental Hazards within each Project Area

EP risk no.	Hazard	Impact / Risk	Project Areas		
			Operational Area	Hydrocarbon Area	EMBA
EP-WC-R01	Liquid hydrocarbon release from wells	Temporary decrease in marine water quality.	x	x	x
		Increased toxicity of, and bioaccumulation in, marine organisms from the ingestion of hydrocarbons. Injury or death of exposed marine fauna (e.g. oiling of seabirds). Habitat impacts where the spill reaches sensitive marine areas such as coral reefs or the shoreline.	x	x	
EP-WC-R02	Liquid hydrocarbon release from the MODU, export equipment or pipeline(s)	Temporary decrease in marine water quality.	x	x	x
		Increased toxicity of, and bioaccumulation in, marine organisms from the ingestion of hydrocarbons. Injury or death of exposed marine fauna (e.g. oiling of seabirds). Habitat impacts where the spill reaches sensitive marine areas such as coral reefs or the shoreline.	x	X	
EP-WC-R03	Diesel spill to sea	Temporary decrease in marine water quality.	x	x	x
		Increased toxicity of, and bioaccumulation in, marine organisms from the ingestion of hydrocarbons.	x	x	
EP-WC-R04	Oil spill response strategy hazards	Increased entrained fraction of hydrocarbons in the water column after adding dispersants. Toxicity effects on marine fauna from dispersant. Disturbance to benthic habitat, adjacent vegetation and other environmentally sensitive areas. Scouring of sediments. Waste generation, disposal and management.	x	x	
EP-WC-R05	Noise	Injury to hearing or other organs of marine fauna	x		
		Masking or interfering with biologically important sounds	x		
		Disturbance leading to behavioural changes or displacement of fauna	x		
EP-WC-R06	Atmospheric emissions	A localised and temporary reduction in air quality leading to the displacement or injury of avifauna. Substantial contribution to global greenhouse gases.	x		
EP-WC-R07	Artificial light	Disorientation, attraction or repulsion of marine fauna and birds. Altered foraging and breeding behaviours including increased predation risk.	x		
EP-WC-R08	Discharge of cooling water/reject water	Thermal impacts to marine organisms. Reduced dissolved oxygen concentrations and dilute hypochlorite content, leading to localised impacts on pelagic fauna. Toxicity effects to marine organisms in the immediate vicinity of the discharge.	x		
EP-WC-R09	Deck drainage and bilge water discharge	Reduction in water quality. Toxicity effects to marine organisms in the immediate vicinity of the discharge.	x		
EP-WC-R10	Non-hazardous and hazardous waste	Marine pollution (litter). Injury and entanglement of marine fauna and seabirds. Potential toxicity effects to marine fauna.	x		
EP-WC-R11	Discharge of drill cuttings, cement, steel shavings and well drilling and completions fluids	Burial and smothering of benthic habitat and fauna; Increased water turbidity and localised changes to water quality; and Potential toxicity effects to marine fauna.	x		
EP-WC-R12	Discharge of sewage, grey water and putrescible wastes	Nutrient enrichment and increased biological demand of surrounding waters.	x		

EP risk no.	Hazard	Impact / Risk	Project Areas		
			Operational Area	Hydrocarbon Area	EMBA
		Low level contamination of organisms caused by ingestion of waste materials. Increase in scavenging behaviour of marine fauna and seabirds.			
EP-WC-R13	Ancillary hydrocarbons or chemical spills	Reduction in water quality. Toxic effects on marine biota.	x		
EP-WC-R14	Physical presence of MODU and AHTS vessels	Disturbance marine fauna including marine mammals, reptiles and birds. Interaction with commercial and recreational fishing and shipping.	x		
EP-WC-R15	Seabed disturbance	Seafloor scour. Increase in turbidity of the water column/reduction light penetration. Localised smothering of benthos. Localised reduction in benthic productivity.	x		
EP-WC-R16	Introduction of invasive marine species	Changes to habitat structure. Predation of native species. Potential introduction of invasive marine species.	x		

3.4 Environmental Performance Outcomes

Based on the review of activities, aspects and related impacts and risks, VOGA has set the following Environmental Performance Outcomes to set the overarching performance level to manage well construction activities.

Table 3-4: Environmental Performance Outcomes

EPO Identifier	Environmental Performance Outcome
EPO WC 01	No change in water quality that may modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Listed Threatened Species is likely to decline.
EPO WC 02	No substantial change in water quality, sediment quality, air quality, ambient noise or ambient light which may adversely impact on biodiversity, ecological integrity, social amenity or human health.
EPO WC 03	No substantial change in water quality, sediment quality, air quality or biota which may adversely impact the function, interests or activities other marine users.
EPO WC 04	No long-term decrease in the size or area of occupancy of a Critically Endangered/Endangered species population or fragment an existing population.
EPO WC 05	No change that may have a substantial adverse effect on habitat critical to the survival of a Listed Threatened Species.
EPO WC 06	No change that may substantially disrupt the breeding cycle of a Listed Threatened Species population.
EPO WC 07	No displacement of blue whales/pygmy blue whales from their foraging BIAs.
EPO WC 08	No displacement of marine turtles from their nesting/interesting BIAs.
EPO WC 09	No change that may interfere with the recovery of the Listed Threatened Species.
EPO WC 10	No change that may substantially modify, destroy or isolate an area of important habitat for a migratory species.
EPO WC 11	No change that may seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.
EPO WC 12	No change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth or State marine area.
EPO WC 13	No change that may have a substantial adverse effect on the protection and conservation of biodiversity, ecological processes and other natural, cultural and heritage values of marine parks and protected areas.
EPO WC 14	No change that may have a substantial adverse effect on a population of a non-listed marine species including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution.
EPO WC 15	No introduction of an invasive species that are harmful to a Listed Threatened or migratory species becoming established in the species' habitat / or result in a known or potential pest species becoming established in the Commonwealth marine area.
EPO WC 16	No change that may cause one or more of the World Heritage values of a declared World Heritage property to be lost, degraded or damaged, or notably altered, modified, obscured or diminished.

EPO WC 17	No change that may cause one or more of the National Heritage values of a National Heritage place to be lost, degraded or damaged, or notably altered, modified, obscured or diminished.
EPO WC 18	No substantial impact to heritage values or social surroundings, including damage or destruction of a historic shipwreck.
EPO WC 19	No interference with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted.
EPO WC 20	No substantial contribution to climate change

4 Description of the Environment

4.1 Overview

The OPPGGS(E)R define 'environment' as the ecosystems and their constituent parts, natural and physical resources, qualities and characteristics or areas, the heritage value of places and includes social, economic and cultural features of those matters. In accordance with the Regulations, the Description of the Environment describes the ecological and social components of the environment relevant to the activity and achieves the following:

- Provides adequate information about the environment that may be affected (EMBA) by the activity in sufficient detail to inform the evaluation of environmental impacts and risks. This includes the environment that may be affected by planned components of the activities, and the area that may be exposed during unplanned events such as a hydrocarbon spill.
- Adequately defines the environment that may be exposed to hydrocarbons in the event of a significant incident and the geographic extent of response and monitoring activities.
- Provides sufficient detail regarding relevant threatened or migratory species and their defined biologically important areas (BIA) and/or habitat critical for species survival.
- Identifies all values and sensitivities (if any) within the environment including matters protected under Part 3 of the EPBC Act.
- Enables relevant persons and members of the public to understand the environmental values and sensitivities that may be affected by the activity.

The Project Context for this EP has been established in Section 3. Using the Project Areas described in Section 3.3, the nature and scale of information provided in this section has been determined to ensure that adequate information is provided to support the assessment of impacts and risks associated with the scope of this EP.

4.2 Environment that May Be Affected

Well construction activities are planned to be undertaken by VOGA at the Wandoo field within Permit WA-14L, which is located in Commonwealth waters in the Carnarvon Basin off the northwest coast of Western Australia (WA), approximately 80 km northwest of Dampier and 110 km northeast of Barrow Island. The operational area lies within the Northwest IMCRA Province.

The EMBA for the Wandoo Field well construction activities have been defined by a spatial area within which a change to the ambient environmental conditions may occur as a result of planned or unplanned activities. It is noted that changes in ambient conditions, as defined for the EMBA, does not imply that an adverse impact will occur. The EMBA for well construction activities within the Wandoo field extends from approximately Perth to the Kimberley region of WA to the southern islands of Indonesia including Java, Penida Island, Lombok, West Nusa

Tenggara, East Nusa Tenggara, Sumba, Suwa Island and Timor, and extending to Christmas Island. According to NOPSEMA (2019), this represents the range of potential socio-economic impacts and establishes the planning area for scientific monitoring based on potential for exceedance of water quality triggers.

For the purposes of this EP, the defined EMBA associated with well construction activities at the Wandoo Field has been split into sub-areas which are used to support the impact and risk assessment process. Sub-regions are described in Section 3.3 and presented in Figure 4-1.

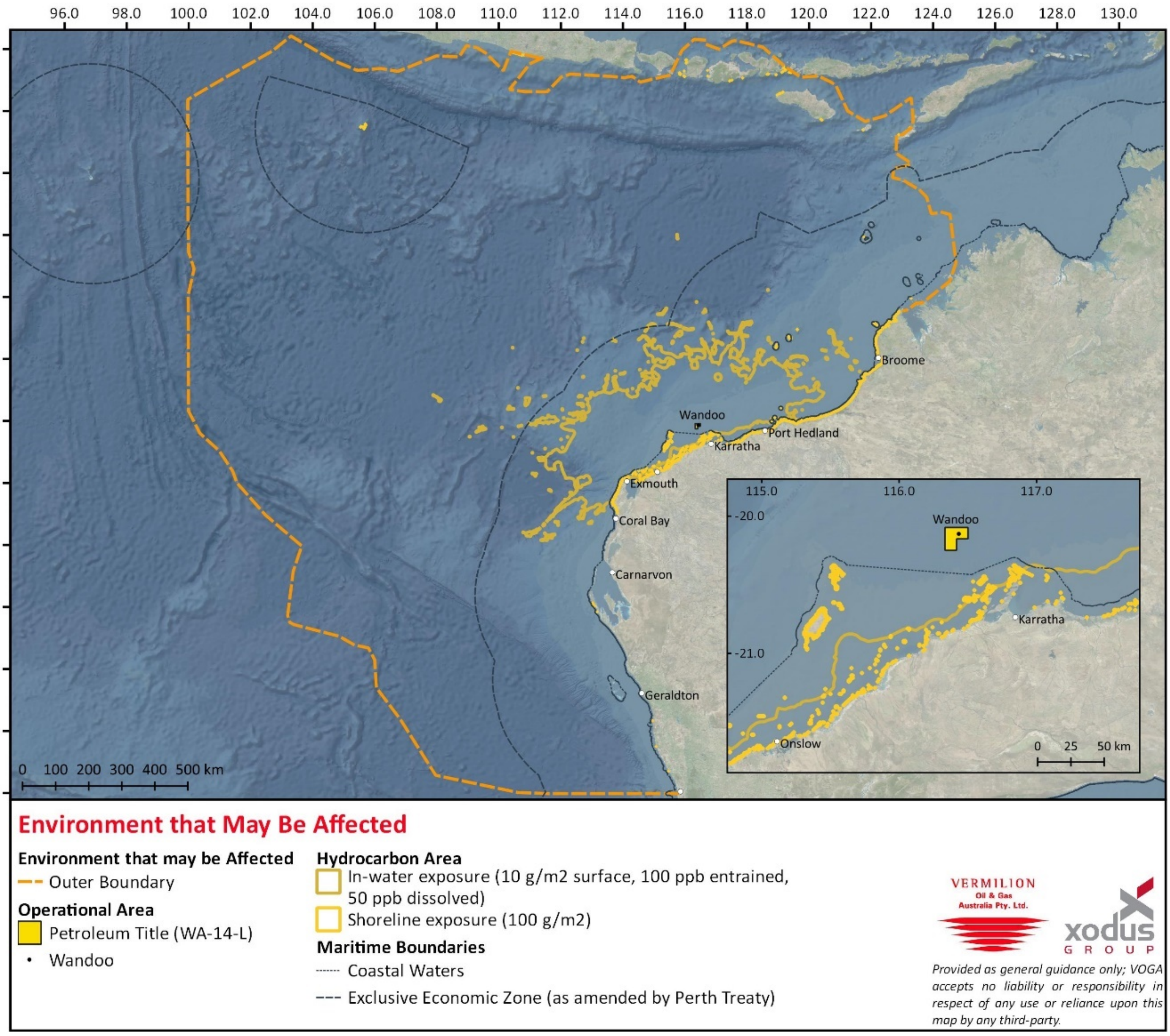


Figure 4-1 Environment that May be Affected

For each receptor or receptor group known to occur within the defined Project Areas, their presence / absence is identified in Table 4-1. This, combined with the understanding of how each receptor is affected by environmental hazards (as listed in Table 3-3), guides the nature and scale of information provided throughout Section 4. Receptors identified in this section may have associated threat abatement plans, threatened species recovery plans and species conservation advices which are detailed in Section 2.

Table 4-1: Receptor presence or absence within Project Areas

Receptor Group	Operational Area	Hydrocarbon Area – In-Water	Hydrocarbon Area - Shoreline	EMBA
Physical Environment	• Ambient water quality • Ambient air quality • Climate • Ambient noise • Ambient light	• Ambient water quality • Ambient air quality • Climate • Ambient noise • Ambient light	• Ambient water quality • Ambient air quality • Climate • Ambient noise Ambient light	• Ambient water quality • Ambient air quality • Climate • Ambient noise • Ambient light
Key marine habitats	• Subtidal soft sediment and benthic fauna	• Subtidal soft sediment and benthic fauna • Corals • Seagrasses • Macroalgae	• Rocky shorelines / intertidal reef platforms • Sandy beaches	• Subtidal soft sediment and benthic fauna • Corals • Seagrasses • Macroalgae
Key marine fauna	• Benthic invertebrates • Marine reptiles • Birds • Sharks and rays • Marine mammals	• Marine reptiles • Birds • Sharks and rays • Marine mammals	• Marine reptiles • Birds	• Benthic invertebrates • Marine reptiles • Birds • Sharks and rays • Marine mammals
Key Coastal Communities	None		• Mangroves • Saltmarsh • Intertidal beaches/ mudflats • Rocky shorelines/ intertidal reef platforms • Sandy beaches	• Mangroves • Sandy beaches • Rocky shorelines / intertidal reef platforms • Intertidal beaches/mudflats
Social and economic environment	• Fisheries and aquaculture • Commercial shipping	• Fisheries and aquaculture • Commercial shipping • Defence • Other users	• Other users	• National Heritage and shipwrecks • Fisheries and aquaculture • Commercial shipping • Defence • Other users
Values and Sensitivities	None	• World Heritage Areas • Commonwealth Marine Protected Areas	• World Heritage Areas • Wetlands of International Importance • Commonwealth Marine Protected Areas	• World Heritage Areas • Commonwealth Marine Protected Areas • State Marine Protected Areas

Receptor Group	Operational Area	Hydrocarbon Area – In-Water	Hydrocarbon Area - Shoreline	EMBA
		• State Marine Protected Areas • KEFs	• State Marine Protected Areas • KEFs	• Wetlands of International Importance • KEFs

4.2.1 Regional Context

Regional descriptions relevant to the EMBA sub-areas as shown in Table 4-2 and Figure 4-2 are provided in the sections below.

Table 4-2: Relevant regions to the EMBA sub-areas

Receptor Group	Operational Area	Hydrocarbon Area-In Water	Hydrocarbon Area-Shoreline	EMBA
North-west Marine Region	x	x	x	x
South-west Marine Region				x
Northwest Shelf Province	x	x	x	x
Northwest Shelf Transition				x
Timor Province				x
Northwest Transition		x	x	x
Northwest Province		x	x	x
Central Western Shelf Transition		x	x	x
Central Western Transition		x		x
Central Western Shelf Province			x	x
Central Western Province				x
Southwest Shelf Transition			x	x
Cocos (Keeling) Island Province				x
Christmas Island Province			x	x
Outside Australian EEZ			x	x

X= present within area

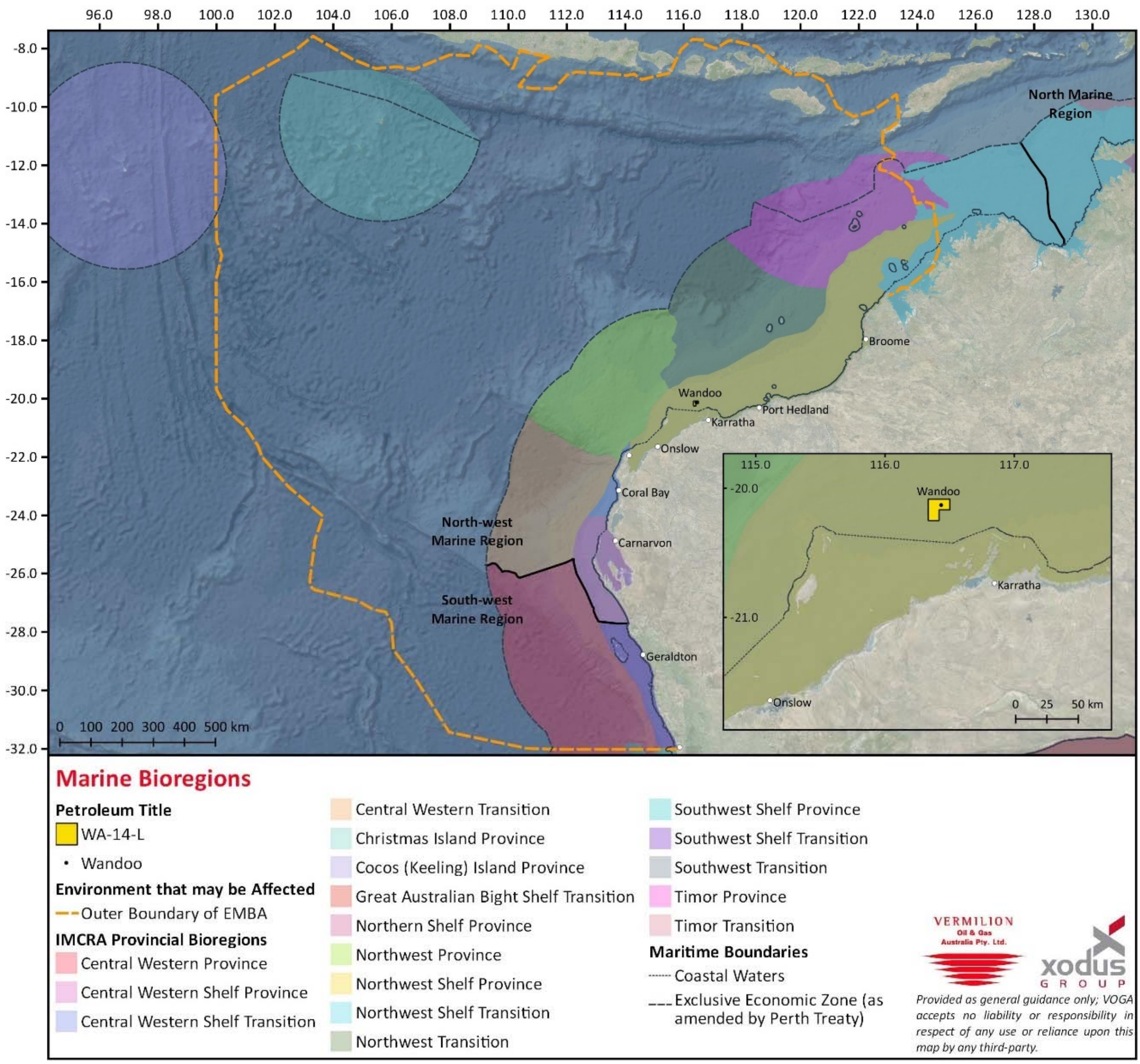


Figure 4-2: Marine Bioregions

4.2.1.1 *North-west Marine Region*

The North-west Marine Region lies within Commonwealth waters from the border of WA and the Northern territory (NT) to Kalbarri, covering ~1.07 million km^2 of tropical and sub-tropical waters.

Over 60% of the seafloor within the region is continental slope, of which extensive terraces and plateaux make up a large proportion. A majority of shallow waters are focused adjacent to the Pilbara and Kimberly regions (~30% of the total region) with the narrowest shelf margin of the region and Australia located at Ningaloo Reef. A majority of the region is relatively shallow with over 50% having water depths of less than 500m. The sections of the Argo and curier plains which lie within the region make up 10% of the its total area and are the deepest sections of the region reaching depths of almost 6000m.

The region is characterised by shallow-water tropical marine ecosystems. Endemism within the region is not particularly high by Australian standards, however, globally significant populations of internationally threatened species commonly occupy within the region.

4.2.1.2 *South-west Marine Region*

The South-west Marine Region lies within Commonwealth waters and extends from the eastern end of Kangaroo island, off the coast of South Australia, to Shark Bay in Western Australia, covering ~1.3 million km^2. The region is characterised by temperate waters off the south west of WA and subtropical waters along the southern coast, with high wave action throughout the region focused on the continental slope. By global standards, the South-west Marine Region is high in biodiversity with many species endemic to the region.

Dominant physical features of the region include a narrow continental shelf on the south-west coast transitioning into a wider continental shelf along the Great Australian Bight (GAB). Water depths vary throughout the region with islands and steep and muddy continental slopes, including canyons, being a common feature. Deeper waters of the region are poorly understood and can extend to greater than 4000m.

4.2.1.3 *North-west Shelf Province*

The North-west Shelf Province lies predominantly on the continental slope, extending from the North-west Cape to Cape Bougainville, covering an area of 238,759 km^2. Width of the bioregion varies along its length from ~ 50km at the Exmouth Gulf to more than 250km off Cape Leveque. About half the bioregion has water depths between 50 and 100m, with maximum depths reaching 200m.

The bioregion is a dynamic oceanographic environment and is influenced by cyclonic storms, strong and internal tides and long period swell. Its waters derive from the Indonesian Throughflow and are warm, oligotrophic and circulate throughout the bioregion via branches of the South Equatorial and Eastern Gyral Currents.

Fish communities in the bioregion are diverse comprising of both benthic and pelagic fish. Humpback Whales migrate through the area with the Exmouth Gulf considered an important resting area, particularly for mothers and calves on their southern migration. Several important breeding sites for seabirds are located within the region (outside Commonwealth Waters), including Eighty Mile Beach and the Montebello, Barrow and Lacepede islands.

Industries that utilise the resources found in bioregion include the petroleum industry, commercial fishers and shipping, with nationally significant ports of Dampier and Port Headland present.

4.2.1.4 *North-west Shelf Transition*

The Northwest Shelf Transition is divided between the North and North-west Marine Regions and extends from Cape Leveque to the eastern end of Melville Island (in the North marine

Region), occupying a total area of 305,463 km^2 of which 44.7% lies within the North-west marine region.

A majority of the region is located on the continental shelf with a small area extending on to the continental slope. Consequently, the regions water depths are relatively shallow, ranging from 0 – 330m with most of the region being between 10 and 100m deep. Topographic features of the region are divers and include reefs, plateaus, submerged terraces, sand banks, pinnacles and canyons.

Due to the generally shallow nature of the region, the Indonesian Throughflow is the dominant oceanographic feature and dominates a majority of the water column. The strength of the throughflow is dependent on seasonal pressures and is heavily influenced by the North-west Monsoon (December to March) which results in a stronger throughflow during winter months. Tides in the region vary greatly and result in increased coastal turbidity levels along with hurricane events.

Biological communities of the region are typical to that of Indo-west Pacific tropical flora and fauna. Marine environments include a range of soft and hard bottom habitats and support a range of filter feeding organisms, coral, crustaceans, sea snakes, turtles, rays, sawfish, fish and sharks. Dugongs are also known to occupy shallower seagrass communities. A number of sites along the Kimberly coastline adjacent to the region are important to seabirds and cetaceans, including the Indo-pacific humpback dolphin and Australian snubfin dolphin which may be endemic to Australian waters.

4.2.1.5 *Timor Province*

The Timor Province lies between Broome and Cape Bougainville, occupying ~15% of the North-west Marine Region and covering predominantly continental slope and abyss. Water depths range from ~200 m from near the shelf break to up to 5920 m over the Argo Abyssal Plain. In addition to the Argo Abyssal Plain, the main geomorphic features within the region are the Ashmore Terrace, Scott Plateau, the Bowers Canyon and part of the Rowley Terrace.

The bioregion is dominated by the warm, oligotrophic waters of the Indonesian Throughflow. This region has a particularly pronounced thermocline in the water column an is associated with the generation of internal tides which is a significant oceanographic feature of this region. The variation in bathymetry together with the variety of geomorphic features in the province results in numerous distinct habitats and biological communities of which many are in close proximity to each other. The islands and reefs that lie within the bioregion are regarded as particular hotspots for biodiversity. Demersal fish communities of the bioregion have high endemism with two distinct communities identified.

4.2.1.6 *North-west Transition*

The North-west Shelf Province covers an area of 184,424 km^2 and predominantly occurs on the continental slope (52%), with smaller areas in the north-west located on the Argo Abyssal Plain and continental rise (DEWHA, 2008). Water depths vary, generally ranging from 200 m depths at the shelf break to more than 1000 m over the continental slope with a maximum depth of 5980 m.

The seafloor topography of the bioregion is complex with a range of features including carbonate banks, submerged terraces, pinnacles, sand banks and reefs. The pinnacles and carbonate banks of the Joseph Bonaparte Gulf are distinctly different in morphology and character to other parts of the Region and are believed to support a high diversity of marine species.

Biological communities of the region are typical to that of Indo-west Pacific tropical flora and fauna. Marine environments include a range of soft bottom and hard substrate habitats. The Western Australian population of humpback whales mate and give birth in the inshore waters off the Kimberley. In addition, the Northwest Shelf Transition is important for commercial fisheries, defence, and the petroleum industry.

4.2.1.7 *North-west Province*

The North-west Province lies offshore between Exmouth and Port Headland, entirely on continental slope. The region covers an area of 178,651 km^2 with water depths ranging from 1000 – 300m.

The dominant geomorphic feature is the Exmouth Plateau. The Montebello Through and Swan Canyon are also important features of the region. The Exmouth Plateau contains the steepest shelf break in the Marine Region along the Cape Range Region near Ningaloo Reef. Dominant surface flow of the region includes circulation and recirculation (via the South Equatorial Current) of the Indonesian Throughflow. As a result of the predominantly southward moving surface waters, waters consolidate along the narrow shelf break adjacent to Cape Range Peninsular to form the Leeuwin Current which is a significant feature for the bioregion and areas further south.

Canyons in the bioregion are thought to aid in the channelling of water onto the Exmouth Plateau and certainly into the shelf along Ningaloo Reef, which aids in enhancing localised biological production. The North-west Province represents the beginning of a transition between tropical and temperate marine species with high endemism in demersal fish communities on the slope evident in this bioregion. Commercial fishing and petroleum are important industries in some parts of the bioregion.

4.2.1.8 *Central Western Shelf Transition*

Of all the provincial bioregions, the Central Western Shelf Transition is the smallest, covering an area of 9698 km^2, located entirely on the continental shelf between the North West Cape and Coral Bay. The maximum water depth in the region is 100 m.

This bioregion is strongly influenced by the Leeuwin Current and Leeuwin Undercurrent interacting with the northward flowing Ningaloo Current. It lies within a significant biogeographic transition between tropical and temperate species. The bioregion is largely covered by the Ningaloo Marine Park and Ningaloo Reef. Ningaloo Reef is an area of high biodiversity with over 200 species of coral and more than 460 species of reef fish. Other fauna which may occupy the reef environments within the region include marine turtles, dugongs and dolphins with the potential for whale sharks and manta rays to occupy outer reef areas. Commercial fishing and petroleum are important industries in some parts of the bioregion.

4.2.1.9 *Central Western Transition*

The Central Western Transition Province is located between Shark Bay and North West Cape covering 162,891 km^2 of continental slope and abyss. Almost half of the region has water depths of more than 4000 m, with maximum recorded water depths within the region of 5330 m. As a result of the proximity of deep ocean areas to the continental slope and shelf, distinctive biological communities may have developed. The major geomorphic features of the bioregion are Carnarvon Terrace, Wallaby Saddle, the Cuvier Abyssal Plain and the Cloates and Cape Range Canyons.

The Leeuwin Current, flowing south along the slope, is the dominant oceanographic feature in the region. Interactions between the Leeuwin Current, Leeuwin Undercurrent and the nearshore Ningaloo Current facilitate vertical mixing of water layers and are thought to be linked with bursts in productivity (particularly during summer). This bioregion also lies within the biogeographic transition between tropical and temperate marine species. The level of endemism within demersal fish communities on the slope is less than that in bioregions further north. Major industries in the bioregion are commercial fishing and petroleum.

4.2.1.10 *Central Western Shelf Province*

The Central Western Shelf Province is located between Kalbarri and Coral Bay lying entirely on the continental shelf, covering an area of 50,516 km^2. Water levels in the region range from 0 – 100 m with the benthic environment being predominantly flat, comprising mainly sand with some mud and gravel. Width of the region varies along its length from less than 20 km from the shoreline to around 125 km in the vicinity of Shark Bay.

The major geomorphic feature of the region is Dirk Hartog Shelf. Other topographic features include a small area of reef and tidal sand banks near the entrance of shark bay and an area of banks and shoals offshore Kalbarri.

Major currents in the region include the Leeuwin Current, Ningaloo Current and the Capes Current with the circulation of the inner bay environment of Shark Bay being restricted by a complex network of sills and channels. This, along with limited fresh water flow and high evaporation rates leads to a hypersaline environment. Due to the shallowness of the region, the Leeuwin current and Shark Bay Outflow are likely to dominate the water column.

This bioregion also lies within the biogeographic transition between tropical and temperate marine species. Biological communities within Shark Bay have been well documented and the bay has been declared a World Heritage Area. It has a diversity of habitat areas including rocky shorelines, sandy plains and seagrass, in both high and low energy zones. The level of endemism within demersal fish communities on the slope is less than that in bioregions further north. Major industries in the bioregion Include commercial fishing.

4.2.1.11 *Central Western Province*

The Central Western Transition Province covers an area of 162,891 km^2 of the continental slope and abyss between Shark Bay and North West Cape. The major geomorphic features of the bioregion are the Wallaby Saddle, Carnarvon Terrace, the Cuvier Abyssal Plain and the Cloates and Cape Range Canyons. Almost half the bioregion has water depths of more than 4000 m, with the maximum water depth in the bioregion recorded at 5330m, and the proximity of deep ocean areas to the continental slope and shelf may have resulted in distinctive biological communities.

The Leeuwin Current, flowing south along the slope, is the dominant oceanographic feature. Interactions between the Leeuwin Current, Leeuwin Undercurrent and the nearshore Ningaloo

Current facilitate vertical mixing of water layers and are believed to be associated with sporadic bursts in productivity (particularly during summer). The level of endemism within demersal fish communities on the slope is less than in the bioregions further north. This bioregion is also within the biogeographic transition between tropical and temperate marine species. The major industries in the bioregion are commercial fishing and petroleum.

4.2.1.12 *South-west Shelf Transition*

The Southwest Shelf Transition covers the area of continental shelf from Perth to Kalbarri. ridges and inshore lagoons characterise the seafloor of the continental shelf of this area. The bioregion has high biodiversity and contains a large number of species that are found nowhere else in the world.

The Houtman Abrolhos Islands off Geraldton are renowned for their high species diversity, coral reefs and a unique mix of temperate and tropical species. These islands are also an important breeding site for seabirds and are the northernmost breeding site for the Australian sea lion. The Houtman Abrolhos Islands, inshore lagoons and other islands further south, such as the Beagle Islands, provide important areas of shelter for shallow water communities in a bioregion that is otherwise exposed to ocean swells. The inshore lagoons are known for the enhanced benthic productivity of their macro-algae and seagrasses and for supporting breeding and nursery aggregations of numerous marine species.

The western rock lobster is an iconic species of the bioregion with an important trophic role for a range of inshore species that prey on juvenile lobsters.

4.2.1.13 *Cocos (Keeling) Islands Province*

Cocos (Keeling) Island is an external territory located in the Indian Ocean. The Islands form a horseshoe-shaped atoll made of 27 coral islands with a total land area of ~15.6 km^2 which surround a lagoon. North Keeling island lies 30 km outside the horseshoe atoll and was declared a National Park in 1995.

Coral and sandy beaches lie on the seaward side of the horseshoe atoll whilst mudflats can be found on the lagoon side. The northern atoll consists of north Keeling Island of which the island and the marine park extend 1.5km around the island from the Pulu Keeling National Park. The island is an important example of an atoll in its natural state and supports an internationally significant seabird rookery. Me terrestrial and marine environment of the islands supports a wide range of flora and fauna including land crabs, corals, fish, molluscs, crustaceans. Other fauna commonly sighted include turtles, common dolphins, manta rays and reef sharks.

The island has a tropical climate with high humidity. Seasonal wet season is from January to August with an average annual precipitation of 2000 mm.

4.2.1.14 *Christmas Island Province*

Christmas Island is an external territory located in the Indian ocean. The island has an 80km coastline and occupies an area of 137.4 km^2 of which 135 km^2 is a National Park. The island has a tropical climate, commonly experiencing humidity between 80 and 90%. Seasonal wet season is from November to April with an average annual precipitation of 2000 mm.

Of the 80 km coastline, a large majority of the is cliff face of up to 20 m high. The island is surrounded by coral reef with the continental shelf extending up to 200m from the shore and then plummeting to depths of ~5000 m.

Due to the islands close proximity to South-East Asia and the equator, Christmas Island has a highly diverse range of flora and fauna. There are a recorded 411 plant species of which 18 are endemic to the island. Commonly known fauna of the island includes land crabs and a range of seabirds. Eight species or subspecies of seabird nest on the island including the endemic Christmas Island Frigatebird (listed as endangered) which has three well defines nesting areas.

4.2.1.15 *Outside of Australia's Exclusive Economic Zone*

The Exclusive Economic Zone (EEZ) located off the Western Australian coastline extends from the territorial sea limit across the mainland of Australia's Indian Ocean Territories, to 200 nautical miles offshore. The Australian EEZ shares boundaries with:

- International waters, which lie to the west and south of the WA section of EEZ. The United Nations Law of the Sea Convention (UNCLOS) manage international waters and is administered by the International Maritime Organisation (IMO).
- The Joint Petroleum Development Area (JPDA) in the Timor Sea which lies along the northern edge of the EEZ. The national Petroleum Authority of Timor-Leste regulates the JPDA on behalf of the Australian and Timor-Leste government.
- Indonesia to the north-west, of which the boundary is defined in accordance with the Perth Treaty, negotiated with the Republic of Indonesia.

Indonesia has the second largest coastline in the world (95 181km) and has the largest coral reef area of any country (51 020 km^2). Central and eastern Indonesia lies within the Coral Triangle which in an area of globally recognised biodiversity. Key threats to Indonesian reefs include direct human impacts such as overfishing and destructive fishing methods, as well as indirect impacts such as pollution and coastal development.

Indonesia has established a large network of marine protected areas (MPA) in order to manage environmental sensitivities within its waters. MPAs relevant to the well construction activities are listed in Table 4-3:

Table 4-3: Relevant Indonesian Marine Protected Areas

Name	Protection Category / Listing	EMBA	Hydrocarbon Area / Operational Area
KKPD Kabupaten Gunung Kidul Marine Nature Reserve	IUCN Category IV	x	
Nusa Penida Marine Recreation Park / District Marine Conservation Area	IUCN Category VI	x	
Bangko-bangko Nature Recreation Park	IUCN Category V	x	
KKPD Kabupaten Lombok Barat Marine Recreation Park	IUCN Category VI	x	

Name	Protection Category / Listing	EMBA	Hydrocarbon Area / Operational Area
KKPN Pulau Gili Ayre, Gili Meno, Dan Gili Trawangan Marine Recreational Park	IUCN Category VI	x	
KKPD Gili Sulat Dan Gili Lawning	IUCN Category VI	x	
Lombok Tengah District Marine Conservation Area	IUCN Category VI	x	
Tanjung Tampa Nature Recreation Park	IUCN Category V	x	
Gunug Tunak Nature Recreation Park	IUCN Category V	x	
KKPD Kabupaten Lombok Tengah Marine Recreation Park	IUCN Category VI	x	
Pulau Panjang Undesignated	Ia	x	
Kab Sumbawa (P. Keramat, P. Bedil, P. Temudong) District Marine Conservation Area District Marine Conservation Area	IUCN Category VI	x	
Pulau Moyo Nature Recreation Park	IUCN Category V	x	
Pulau Satonda Nature Recreation Park	Not Reported	x	
Toffo Kota Lambu Nature Reserve	IUCN Ia	x	
Komodo National Park	IUCN II	x	
Teluk Kupang Nature Recreation Park	IUCN V	x	
KKPN Laut Sawa Marine National Park	II	x	

X = Present within area

4.3 Detailed Receptor Descriptions

Through an assessment of the Project Context for this EP, the nature and scale of information provided within the Description of the Existing Environment has been determined. This has been undertaken to ensure that information provided aligns with the requirements of the Regulations.

4.3.1 Physical Environment

4.3.1.1 *Ambient water quality*

Table 4-1 identifies that ambient water quality may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area and EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to ambient water quality.

Marine water quality within the EMBA is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Variations to this state (e.g. increased turbidity) may occur in more coastal regions that are subject to large tidal ranges, terrestrial run-off or anthropocentric factors (i.e. ports, industrial discharges, etc.).

Water quality sampling data is available within Pilbara coastal waters, within the EMBA:

- No detectable hydrocarbons, with BTEX, PAH and TPH below the laboratory LOR (Wenziker *et al.,* 2006).
- Concentrations of metals were typically below the ANZECC & ARMCANZ (2000) 99% species protection guidelines (Wenziker *et al.,* 2006).
- Slightly elevated levels (although still above the 95% species protection levels) of copper and zinc were recorded within the inner harbour at Port Hedland (Wenziker *et al.,* 2006).

4.3.1.2 *Ambient sediment quality*

Table 4-1 identifies that ambient sediment quality may be a relevant receptor to aspects of the activity occurring within the Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to ambient sediment quality.

Marine sediment quality within the Operational Area is expected to be representative of the typically pristine offshore Western Australian waters. Variations to this state (e.g. increased metal concentrations) may occur in more coastal regions that are subject to large tidal ranges, terrestrial run-off or anthropocentric factors (i.e. ports and industrial discharges).

Several surveys have been undertaken within the Operational Area. In addition to the Bowman Bishaw Gorham (BBG) (1996) baseline sediment survey, a post-commissioning sediment survey was undertaken by Sinclair Knight Merz (SKM) in 1998. BBG (1996) found the sediments were comprised of a mixture of fine, medium, coarse and very coarse sands. This is consistent with sediments found throughout the NWS Province where sediment is dominated by sand (Baker *et al.,* 2008). Particle size data from the study undertaken by SKM in 1998 indicated that sediments are typically comprised of unconsolidated to coarse sands. This shift towards a coarser grain size is indicative of discharge received from drilling at Wandoo.

Sediment metal, petroleum hydrocarbon and Polycyclic Aromatic Hydrocarbon (PAH) levels were also tested during both studies. Sediment metal levels increased since the baseline survey; however, they were within the trigger values outlined in the ANZECC/ARMCANZ sediment quality guidelines (ANZECC/ARMCANZ, 2000). These metal concentrations reflect background levels of the region (Long *et al*., 1995). Petroleum hydrocarbons and PAH levels were below detection limits in all samples collected during the surveys.

An additional baseline survey was undertaken in 2015 to assess changes that may have occurred since the original baseline and post-commissioning surveys undertaken in the 1990s (Operational Baseline Survey 2015 Report Ref: 246043-001-REP-NM-001, August 2016).

Hydrocarbons in sediments at all sites were below the limits of reporting or below the available Sediment Quality Guideline for the highest level of protection. Sediment metal/metalloid concentrations at all sites were below their respective trigger values, or where no guidelines exist lower or similar to previous studies with the exception of Barium. This was likely due to the presence of residual drilling muds (containing barium) at the time of the post-commissioning survey.

There has been an overall increase in sediment metal concentrations since the baseline survey 20 years ago (BBG 1996) but there is no trend in direction or distance from the WNB Platform. Furthermore, of the metals that have increased in sediments since the baseline survey, none are currently at concentrations exceeding the recommended guideline for the highest level of species protection.

In 2015, sediment infauna abundance and species richness were significantly higher than during the baseline survey in 1996 and the post-commissioning survey in 1998.

4.3.1.3 *Air Quality*

Table 4-1 identifies that air quality may be a relevant receptor to aspects of the activity occurring within the Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to air quality.

The majority of the offshore NWS Province region is relatively remote and therefore air quality in the Operational Area is expected to be high. Anthropogenic sources (e.g. vessels, industry developments) would contribute to local variation in air quality. However, results of previous monitoring within the region suggest that the concentration of air quality parameters remains low. For example, measured levels of nitrogen dioxide and ozone during a Pilbara air quality study were below the NEPM standards (DoE 2004).

4.3.1.4 *Climate*

Table 4-1 identifies that climate may be a relevant receptor to aspects of the activity occurring within the Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to climate.

Climate within the Operational Area is tropical, exhibiting a hot ‘summer’ season from October to April and a milder ‘winter’ season between May and September. Winds vary seasonally, with a tendency for westerly winds in summer and southerly winds in winter (Pearce *et al.,* 2003). There are often distinct ‘transition’ periods between the summer and winter regimes, which are characterised by calmer periods. Rainfall is low and unpredictable, with most rainfall occurring between January and May, often associated with the passage of tropical cyclones (Pearce *et al.,* 2003).

4.3.1.5 *Ambient noise*

Table 4-1 identifies that ambient noise may be a relevant receptor to aspects of the activity occurring within the Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to ambient noise.

The Operational Area is relatively remote and therefore ambient noise levels are expected to be low. Ambient noise within the NWS Province region is expected to be dominated by natural physical (e.g. wind, waves, rain) and biological (e.g. echo-location and communication noises generated by cetaceans and fish) sources. Anthropogenic noise sources that are also likely to be experienced in the area include low-frequency noise from vessels.

4.3.1.6 *Ambient light*

Table 4-1 identifies that ambient light be a relevant receptor to aspects of the activity occurring within the Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to ambient light.

The Operational Area is relatively remote and therefore ambient light levels are expected to be low. Ambient light within the NWS Province region is expected to predominantly be from solar/lunar luminance. However, artificial light sources associated with anthropogenic activities also exist, including both permanent (e.g. onshore/offshore developments) and temporary (e.g. vessels) light sources.

4.3.2 Key Marine Habitats

Table 4-1 identifies that key marine habitats may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area and EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to key marine habitats.

4.3.2.1 *Subtidal soft sediment and benthic fauna*

Unconsolidated sediments support diverse benthic fauna living both in the sediments (infauna) and on the sediment surface (epifauna). Infauna species consist predominantly of mobile burrowing species including molluscs, crustaceans (crabs, shrimps and smaller related species), polychaetes, sipunculid and platyhelminth worms, asteroids (sea stars), echinoids (sea urchins) and other small animals. Epifauna species include small crustaceans and molluscs, echinoderms and larger sessile organisms such as sponges, corals, sea whips and sea squirt (DEC, 2006).

Remote Operated Vehicle (ROV) surveys on the NWS, at similar water depths to those in the Operational Area, have indicated a sea floor is comprised of fine silt/sand substrates (RPS, 2012 unpublished data). The sediments were variously bioturbated, however benthic communities were generally sparse with low densities of organisms (e.g. crustaceans, molluscs, and polychaetes).

Soft sediment habitats that support infauna are widespread in deeper offshore areas and in more protected environments throughout the region (CALM and MPRA, 2005; DEC, 2006). The sediments range from clays to silts and fine sands. The spatial and temporal distribution and density of infauna depends not only on sediment composition but also on factors such as season, water depth, water temperature and wave-induced currents (Ward and Rainer, 1988; Rainer, 1991; Kinhill, 1997). Communities in shallower areas (less than 30m deep) are likely to be dominated by sessile filter-feeding species such as sponges, sea pens and ascidians. Sediments in deeper water are typically finer (muddier) and the benthic community is dominated by benthic scavengers and deposit feeders including polychaete worms, crustaceans, molluscs and echinoderms (DEWHA, 2008).

The sea floor of the deeper waters of the NWS is primarily a soft sediment habitat that can support scavengers, benthic filter feeders and epifauna communities (Brewer *et al.,* 2007). Any areas of exposed hard substrate are likely to be colonised by deep water filter-feeding organisms, such as hydroids and sponges.

4.3.2.2 *Corals*

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

Hard corals are widespread within the EMBA, with significant coral reefs occurring at a number of sites including within the Ningaloo Marine Park near Exmouth, the Montebello/ Barrow/ Lowendal islands, Shark Bay, Muiron island, the Dampier Archipelago, Glomar Shoals, Rankin Bank, Mermaid Reef and the Rowley Shoals (Figure 4-3). The in water Hydrocarbon Area encompasses these sites but does not overlap with Shark Bay. In the NWS region coral reefs in clearer, offshore waters typically have higher coral density and diversity than reefs associated with turbid near-shore waters (Woodside, 2006).

In addition to the larger coral reefs that have regional significance, smaller reefs and individual coral colonies are found throughout areas where water quality and benthic substrate are conducive to coral survival. Intertidal hard corals also occur within the EMBA, typically as individual colonies on rocky shores. These intertidal corals do not form a large habitat class within the region, with beaches/mudflats and mangroves the most common shoreline habitat.

Significant coral spawning occurs in autumn for a number of species, although some taxa such as *Porites* and *Acropora* spp. may spawn in spring and summer (Baird *et al.,* 2011; Rosser and Gilmour, 2008). Spawning events have been observed throughout the Dampier Archipelago in March and April (Stoddart and Gilmour, 2005) and along the Ningaloo Coast during March (Simpson *et al.*, 1993).

No coral reef communities are found in the Operational Area. The nearest area of significant corals reef to the Operational Area are the Glomar Shoals (approximately 37 km northeast) and Ningaloo Reef (approximately 250km away). For further details on Glomar Shoals refer to Section 4.3.6.5.

The Ningaloo Reef is unique in that it is a mainland fringing coral reef, the largest of its kind in Australia (CALM and MPRA, 2005). The Ningaloo Reef extends over 260km and is the only large reef in the world found so close to the western coast of a continental land mass (within 100m at closest point). The Reef includes intertidal and deeper sub-tidal corals, with over 300 species representing 54 genera recorded (UNESCO, 2011).

4.3.2.3 *Seagrasses*

Seagrass are marine flowering plants, with about 30 species found in Australian waters (Huisman 2000). Seagrass generally grows in soft sediments within intertidal and shallow subtidal waters where there is sufficient light and are common in sheltered coastal areas such as bays, lees of islands and fringing coastal reefs (McClatchie *et al.,* 2006; McLeay *et al.,* 2003). Seagrass meadows are important in stabilising seabed sediments, and providing nursery grounds for fish and crustaceans, and a protective habitat for the juvenile fish and invertebrates species (Huisman 2000; Kirkman 1997). Seagrasses also provide important habitat for fish and dugongs within the Northwest Shelf Province (DEWHA 2008).

Seagrasses are widespread throughout shallower areas of the EMBA and Hydrocarbon Area. No seagrasses are found within the Operational Area.

The southern half of WA offers ideal conditions for seagrasses – clear waters, low nutrients, protection from heavy seas and swells, and sandy substrate. Many southern seagrass species are perennial (grow all year round), covering extensive areas of Shark Bay, and can be found adjacent to offshore islands, including those of the Dampier Archipelago and the Montebello and Barrow islands (CALM and MPRA, 2005; DEC, 2006). The Hydrocarbon Area overlaps Ningaloo Reef, Dampier Archipelago and Montebello and Barrow islands.

Seagrass species within the EMBA exhibit seasonal trends in abundance and distribution (Orth *et al.,* 2006). Natural disturbance events such as cyclones and dugong grazing can also affect local seagrass distribution and abundance.

Seagrass meadows are mostly found in the sheltered bays along the southern mainland coast of the Kimberley region, as well as along the coast between Shark Bay and Augusta. Montebello and Barrow Islands contain sparse seagrass habitat (McMahon *et al.,* 2017), however the closest known key areas of seagrass habitat to the Wandoo Well Construction Program is the Ningaloo reef area.

4.3.2.4 *Macroalgae*

Macroalgae are widely distributed throughout shallower areas of the region, particularly where hard substrates occur within the EMBA and Hydrocarbon Area (Table 4-3). Subtidal macroalgal reefs are likely to be widespread and will generally occur wherever there is hard substrate suitable for algal recruitment and sufficient light. Subtidal macroalgae often occur with coral reefs, colonising dead coral and coral rubble for attachment. *Caulerpa* spp. which, unlike most other macroalgae are capable of growing on soft substrate, also occur in the EMBA and Hydrocarbon Area.

Intertidal macroalgae may occur throughout the region, as there is widespread intertidal hard substrate and intertidal rock platforms suitable for macro-algal growth.

A large number of tropical macroalgal species have been recorded from the region, with over 200 species documented in the Pilbara alone (Huisman, 2004; Huisman and Borowitzka, 2003). Macroalgal habitat within the region may occur in subtidal or intertidal areas of hard substrate where sufficient light is available for photosynthesis. Such areas are likely to include shallow (<25m) subtidal reefs and rocky intertidal shores and be widespread throughout the region.

Due to the widespread nature of macroalgal habitat within the region, there are no specifically identified areas of significant environmental value.

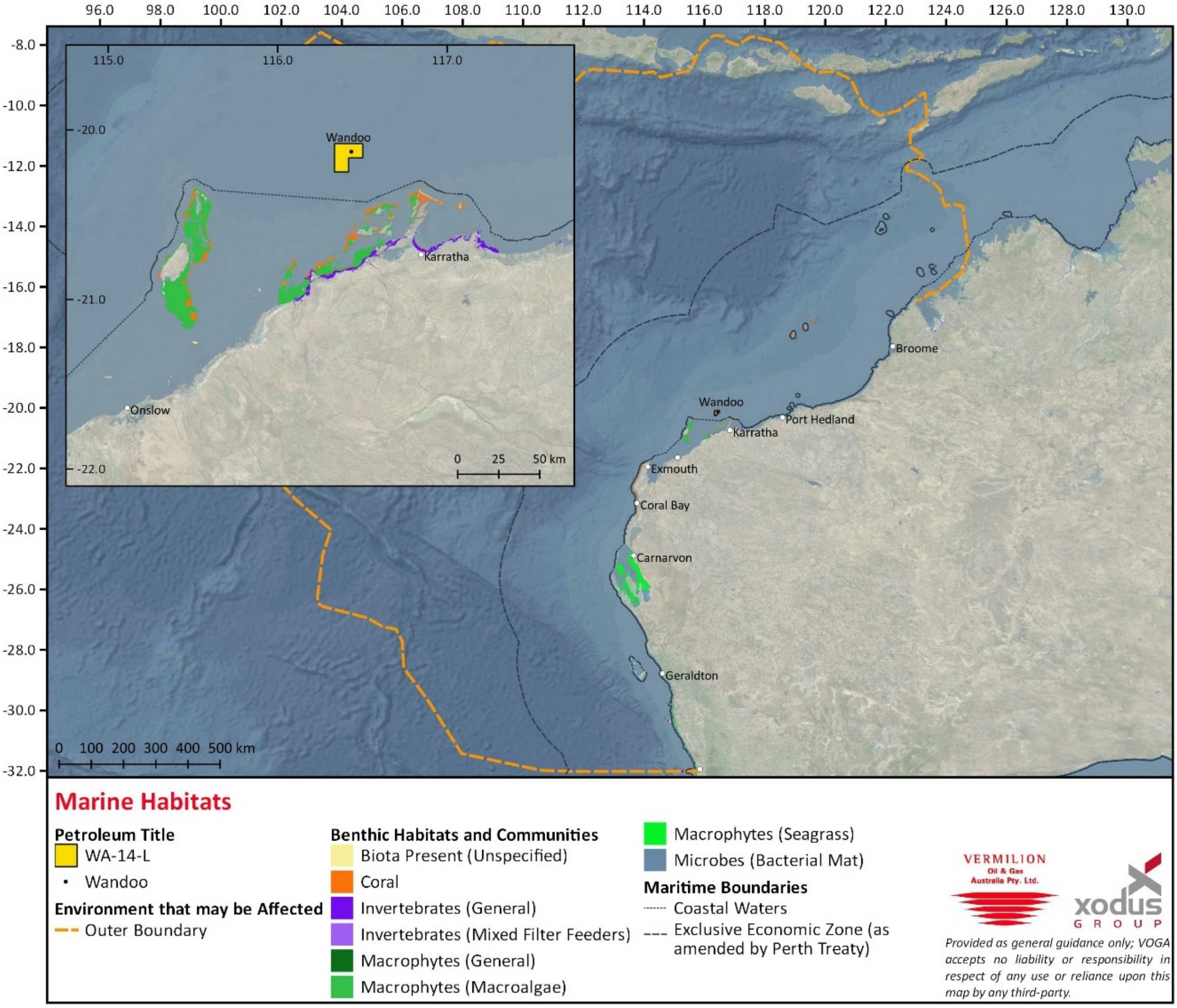


Figure 4-3: Key Marine Habitats

4.3.3 Key Coastal Communities

Table 4-1 identifies that key marine habitats may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area and EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to key coastal communities.

4.3.3.1 *Mangroves*

Mangroves are recognised as significant because they are productive coastal forest systems, providing habitat and shelter for infauna, epifauna, gastropods, crustaceans, fish and other marine species. Mangroves are important nursery areas for fish, lobster and prawn species, some of which are targeted by recreational and commercial fishers (Nagelkerken *et al.,* 2008;

DEC, 2007a). Mangroves may also provide shelter for other species such as juvenile turtles (DEC, 2007a). Ospreys (*Pandion haliaetus*) and white-bellied sea eagles (*Haliaeetus leucogaster*) roost in mangroves, while brahminy kites (*Haliastur indus*) and a range of smaller birds nest in them (DEC, 2007a).

Mangroves can occur on a wide range of geomorphic types (Semeniuk, 1986) and are one of the dominant intertidal and coastal habitat classes within the EMBA and Hydrocarbon Area shoreline, with extensive belts of mangroves between Coral Bay (within shoreline Hydrocarbon Area and approximately 400 km from Operational Area) and Eighty Mile Beach (approximately 300 km away from Operational Area and within shoreline Hydrocarbon Area) (Carr and Livesey, 1996) (Figure 4-4). They also occur on the offshore islands in the region, including Barrow Island, the Montebello Islands and the Dampier Archipelago.

Mangrove communities in the Pilbara region are classified as 'tropical arid' mangroves and represent Australia's only 'tropical-arid' mangroves (Pedretti and Paling, 2000). WA does not support any unusual, endemic or restricted mangrove species. All mangrove species within WA are common and widespread elsewhere, either in northern Australia or in the Indo-Pacific region near northern Australia.

No mangrove communities are found within the Operational Area. The closest regionally significant mangroves to the Operational Area are those occurring within the Dampier Archipelago. Other significant areas of mangrove habitat occurring within the EMBA and Hydrocarbon Area include the Montebello Islands, Ningaloo Coast, and scattered areas along the coast between Onslow and just north of Port Hedland (EPA, 2001).

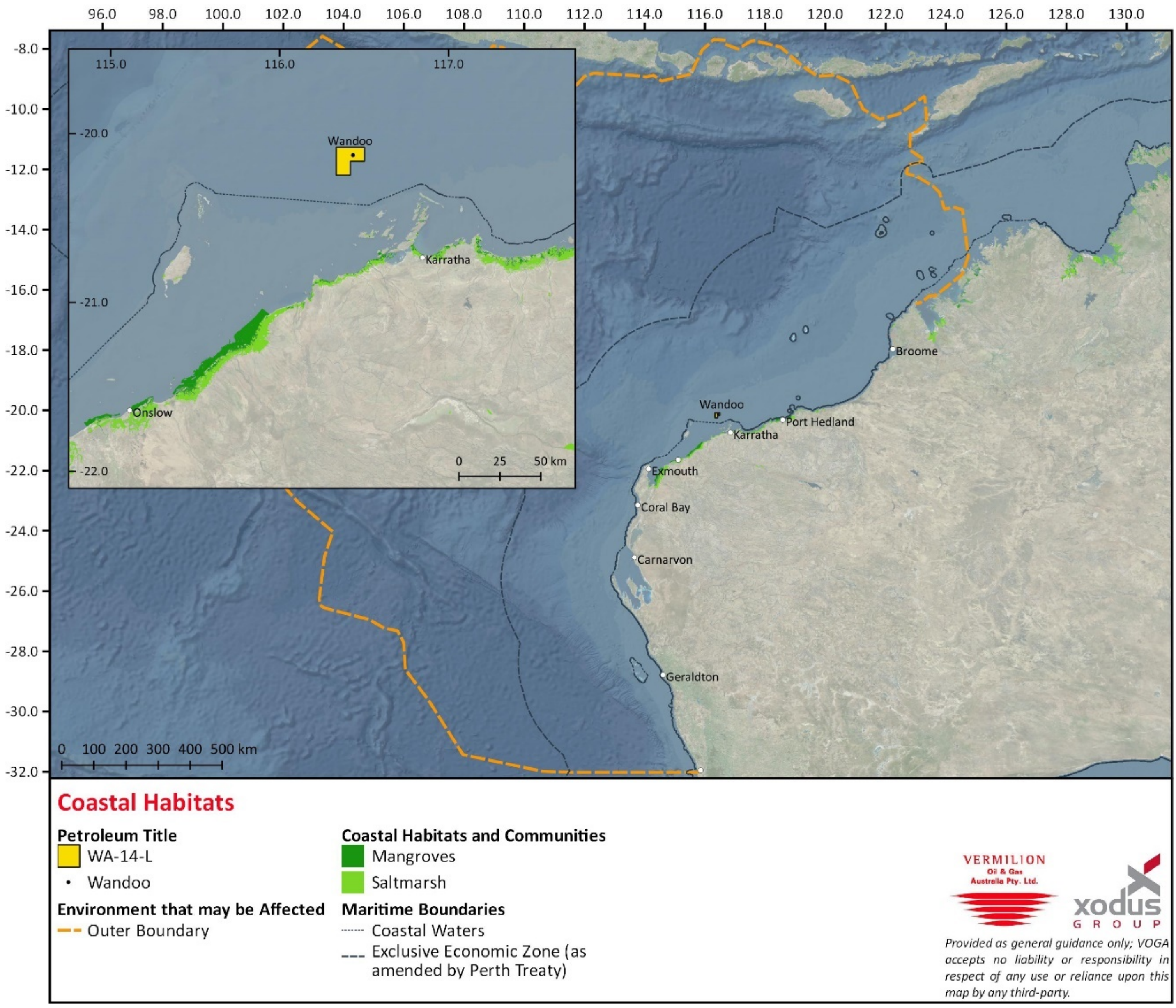


Figure 4-4: Key Coastal Habitats

4.3.3.2 *Saltmarsh*

Saltmarshes are terrestrial halophytic (salt-adapted) ecosystems that mostly occur in the upper-intertidal zone. They are typically dominated by dense stands of halophytic plants such as herbs, grasses and low shrubs. The diversity of saltmarsh plant species increases with increasing latitude (in contrast to mangroves). The vegetation in these environments is essential to the stability of the saltmarsh, as they trap and bind sediments. The sediments are generally sandy silts and clays, and can often have high organic material content. Saltmarshes provide a habitat for a wide range of both marine and terrestrial fauna, including infauna and epifaunal invertebrates, fish and birds.

Saltmarsh habitat is common within tidal flats or wetland habitats along the Pilbara coast (Figure 4-4).

4.3.3.3 *Intertidal beaches/mudflats*

Intertidal beaches and mudflats are widespread throughout the EMBA and occur on both mainland and island shores. Intertidal beaches and mudflats in the region host a range of infauna, including molluscs and polychaetes that are likely to be an important food source for wading birds.

Three intertidal beach/mudflat areas of international conservation significance occur within the: shoreline Hydrocarbon Area: Bandicoot Bay, Eighty Mile Beach and Roebuck Bay. Bandicoot Bay is a Conservation Reserve within the Montebello/Barrow Islands Marine Management Area and Eighty Mile Beach and Roebuck Bay are listed under the Ramsar Convention (for wetlands; see Section 4.3.6.4) and are afforded specific protection under the EPBC Act. No Intertidal beaches/mudflats are found within the Operational Area.

These habitats are recognised as an important resource for a diverse range of migratory bird species, the majority of which feed in the area after migrating from the northern hemisphere.

4.3.3.4 *Rocky shorelines/intertidal reef platforms*

Rocky shorelines and intertidal reef platforms are widespread throughout the EMBA and Hydrocarbon Area, occuring on both mainland and island shores. No rocky shorelines/intertidal reef platforms are found within the Operational Area. Rocky shores can include pebble/cobble, boulders, rocky limestone cliffs and horizontal rock platforms. Intertidal reef platforms are located in the intertidal zone and consist of hard bedrock. Examples include areas with or without a sediment veneer of varying thickness. Rocky shoreline formations offer habitat to a range of intertidal species including invertebrates and shorebirds. Rocky shorelines are found across the region and are often indicative of high-energy areas (wave action) where sediment deposition is limited or restricted. They are formed from limestone pavement extending out from the beach into subtidal zones, e.g. along the Ningaloo Coast and North West Cape. Higher relief platforms (>0.5 m off the high water mark) are also present at several headlands along the North West Cape (DEC, 2006).

Intertidal habitats support a diverse assemblage of vertebrates and invertebrates, particularly in vegetated areas. Coral reef communities located in the intertidal zone include the reef crest, shallow reef fronts, reef flat and shallow back reef zones, generally with a mixture of live coral and macro-algal coverage. Subtidal communities include the upper seaward reef slope, sheltered back reef, deep lagoonal reef and bommie clusters with a high percentage of hard corals, macro-algae and coralline algae (Bancroft, 2003). Invertebrates such as polychaete worms, crustaceans and echinoderms are also known to be present.

4.3.3.5 *Sandy beaches*

Sandy beaches are those areas within the intertidal zone where unconsolidated sediment has been deposited by wave and tidal action. Sandy beaches can vary from low to high energy zones which will influence the profile of each beach through varying rates of erosion and accretion. Sandy beaches are found throughout the EMBA and shoreline Hydrocarbon Area. They are generally interspersed among areas of hard substrate (e.g. sandstone) that form intertidal platforms and rocky outcrops.

Sandy beaches can also provide a turtle nesting habitat, particularly at the Barrow/Montebello/ Lowendal islands and Ningaloo Coast. Further information on turtle nesting areas is provided in Section 4.3.4.6.

Sandy beaches provide habitat for a variety of burrowing invertebrates and subsequently provide foraging areas for seabirds. Crested terns are known to nest on sandy beaches. Further detail on breeding and nesting sites for seabirds is provided in Section 4.3.4.3.

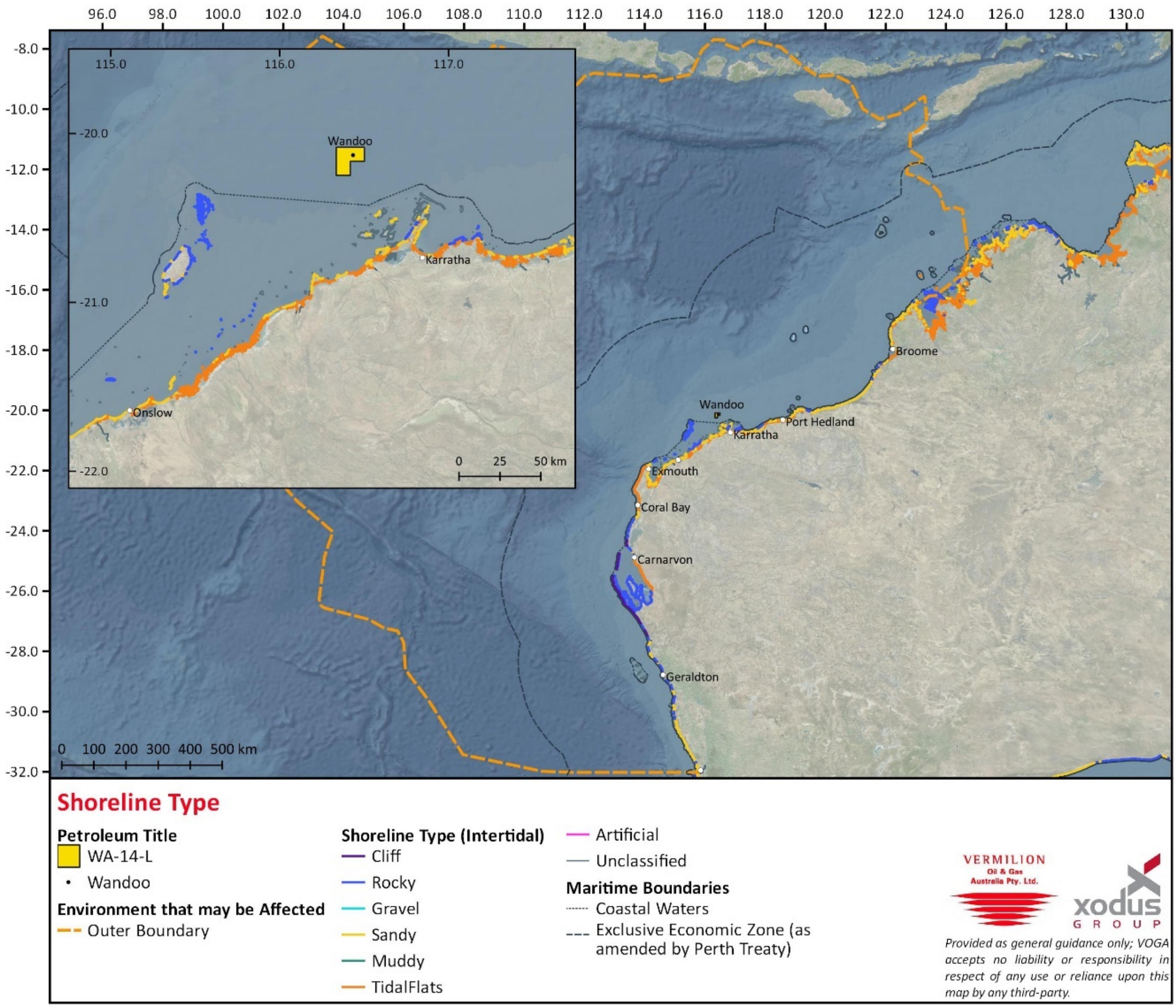


Figure 4-5: Shoreline Types

4.3.4 Key Marine Fauna

4.3.4.1 *Plankton*

Table 4-1 identifies that plankton may be a relevant receptor to aspects of the activity occurring within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to plankton.

Plankton species, including both phytoplankton and zooplankton, are a key component in oceanic food chains. Phytoplankton are autotrophic planktonic organisms living within the photic zone; and are the start of the food chain in the ocean (McClatchie *et al.,* 2006). Phytoplankton communities are largely comprised of protists, including green algae, diatoms, and dinoflagellates (McClatchie *et al.,* 2006). There are three size classes of phytoplankton:

microplankton (20-200 µm), nanoplankton (2-20 µm) and picoplankton (0.2-2 µm). Diatoms and dinoflagellates are the most abundant of the micro and nanoplankton size classes and are generally responsible for the majority of oceanic primary production (McClatchie *et al.,* 2006). Phytoplankton are dependent on oceanographic processes (e.g. currents and vertical mixing), that supply nutrients needed for photosynthesis. Thus, phytoplankton biomass is typically variable (spatially and temporally), but greatest in areas of upwelling, or in shallow waters where nutrient levels are high.

Primary productivity of the North-west Marine Region is generally low and appears to be largely driven by offshore influences (Brewer *et al.,* 2007), with periodic upwelling events and cyclonic influences driving coastal productivity with nutrient recycling and advection. Within the region, peak primary productivity along the shelf edge occurs in late summer/early autumn. Variation in productivity can also be linked to higher biologically productive period in the area (e.g. mass coral spawning events).

Zooplankton is the faunal component of plankton, comprised of small protozoa, crustaceans (e.g. krill) and the eggs and larvae from larger animals. Zooplankton includes species that drift with the currents and also those that are motile. The inshore ichthyoplankton assemblages are characterised by shallow reef fishes such as blennies (family Blenniidae), damselfish (family Pomacentridae) and north-west snappers (family Lethrinidae), while offshore assemblages are dominated by deepwater and pelagic taxa such as tuna (family Scombridae) and lanternfish (family Myctophidae) (Beckley, Muhling, & Gaughan, 2009). Some of these taxa are commercially and recreationally important species in the region.

4.3.4.2 *Benthic invertebrates*

Table 4-1 identifies that benthic invertebrates may be a relevant receptor to aspects of the activity occurring within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to benthic invertebrates.

The benthic invertebrates of the NWS region are of low abundance but highly diverse and is comprised largely of borrowing polychaete worms and crustaceans (Rainer, 1991). Echinoderms and molluscs are also common on the continental shelf and slope in this region. The diversity and abundance of benthic invertebrates decreases with distance from the coast over most of the NWS – this may be attributed to increasing depth or increasing distance from terrestrial and coastal organic input (SKM, 1998).

A baseline survey, conducted in May 1996 (BBG, 1996) prior to installation of the Wandoo facilities, concluded that the infaunal assemblage was depauperate, with low numbers of species and low abundance. Most of the common species (small crabs, shrimps and polychaetes) are detritivores, feeding on organic matter in the surface layers of the sediment. This survey also found that most areas were bare of epifauna but occasional epifauna mainly sponges and corals were observed.

A subsequent environmental monitoring study of the benthic infauna conducted in May 1998 post commissioning of the facility (SKM, 1998) found that the overall abundance and richness of infauna was higher than reported for the baseline survey. On a regional scale the infaunal community in the vicinity of the Operational Area is also comparable to those at similar sites on the NWS.

It is unlikely that the infaunal community would have changed significantly from the baseline survey as the infaunal assemblage was depauperate, with low numbers of species and low abundance.

4.3.4.3 *Birds*

Table 4-1 identifies that birds may be a relevant receptor to aspects of the activity occurring within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity. The wedge-tailed shearwater is a migratory visitor to WA and may occur within the EMBA and Hydrocarbon Area (Table 4-4). Estimates indicate more than one million shearwaters migrate to the Pilbara islands each year (DBCA 2017). The wedge-tailed shearwater will excavate burrows on vegetated islands for nesting. Known breeding locations in the North-west Marine Region. Breeding locations within the Hydrocarbon Area include Forestier Island (Sable Island), Bedout Island, Dampier Archipelago, Passage Island, Lowendal Island, islands off Barrow Island (Mushroom, Double and Boodie Islands), islands in the Onslow area (including Airlie, Bessieres, Serrurier, North and South Muiron and Locker Islands) (DEWHA 2008a) Breeding locations within the broader EMBA are inclusive of those with Hydrocarbon Area as well as islands in the Freycinet Estuary, and south Shark Bay (Slope, Friday, Lefebre, Charlie, Freycinet, Double and Baudin Islands) (DEWHA 2008a).

The fairy, lesser crested and roseate terns may have both a resident sub-population and a migratory population present in the Pilbara (DBCA 2017). These tern species nest in open areas, typically sand scrapes/depressions on the sandy beaches of offshore islands. Within the EMBA these tern species are known to nest within the region of the Ningaloo Marine Park, Muiron and Sunday islands (CALM 2005). The Montebello Islands support the largest breeding population of roseate terns in WA (DEWHA 2008). Ningaloo Marine Park, Muiron and Sunday islands, and Montebello Islands occur within the Hydrocarbon Area.

Caspian terns, little terns, and ospreys have also been known to breed on Serrurier Island and neighbouring inshore islands (DEWHA 2008) within the Hydrocarbon Area.

Bedout Island (offshore from Port Hedland and within the Hydrocarbon Area) supports one of the largest colonies of brown booby in WA (Figure 3 10); the masked booby, lesser frigatebird, roseate tern and common noddy also breed in the area (DEWHA 2008).

Tropicbird species spend most of their lives at sea, typically found in tropical and subtropical seas around northern Australia. A small sand cay at Bedwell Island, within Clerke Reef in Rowley Shoals Marine Park, is one of very few breeding areas in Western Australia for the Red-tailed tropicbird. Both locations occurring within the Hydrocarbon Area.

Table 4-4). The description below provides sufficient details to assess all impacts and risks to birds.

There are multiple species (or species habitat) of birds that may occur within the Operational Area and Hydrocarbon Area. The presence of most species, particularly within the Operational Area, are expected to be of a transitory nature only. However, some species within the Hydrocarbon Area were identified as displaying important behaviour (e.g. breeding, roosting, foraging), some recognised as Biologically important areas (BIAs). The Operational Area for the Wandoo Well Construction Program is within a breeding BIA for the wedge-tailed shearwater; these BIAs are based on buffer areas surrounding the offshore islands (e.g. within Dampier Archipelago) that are used for nesting by this species (Table 4-5).

The northwestern coast of WA and islands provide important refuge for several seabird and shorebird species. For migratory shorebirds, the rocky shores, sandy beaches, saltmarshes, intertidal flats and mangroves are important feeding and resting habitat during spring and summer (DBCA 2017). Migratory seabirds, including terns and shearwaters, use the islands for nesting (DBCA 2017). Island habitats are important for seabirds as they provide relatively undisturbed roosting and nesting habitats close to oceanic foraging grounds. Oystercatchers, red-capped plovers and beach stone-curlews are among the species that have resident populations; these shorebirds are present throughout the year and nest along the coast and on offshore islands (DBCA 2017).

The wedge-tailed shearwater is a migratory visitor to WA and may occur within the EMBA and Hydrocarbon Area (Table 4-4). Estimates indicate more than one million shearwaters migrate to the Pilbara islands each year (DBCA 2017). The wedge-tailed shearwater will excavate burrows on vegetated islands for nesting. Known breeding locations in the North-west Marine Region. Breeding locations within the Hydrocarbon Area include Forestier Island (Sable Island), Bedout Island, Dampier Archipelago, Passage Island, Lowendal Island, islands off Barrow Island (Mushroom, Double and Boodie Islands), islands in the Onslow area (including Airlie, Bessieres, Serrurier, North and South Muiron and Locker Islands) (DEWHA 2008a) Breeding locations within the broader EMBA are inclusive of those with Hydrocarbon Area as well as islands in the Freycinet Estuary, and south Shark Bay (Slope, Friday, Lefebre, Charlie, Freycinet, Double and Baudin Islands) (DEWHA 2008a).

The fairy, lesser crested and roseate terns may have both a resident sub-population and a migratory population present in the Pilbara (DBCA 2017). These tern species nest in open areas, typically sand scrapes/depressions on the sandy beaches of offshore islands. Within the EMBA these tern species are known to nest within the region of the Ningaloo Marine Park, Muiron and Sunday islands (CALM 2005). The Montebello Islands support the largest breeding population of roseate terns in WA (DEWHA 2008). Ningaloo Marine Park, Muiron and Sunday islands, and Montebello Islands occur within the Hydrocarbon Area.

Caspian terns, little terns, and ospreys have also been known to breed on Serrurier Island and neighbouring inshore islands (DEWHA 2008) within the Hydrocarbon Area.

Bedout Island (offshore from Port Hedland and within the Hydrocarbon Area) supports one of the largest colonies of brown booby in WA (Figure 3 10); the masked booby, lesser frigatebird, roseate tern and common noddy also breed in the area (DEWHA 2008).

Tropicbird species spend most of their lives at sea, typically found in tropical and subtropical seas around northern Australia. A small sand cay at Bedwell Island, within Clerke Reef in Rowley Shoals Marine Park, is one of very few breeding areas in Western Australia for the Red-tailed tropicbird. Both locations occurring within the Hydrocarbon Area.

Table 4-4: Seabird and Shorebird species or species habitat that may occur within the Project Areas

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	Operational Area	Hydrocarbon Area	EMBA
Accipiter hiogaster natalis	Christmas Island Goshawk	E					KO
Acrocephalus orientalis	Oriental Reed-Warbler		x(W)	x			KO
Actitis hypoleucos	Common Sandpiper		x(W)	x	MO	KO	KO
Anous minutus	Black Noddy			x			BKO
Anous stolidus	Common Noddy		x(M)	x	MO	LO	BKO
Anous tenuirostris melanops	Australian Lesser Noddy	V		x			BKO
Anseranas semipalmata	Magpie Goose			x			MO
Apus pacificus	Fork-tailed Swift		x(M)	x		LO	LO
Ardea alba	Great Egret			x		KO	BKO
Ardea ibis	Cattle Egret			x		KO	MO
Ardenna carneipes	Flesh-footed Shearwater		x(M)			KO	FLO
Ardenna pacifica	Wedge-tailed Shearwater		x(M)	x		BKO	BKO
Arenaria interpres	Ruddy Turnstone		x(W)	x			RKO
Calidris acuminata	Sharp-tailed Sandpiper		x(W)	x	MO	KO	RKO
Calidris alba	Sanderling		x(W)	x			RKO
Calidris canutus	Red Knot	E	x(W)	x	MO	KO	KO
Calidris ferruginea	Curlew Sandpiper	CE	x(W)	x	MO	KO	KO
Calidris melanotos	Pectoral Sandpiper		x(W)	x	MO	MO	KO
Calidris ruficollis	Red-necked Stint		x(W)	x			RKO
Calidris subminuta	Long-toed Stint		x(W)	x			KO
Calidris tenuirostris	Great Knot	CE	x(W)	x			RKO
Calonectris leucomelas	Streaked Shearwater		x(M)	x	LO	LO	KO
Calyptorhynchus latirostris	Carnaby's Cockatoo	E					KO
Catharacta skua	Great Skua			x			MO
Cecropis daurica	Red-rumped Swallow		x(T)				KO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	Operational Area	Hydrocarbon Area	EMBA
Chalcophaps indica natalis	Christmas Island Emerald Dove	E					KO
Charadrius bicinctus	Double-banded Plover		x(W)	x			RKO
Charadrius leschenaultii	Greater Sand Plover	V	x(W)	x			RKO
Charadrius mongolus	Lesser Sand Plover	E	x(W)	x			RKO
Charadrius ruficapillus	Red-capped Plover			x			RKO
Charadrius veredus	Oriental Plover		x(W)	x		MO	RKO
Chrysococcyx osculans	Black-eared Cuckoo			x		KO	KO
Cuculus optatus	Oriental Cuckoo		x(T)			MO	KO
Diomedea amsterdamensis	Amsterdam Albatross	E	x(M)	x			LO
Diomedea epomophora	Southern Royal Albatross	V	x(M)	x			FLO
Diomedea exulans	Wandering Albatross	V	x(M)	x			FLO
Diomedea sanfordi	Northern Royal Albatross	E	x(M)	x			FLO
Erythrotriorchis radiatus	Red Goshawk	V					MO
Erythrura gouldiae	Gouldian Finch	E					KO
Fregata andrewsi	Christmas Island Frigatebird	E	x(M)	x			BKO
Fregata ariel	Lesser Frigatebird		x(M)	x	LO	BKO	BKO
Fregata minor	Great Frigatebird		x(M)	x		MO	BKO
Gallinago megala	Swinhoe's Snipe		x(W)	x			RLO
Gallinago stenura	Pin-tailed Snipe		x(W)	x			RLO
Glareola maldivarum	Oriental Pratincole		x(W)	x		MO	RKO
Haliaeetus leucogaster	White-bellied Sea-Eagle			x		KO	RKO
Halobaena caerulea	Blue Petrel	V		x			MO
Heteroscelus brevipes	Grey-tailed Tattler			x			RKO
Himantopus himantopus	Pied Stilt			x			RKO
Hirundo daurica	Red-rumped Swallow			x			KO
Hirundo rustica	Barn Swallow		x(T)	x		MO	KO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	Operational Area	Hydrocarbon Area	EMBA
Hydroprogne caspia	Caspian Tern		x(M)			BKO	BKO
Larus novaehollandiae	Silver Gull			x		BKO	KO
Larus pacificus	Pacific Gull			x		BKO	KO
Leipoa ocellata	Malleefowl	V					LO
Limicola falcinellus	Broad-billed Sandpiper		x(W)	x			KO
Limnodromus semipalmatus	Asian Dowitcher		x(W)	x			RKO
Limosa lapponica	Bar-tailed Godwit	V	x(W)	x		KO	KO
Limosa lapponica baueri	Bar-tailed Godwit (baueri)	V				KO	KO
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE				LO	KO
Limosa limosa	Black-tailed Godwit		x(W)	x			RKO
Macronectes giganteus	Southern Giant-Petrel	E	x(M)	x	MO	MO	MO
Macronectes halli	Northern Giant Petrel	V	x(M)	x			MO
Malurus leucopterus edouardi	White-winged Fairy-wren (Barrow Island)	V				LO	LO
Malurus leucopterus leucopterus	White-winged Fairy-wren (Dirk Hartog Island),	V					LO
Merops ornatus	Rainbow Bee-eater			x		MO	MO
Motacilla cinerea	Grey Wagtail		x(T)	x		MO	KO
Motacilla flava	Yellow Wagtail		x(T)	x		LO	KO
Ninox natalis	Christmas Island Hawk-Owl	V					KO
Numenius madagascariensis	Eastern Curlew	CE	x(W)	x	MO	KO	KO
Numenius minutus	Little Curlew		x(W)	x			RKO
Numenius phaeopus	Whimbrel		x(W)	x			RKO
Onychoprion anaethetus	Bridled Tern		x(M)			BKO	BKO
Pachyptila turtur	Fairy Prion			x			LO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	Operational Area	Hydrocarbon Area	EMBA
Pachyptila turtur subantarctica	Fairy Prion (southern)	V					LO
Pandion haliaetus	Osprey		x(W)	x	MO	BKO	BKO
Papasula abbotti	Abbott's Booby	E		x		MO	KO
Pelagodroma marina	White-faced Storm-Petrel			x			BKO
Pezoporus occidentalis	Night Parrot	E				MO	MO
Phaethon lepturus	White-tailed Tropicbird		x(M)	x		BLO	BKO
Phaethon lepturus fulvus	Christmas Island White-tailed Tropicbird	E		x			BLO
Phaethon rubricauda	Red-tailed Tropicbird		x(M)	x		BKO	BKO
Phalacrocorax fuscescens	Black-faced Cormorant			x			BLO
Phalaropus lobatus	Red-necked Phalarope		x(W)	x			KO
Philomachus pugnax	Ruff (Reeve)		x(W)	x			KO
Phoebetria fusca	Sooty Albatross	V	x(M)	x			MO
Pluvialis fulva	Pacific Golden Plover		x(W)	x			RKO
Pluvialis squatarola	Grey Plover		x(W)	x			RKO
Polytelis alexandrae	Princess Parrot	V					KO
Pterodroma arminjoniana	Round Island Petrel	CE					MO
Pterodroma macroptera	Great-winged Petrel			x			FKO
Pterodroma mollis	Soft-plumaged Petrel	V		x		FLO	FKO
Puffinus assimilis	Little Shearwater			x			BKO
Puffinus carneipes	Flesh-footed Shearwater			x		LO	FLO
Puffinus huttoni	Hutton's Shearwater			x			FKO
Recurvirostra novaehollandiae	Red-necked Avocet			x			RKO
Rostratula australis	Australian Painted-snipe	E				LO	KO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	Operational Area	Hydrocarbon Area	EMBA
Rostratula benghalensis (sensu lato)	Painted Snipe	E		x		LO	KO
Sterna anaethetus	Bridled Tern			x		BKO	KO
Sterna bengalensis	Lesser Crested Tern			x		BKO	BKO
Sterna bergii	Crested Tern		x(W)	x		BKO	BKO
Sterna caspia	Caspian Tern			x		BKO	BKO
Sterna dougallii	Roseate Tern		x(M)	x		BKO	BKO
Sterna fuscata	Soot Tern			x			BKO
Sterna nereis	Fairy Tern			x			BKO
Sternula albifrons	Little Tern		x(M)	x		CKO	BKO
Sternula nereis nereis	Australian Fairy Tern	V			FLO	BKO	BKO
Stiltia isabella	Australian Pratincole			x			RKO
Sula dactylatra	Masked Booby		x(M)	x		BKO	BKO
Sula leucogaster	Brown Booby		x(M)	x			BKO
Sula sula	Red-footed Booby		x(M)	x			BKO
Thalassarche carteri	Indian Yellow-nosed Albatross	V	x(M)	x			FMO
Thalassarche cauta	Tasmanian Shy Albatross	V*	x(M)	x			MO
Thalassarche cauta cauta	Shy Albatross	V					MO
Thalassarche cauta steadi	White-capped Albatross	V	x(M)	x			FLO
Thalassarche impavida	Campbell Albatross	V	x(M)	x		MO	FLO
Thalassarche melanophris	Black-browed Albatross	V	x(M)	x			MO
Thinornis rubricollis	Hooded Plover			x		KO	KO
Tringa brevipes	Grey-tailed Tattler		x(W)				RKO
Tringa glareola	Wood Sandpiper		x(W)	x			RKO
Tringa nebularia	Common Greenshank		x(W)	x		LO	KO
Tringa stagnatilis	Marsh Sandpiper		x(W)	x			RKO
Tringa totanus	Common Redshank		x(W)	x			RKO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	Operational Area	Hydrocarbon Area	EMBA
Turdus poliocephalus erythropleurus	Christmas Island Thrush	E					LO
Tyto novaehollandiae kimberli	Masked Owl (northern)	V					MO
Xenus cinereus	Terek Sandpiper		x(W)	x			RKO

Threatened Species:
- *V* — *Vulnerable*
- *E* — *Endangered*
- *CE* — *Critically Endangered*

Migratory Species:
- *M* — *Marine*
- *W* — *Wetland*
- *T* — *Terrestrial*

Type of Presence:
- *MO* — *Species of species habitat may occur within area*
- *LO* — *Species or species habitat likely to occur within area*
- *KO* — *Species or species habitat known to occur within area*
- *FMO* — *Foraging, feeding or related behaviour may occur within area*
- *FLO* — *Foraging, feeding or related behaviour likely to occur within area*
- *FKO* — *Foraging, feeding or related behaviour known to occur within area*
- *BLO* — *Breeding likely to occur within area*
- *BKO* — *Breeding known to occur within area*
- *RLO* — *Roosting likely to occur within area*
- *RKO* — *Roosting known to occur within area*
- *CKO* — *Congregation or aggregation known to occur within area*

** Species is listed under a different scientific name on the EPBC Act - Threatened Species list*

Table 4-5: Biologically Important Areas for relevant seabird and shorebird species

Species	BIA Presence			Summary Description of BIA
	EMBA	Opetional Area	Hydrocarbon Area	
Common Noddy (*Anous stolidus*)	f			Foraging grounds lie around islands used for breeding such as the Abrolhos with presence likely to occur mid-August to late-April.
Australian Lesser Noddy (*Anous tenuirostris melanops*)	f			Foraging grounds lie around islands used for breeding such as the Abrolhos with the potential for presence throughout the year.
Flesh-footed Shearwater (*Ardenna carneipes*)	a			Seasonal presence, late-April to late-June and late-August to early-November. Typically, pelagic and mostly well offshore.
Wedge-tailed Shearwater (*Ardenna pacifica*)	b,f	b	b	Breeding grounds and buffer area around offshore islands including Bedout Island, Dampier Archipelago, Forestier Islands, Montebello and Lowendal Islands. Breeding presence may occur between mid-August to April (Pilbara) or to mid-May (Shark Bay).

Species	BIA Presence			Summary Description of BIA
	EMBA	Opetional Area	Hydrocarbon Area	
Little Penguin (*Eudyptula minor*)	f			Pelagic foraging grounds from Perth to Bunbury; typically inshore waters.
Lesser Frigatebird (*Fregata ariel*)	b		b	Breeding grounds and buffer area around offshore islands in the Pilbara and Kimberley (including Bedout Island). Breeding season from March to September.
Pacific Gull (*Larus pacificus*)	f			Foraging grounds generally within inshore aters along th west coast and around Abrolhos Islands.
White-tailed Tropicbird (*Phaethon lepturus*)	b		b	Breeding grounds and buffer area around offshore islands in the Pilbara and Kimberley (including Rowley Shoals). Breeding recorded between May and October.
Soft-plumaged Petrel (*Pterodroma mollis*)	f			Oceanic foraging grounds are on continental shelf waters and not observed inshore. Presence may occur March to Late September.
Little Shearwater (*Puffinus assimilis*)	f			Oceanic foraging grounds extend 4 – 200 km offshore between Kalbarri and Eucla, with high usage around Abrolhos Islands. Presence mainly occurs April to November.
Bridled Tern (*Sterna anaethetus*)	f			Oceanic foraging grounds with presence generally driven by breeding season, late-September to late-febuary/ early-May.
Caspian Tern (*Sterna caspia*)	f			Oceanic foraging grounds.
Roseate Tern (*Sterna dougallii*)	b,f, r		b	Breeding grounds and buffer area around offshore islands in Gascoyne, Pilbara and Kimberly. Breeding presence may occur mid-March to July. Oceanic foraging grounds on west coast and round Abrolhos Islands. Resting area located northern end of Eighty Mile Beach.
Sooty Tern (*Sterna fuscata*)	f			Oceanic foraging grounds; common in Abrolhos area but in small numbers. Presence associated with breeding season from late-August to early-May.
Fairy Tern (*Sterna nereis*)	b,f		b	Breeding grounds and buffer area around offshore islands in Gascoyne and Pilbara. Breeding may occur late-July to September. Oceanic foraging grounds on west coast and round Abrolhos Islands.
Little Tern (*Sternula albifrons*)	b,r		r	Breeding grounds and buffer area and resting areas, around offshore islands in Pilbara and Kimberley. Breeding has been recorded June to October.

Species	BIA Presence			Summary Description of BIA
	EMBA	Opetional Area	Hydrocarbon Area	
Brown Booby (*Sula leucogaster*)	b		b	Breeding grounds and buffer area around offshore islands in Pilbara and Kimberley (including Bedout Island). Breeding presence may occur February to October.
Red-footed Booby (*Sula sula*)	b			Breeding grounds and buffer areas stounf offshore islands and reef areas in the Kimberley (e.g. Ashmore Reef, Adele Island). Breeding typically occurs May to June.
Lesser Crested Tern (*Thalasseus bengalensis*)	b		b	Breeding grounds and buffer area around offshore islands in Gascoyne, Pilbara and Kimberley (including Lowendal Islands and Bedout Island). Breeding may occur March to June.

Biologically Important Areas
a *Aggregation*
b *Breeding*
f *Foraging*
r Resting

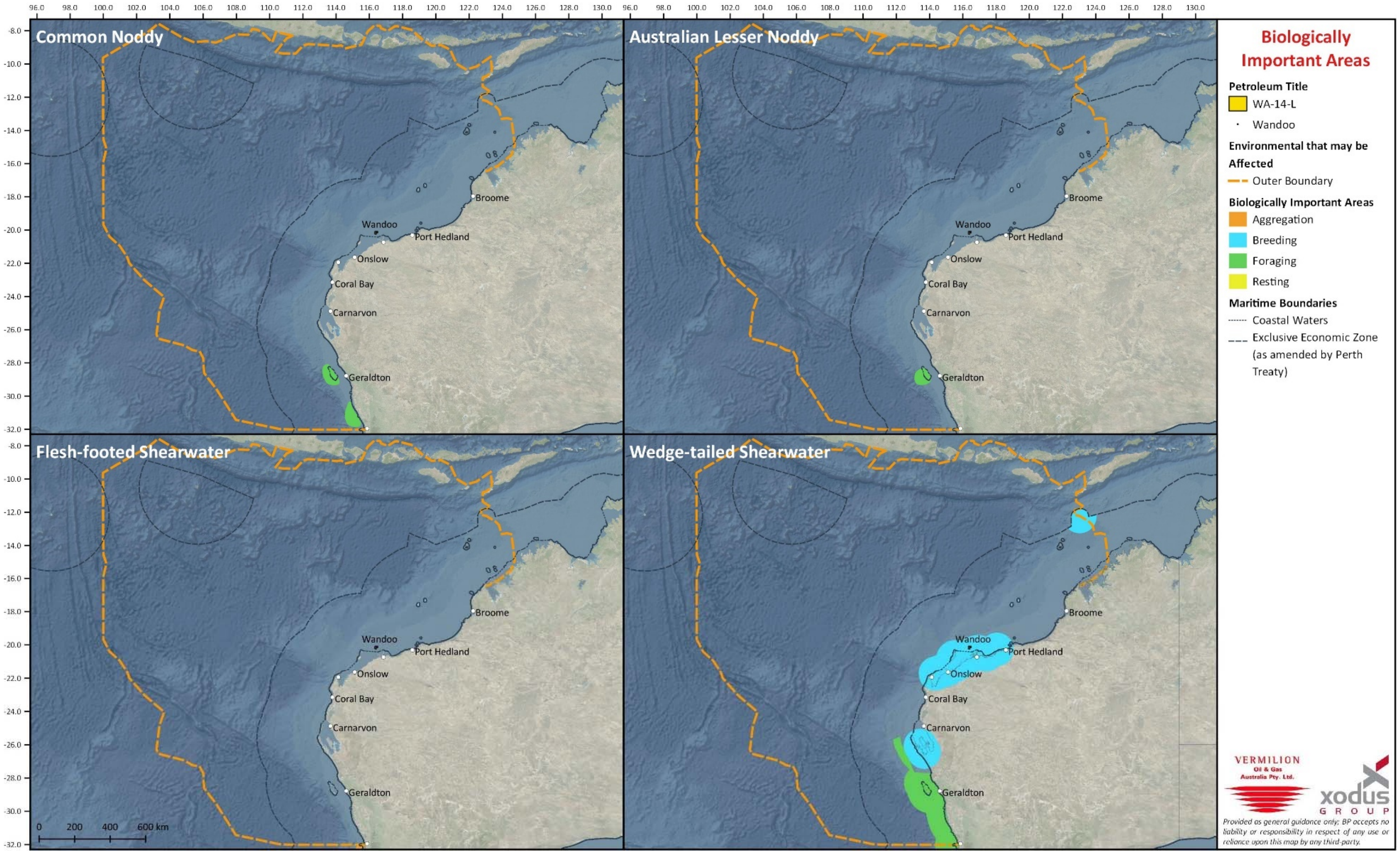


Figure 4-6: Biologically Important Areas for Bird Species

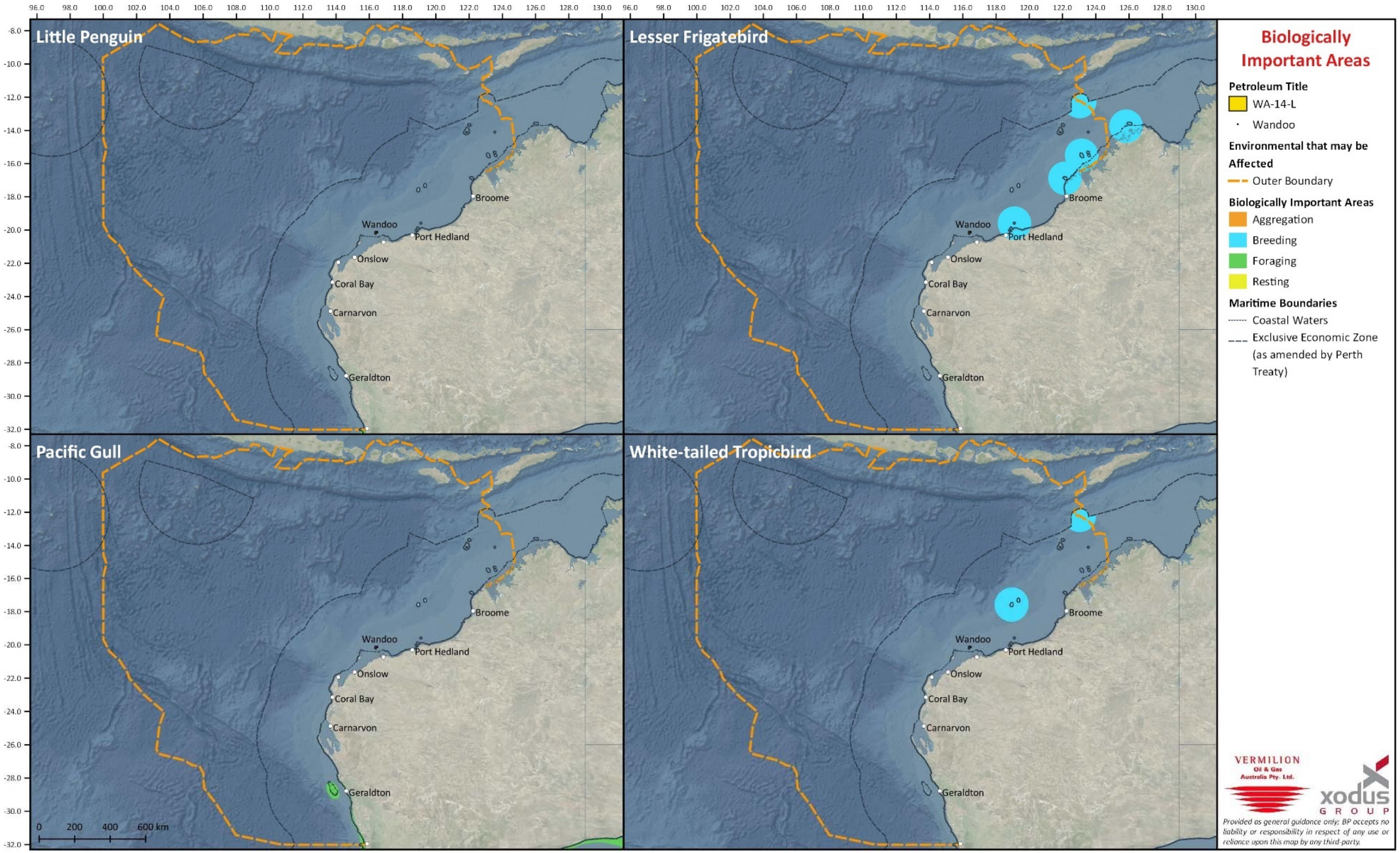


Figure 4-7: Biologically Important Areas for Bird Species

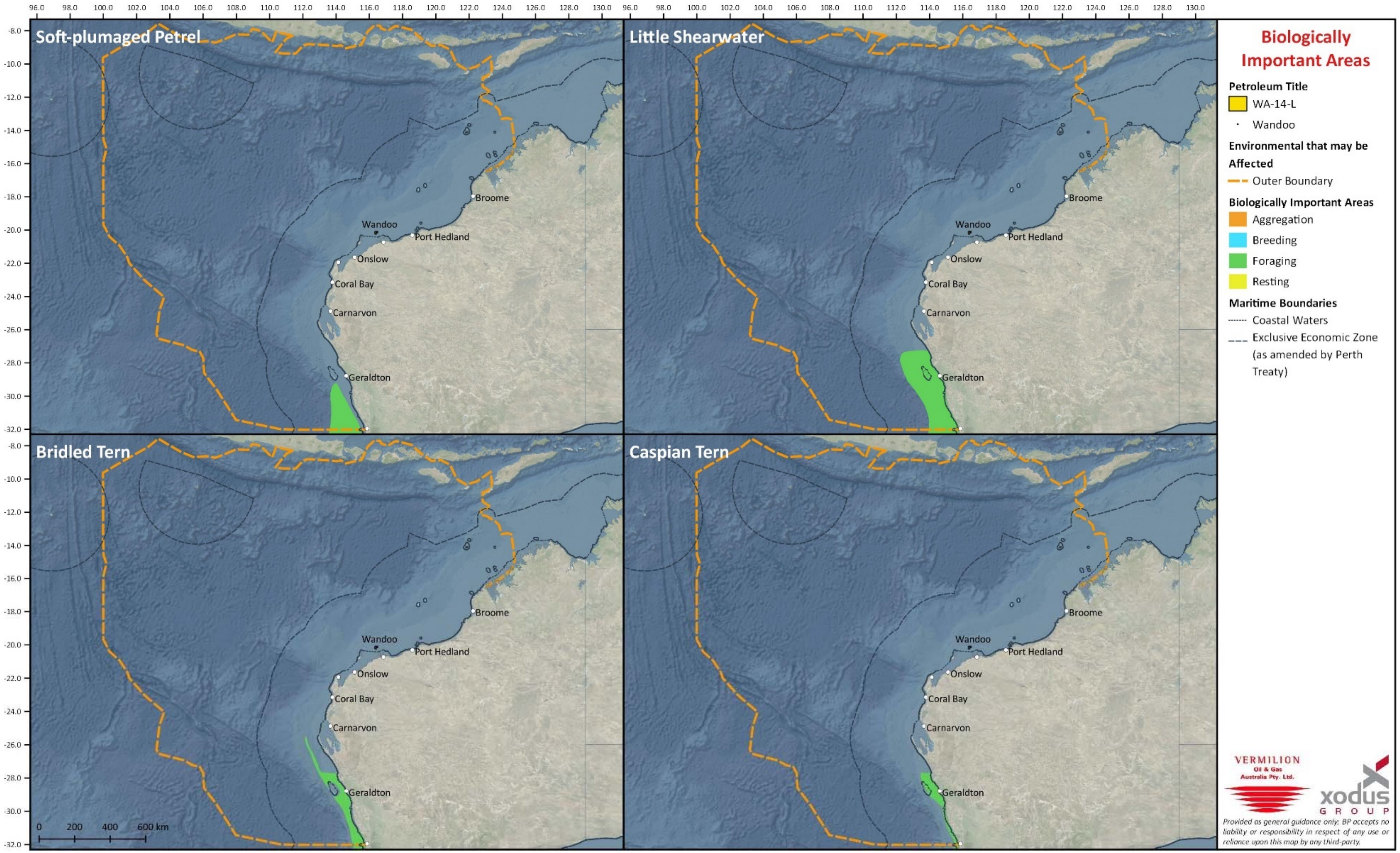


Figure 4-8: Biologically Important Areas for Bird Species

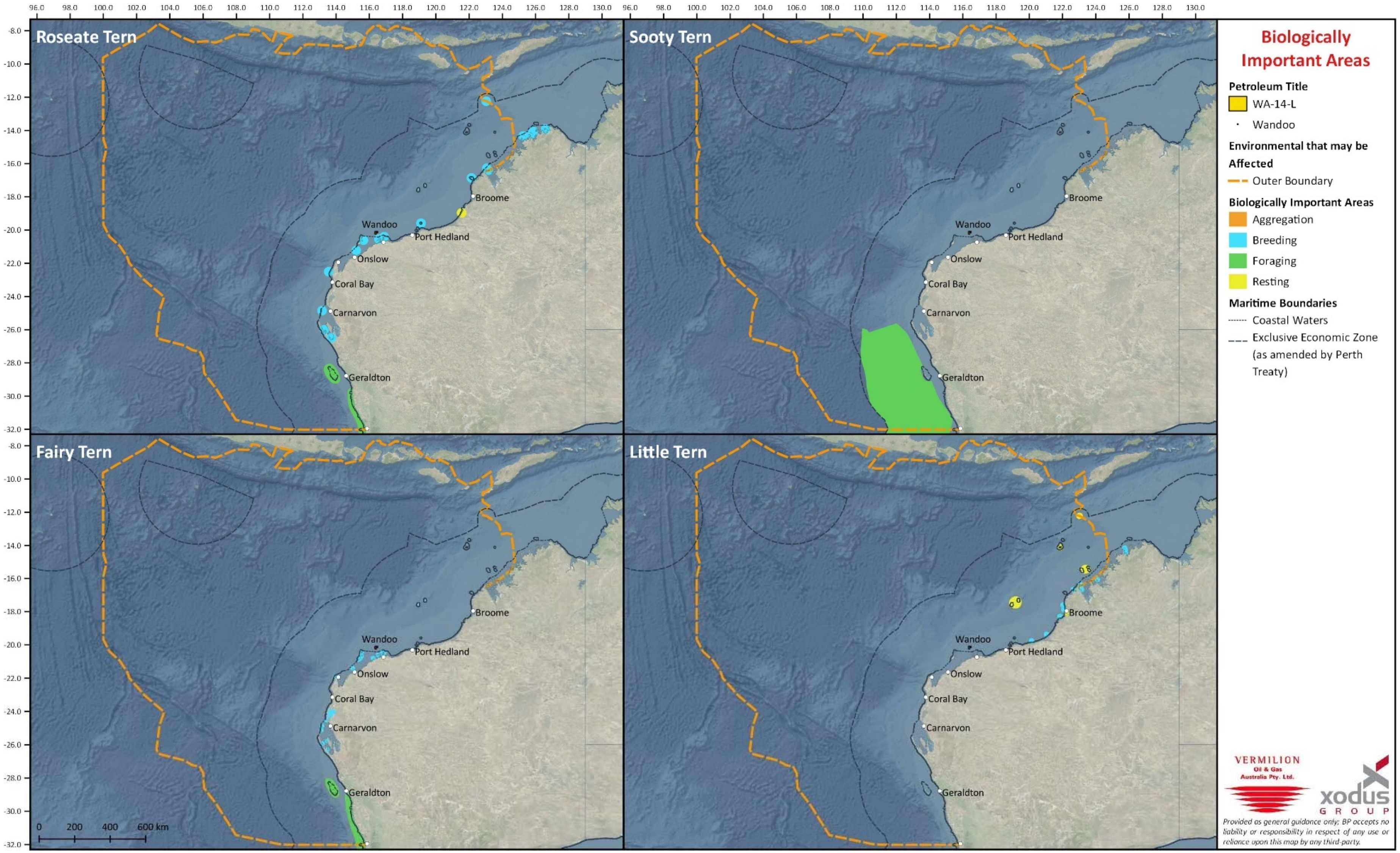


Figure 4-9: Biologically Important Areas for Bird Species

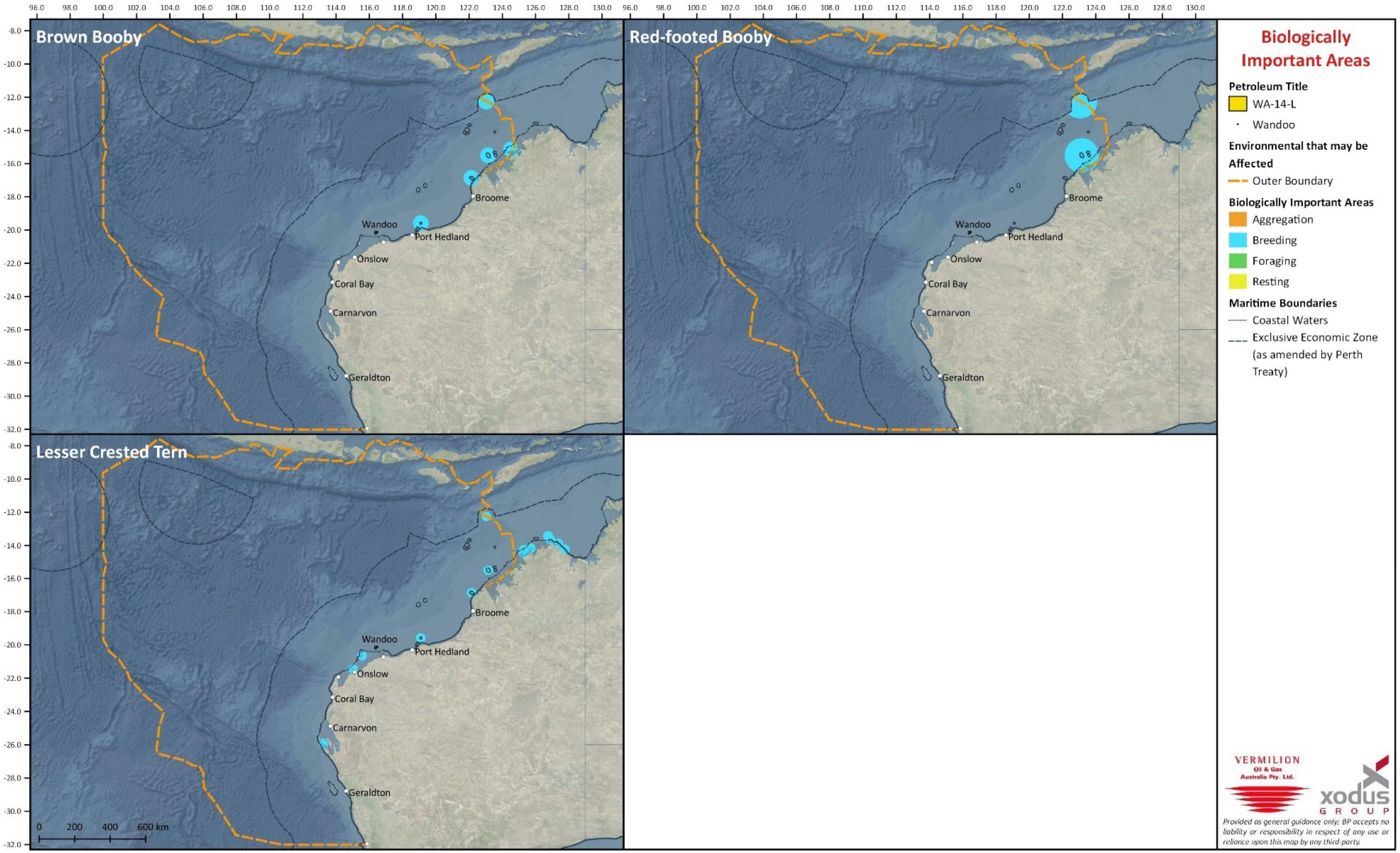


Figure 4-10: Biologically Important Areas for Bird Species

4.3.4.4 *Fish and sharks*

Table 4-1 identifies that fish and sharks may be a relevant receptor to aspects of the activity occurring within the EMBA, Hydrocarbon Area and Operational Area. The description below provides sufficient details to assess all impacts and risks to fish and sharks.

There are multiple species (or species habitats) of fish that may occur within the Operational Area and Hydrocarbon Area. The presence of most species within the Hydrocarbon Area and Operational Area is expected to be of a transitory nature only, with only a small number of species having an important behaviour (e.g. foraging) identified.

The Operational Area for the Wandoo Well Contruction Program is partially within a foraging BIA for the whale shark (Table 4-7, Figure 4-11). However, it is known that the whale sharks are more common migrating along the 200 m depth contour, which is further offshore to the Wandoo facility. The whale shark is widely distributed in Australian waters; but Ningaloo Reef is the main known aggregation area and occurs within the Hydrocarbon Area (DEWHA 2008b). Whale sharks aggregate at Ningaloo between March and June each year to feed. The whale shark is a suction filter feeder, with a diet consisting of planktonic and nektonic prey, and feeds at or close to the water's surface by swimming forward with mouth agape, sucking in prey (DoEE 2017b). While the species is generally encountered close to or at the surface, it will regularly dive and move through the water column.

Much of the seabed in the immediate vicinity of the Operational Area is flat and unvegetated soft sediment. Consequently, the demersal fish fauna abundance and diversity is likely to be lower as compared to nearshore vegetated areas or offshore areas with complex topography.

The fish communities of the Northwest Province in which Hydrocarbon Area exists are diverse, with high level of endemism in demersal fish communities on the slope. Fish species commonly found on the inner shelf include lizardfish, goatfish, trevally, anglefish and tuskfish; and fish species commonly found in slightly deeper (100–200 m) shelf water include deep goatfish, deep lizardfish, ponyfish, deep threadfin bream, adult trevally, billfish and tuna (DEWHA 2008). Fish found in water depths up to 300 m include grouper and snapper species (Rome and Newman 2010). Spanish mackerel spawn in the region between August and November. A small aggregation of the vulnerable grey nurse sharks has been identified off Exmouth during a five-year (2007–2012) study (Hosche and Whisson 2016). Aggregation sites are important in the life cycle of the grey nurse shark for mating and pupping (Hosche and Whisson 2016).

Previous consultation with the Department of Fisheries (DoF; now Department of Primary Industries and Regional Development [DPIRD]) identified that a number of commercial fish species have spawning areas with the EMBA. Their spawning and aggregation times are outlined in Table 4-8.

Table 4-6: Fish species or species habitat that may occur within the Project Areas

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Sharks and Rays							
Anoxypristis cuspidata	Narrow Sawfish		x(M)		KO	MO	KO
Carcharias taurus (west coast population)	Grey Nurse Shark (west coast population)	V			KO	LO	KO
Carcharodon carcharias	White Shark	V	x(M)		FKO	MO	KO
Glyphis garricki	Northern River Shark	E			MO		
Isurus oxyrinchus	Shortfin Mako		x(M)		LO		LO
Isurus paucus	Longfin Mako		x(M)		LO	LO	
Lamna nasus	Porbeagle		x(M)		MO		MO
Manta alfredi	Reef Manta Ray		x(M)		KO	KO	KO
Manta birostris	Giant Manta Ray		x(M)		KO	LO	KO
Pristis clavata	Dwarf Sawfish	V	x(M)		BKO	KO	KO
Pristis pristis	Freshwater Sawfish	V	x(M)		KO		KO
Pristis zijsron	Green Sawfish	V	x(M)		BKO	KO	KO
Rhincodon typus	Whale Shark	V	x(M)		FKO	FKO	FKO
Other							
Acentronura australe	Southern Pygmy Pipehorse			x	MO		
Acentronura larsonae	Helen's Pygmy Pipehorse			x	MO	MO	MO
Bhanotia fasciolata	Corrugated Pipefish			x	MO		MO
Bulbonaricus brauni	Braun's Pughead Pipefish			x	MO	MO	MO
Campichthys galei	Gale's Pipefish			x	MO		
Campichthys tricarinatus	Three-keel Pipefish			x	MO	MO	MO
Choeroichthys brachysoma	Pacific Short-bodied Pipefish			x	MO	MO	MO
Choeroichthys latispinosus	Muiron Island Pipefish			x	MO		MO
Choeroichthys sculptus	Sculptured Pipefish			x	MO		
Choeroichthys suillus	Pig-snouted Pipefish			x	MO	MO	MO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Corythoichthys amplexus	Fijian Banded Pipefish			x	MO		MO
Corythoichthys flavofasciatus	Reticulate Pipefish			x	MO		MO
Corythoichthys haematopterus	Reef-top Pipefish			x	MO		
Corythoichthys intestinalis	Australian Messmate Pipefish			x	MO		MO
Corythoichthys schultzi	Schultz's Pipefish			x	MO		MO
Cosmocampus banneri	Roughridge Pipefish			x	MO		MO
Cosmocampus maxweberi	Maxweber's Pipefish			x	MO		
Doryrhamphus baldwini	Redstripe Pipefish			x	MO		
Doryrhamphus dactyliophorus	Banded Pipefish			x	MO	MO	MO
Doryrhamphus excisus	Bluestripe Pipefish			x	MO		MO
Doryrhamphus janssi	Cleaner Pipefish			x	MO	MO	MO
Doryrhamphus multiannulatus	Many-banded Pipefish			x	MO	MO	MO
Doryrhamphus negrosensis	Flagtail Pipefish			x	MO	MO	MO
Festucalex scalaris	Ladder Pipefish			x	MO	MO	MO
Filicampus tigris	Tiger Pipefish			x	MO	MO	MO
Halicampus brocki	Brock's Pipefish			x	MO	MO	MO
Halicampus dunckeri	Red-hair Pipefish			x	MO		MO
Halicampus grayi	Mud Pipefish			x	MO	MO	MO
Halicampus macrorhynchus	Whiskered Pipefish			x	MO		
Halicampus mataafae	Samoan Pipefish			x	MO		
Halicampus nitidus	Glittering Pipefish			x	MO	MO	MO
Halicampus spinirostris	Spiny-snout Pipefish			x	MO	MO	MO
Haliichthys taeniophorus	Ribboned Pipehorse			x	MO	MO	MO
Hippichthys cyanospilos	Blue-speckled Pipefish			x	MO		
Hippichthys heptagonus	Madura Pipefish			x	MO		

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Hippichthys penicillus	Beady Pipefish			x	MO	MO	MO
Hippichthys spicifer	Belly-barred Pipefish			x	MO		
Hippocampus angustus	Western Spiny Seahorse			x	MO	MO	MO
Hippocampus breviceps	Short-head Seahorse			x	MO		
Hippocampus histrix	Spiny Seahorse			x	MO	MO	MO
Hippocampus kuda	Spotted Seahorse			x	MO	MO	MO
Hippocampus planifrons	Flat-face Seahorse			x	MO	MO	MO
Hippocampus spinosissimus	Hedgehog Seahorse			x	MO		MO
Hippocampus subelongatus	West Australian Seahorse			x	MO		
Hippocampus trimaculatus	Three-spot Seahorse			x	MO	MO	MO
Lissocampus fatiloquus	Prophet's Pipefish			x	MO		
Maroubra perserrata	Sawtooth Pipefish			x	MO		
Micrognathus brevirostris	thorntail Pipefish			x	MO		
Micrognathus micronotopterus	Tidepool Pipefish			x	MO	MO	MO
Milyeringa veritas	Blind Gudgeon	V			KO		KO
Mitotichthys meraculus	Western Crested Pipefish			x	MO		
Nannatherina balstoni	Balston's Pygmy Perch	V			LO		
Nannocampus subosseus	Bonyhead Pipefish			x	MO		
Ophisternon candidum	Blind Cave Eel	V			KO		KO
Phoxocampus belcheri	Black Rock Pipefish			x	MO	MO	MO
Phycodurus eques	Leafy Seadragon			x	MO		
Phyllopteryx taeniolatus	Common Seadragon			x	MO		
Pugnaso curtirostris	Pugnose Pipefish			x	MO		
Solegnathus hardwickii	Pallid Pipehorse			x	MO	MO	MO
Solegnathus lettiensis	Gunther's Pipehorse			x	MO	MO	MO
Solenostomus cyanopterus	Robust Ghostpipefish			x	MO	MO	MO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Stigmatopora argus	Spotted Pipefish			x	MO		
Stigmatopora nigra	Widebody Pipefish			x	MO		
Syngnathoides biaculeatus	Double-end Pipehorse			x	MO	MO	MO
Trachyrhamphus bicoarctatus	Bentstick Pipefish			x	MO	MO	MO
Trachyrhamphus longirostris	Straightstick Pipefish			x	MO	MO	MO
Urocampus carinirostris	Hairy Pipefish			x	MO		
Vanacampus margaritifer	Mother-of-pearl Pipefish			x	MO		

Threatened Species: *V Vulnerable* *E Endangered* *Migratory Species:* *M Marine*	*Type of Presence:* *MO Species of species habitat may occur within area* *LO Species or species habitat likely to occur within area* *KO Species or species habitat known to occur within area* *FKO Foraging, feeding or related behaviour known to occur within area* *BKO Breeding known to occur within area*

Table 4-7: Biologically important areas for relevant marine fish species

Species	BIA Presence			Summary Description of BIA
	EMBA	Opetional Area	Hydrocarbon Area	
White Shark (*Carcharodon Carcharias*)	f			Foraging grounds around Abrolhos Islands and is associated withsea lion colonies along the south-west coast between Dongara and Augusta.
Whale Shark (*Rhincodon typus*)	f	f	f	Oceanic foraging ground: known to travel along the 200 m depth contour. Presence may occur during spring. Ningaloo Reef foraging grounds: high density prey. Between April and June, and in Autumn.
Dwarf Sawfish (Pristis clavate)	n,f			Inshore foraging, pupping and nursery area along Eighty Mile Beach with nursery area at Fitzroy River Mouth, May and Robinson River.

Species	BIA Presence			Summary Description of BIA
	EMBA	Opetional Area	Hydrocarbon Area	
Freshwater Sawfish (*Pristis pristis*)	n,f			Inshore foraging and pupping area along Eighty Mile Beach. Foraging, pupping and nursery area at Roebuck Bay. Pupping occurs from January to May. Foraging and nursing occurs in King Sound.
Green Sawfish (*Pristis zijsron*)	n,f			Inshore foraging and pupping area along Eighty Mile Beach. Pupping occurs at Willie Creek. Foraging and pupping area at Roebuck Bay. Pupping occurs from January to May. Foraging and nursing occurs in King Sound. Foraging occurs in Camden Sound.
Biologically Important Areas *f* *Foraging* *n* *Nursing, Pupping and/or Juvinile*				

Table 4-8: Commercial fish spawning times

Key fish species within EMBA	Spawning/aggregation times
Blacktip shark (*Carcharhinus tilstoni* and *C.limbatus*)	November to December
Goldband snapper (*Pristipomoides multidens*)	January to April
Rankin cod (*Epinephelus multiinotatus*)	August to October
Red emperor (*Lutjanus sebae*)	January, March
Pink snapper (*Pagrus auratus*) (rare)	May to July
Sandbar shark (*Carcharhinus plumbeus*)	October to January
Spanish mackerel (*Scomberomorous commerson*)	August to November

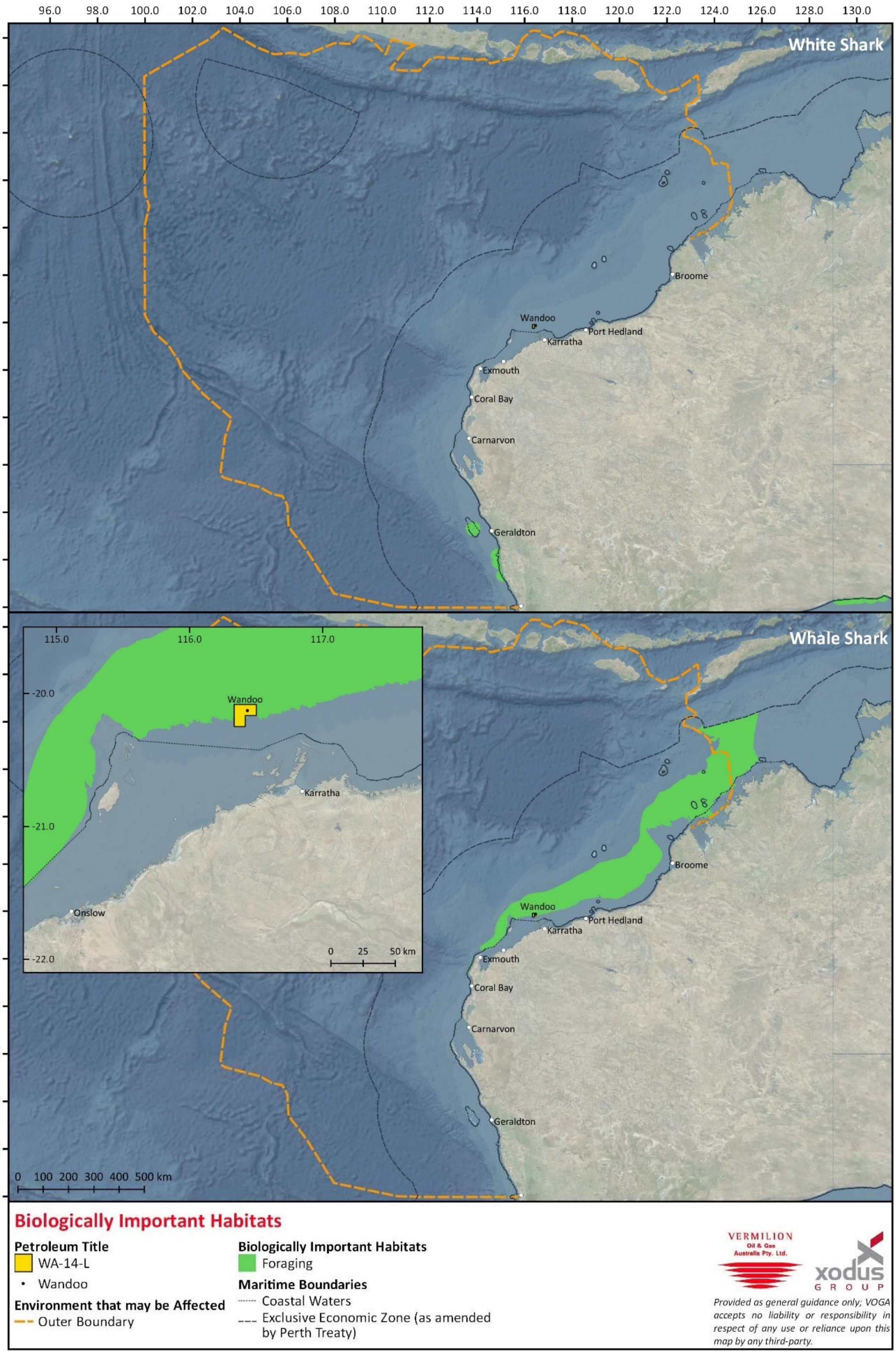


Figure 4-11: Biologically Important Areas for Shark Species

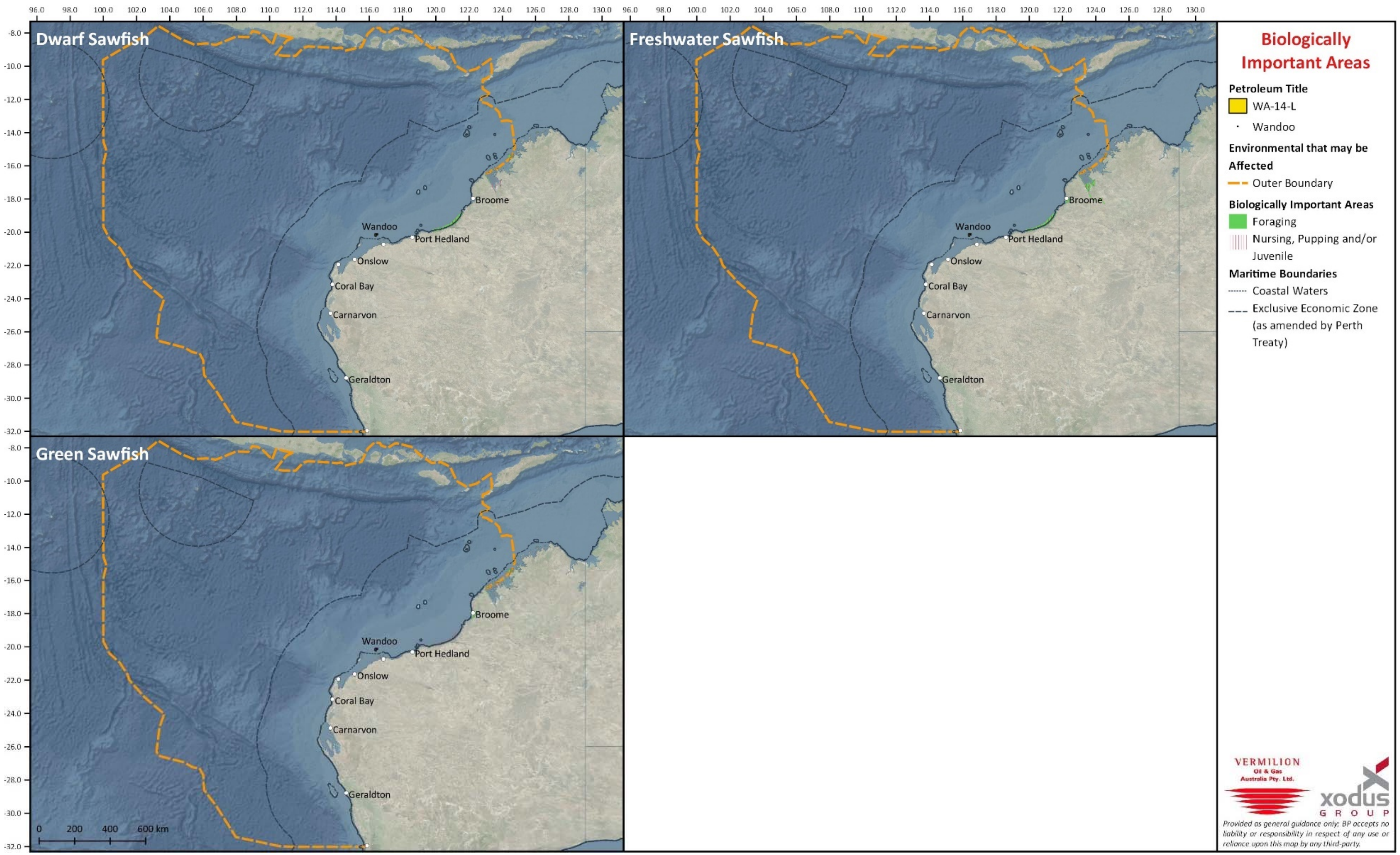


Figure 4-12: Biologically Important Areas for Sawfish Species

4.3.4.5 *Marine mammals*

Table 4-1 identifies marine mammals as a relevant receptor to aspects of the activity occurring within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to marine mammals.

There are multiple marine mammal species (or habitat) that may occur within the Operational Area and the Hydrocarbon Area. The presence of most species are expected to be of a transitory nature only, with a small number of species having an important behaviour (e.g. foraging, breeding) identified within the Hydrocarbon Area.The Operational Area for the Wandoo Well Contruction Program is within a migration BIA for the humpback whale, and a distribution BIA for the pygmy blue whale (Table 4-10, Figure 4-13).

There are two subspecies of blue whales found in the southern hemisphere and known to occur in Australian waters: the Antarctic blue whale and the pygmy blue whale. Antarctic blue whales are not expected to occur within the EMBA orHydrocarbon Area. Pygmy blue whales are expected to occur; and seasonally important areas within WA include the Perth Canyon. The migratory pathway of pygmy blue whales along the WA coast is reasonably well understood (McCauley and Jenner 2010; DEWHA 2008c) with recent information collected from satellite tags showing that the Banda and Molucca seas in Indonesia is the likely destination for the northern migration of whales that feed off the Perth Canyon (Double *et al.,* 2012; Gales et al 2010; Branch et al 2007).

During the northern migration the pygmy blue whales are around the Perth Canyon area from January to May, and then travel past North West Cape between April to August; and the southern migration typically occurs from October to late-December (DEWHA 2008c). The migratory path for the pygmy blue whales is in deeper waters, typically 500–1,000 m.

Humpback whales migrate north through the EMBA from their Antarctic feeding grounds around May each year, and reach the waters of the North-west Marine Region in early-June (DEWHA 2008c); however, the exact timing of the migration period can vary from year to year. From the North West Cape, northbound humpback whales travel along the edge of the continental shelf passing to the west of the Muiron, Barrow and Montebello Islands (within the Hydrocarbon Area), peaking in late July (Jenner *et al.,* 2001).

Breeding and calving grounds are estimated to extend south from Camden Sound to at least North West Cape (Irvine *et al.,* 2018) within the Hydrocarbon Area; with breeding and calving occurring between August and September (DEWHA 2008c). This also coincides with the start of the southern migration. Exmouth Gulf (within Hydrocarbon Area) and Shark Bay (outside of the Hydrocarbon Area but within EMBA) are both important resting areas for migrating humpbacks, particularly for cow-calf pairs on the southern migration (DEWHA 2008). The southerly migration, from around the Lacepede Islands (north of Broome, outside of the Hydrocarbon Area but within the EMBA) extends parallel to the coast on approx. the 20–30 m depth contour (Jenner *et al.,* 2001, DEWHA 2008). Southbound migration is more diffuse and irregular, lacking an obvious peak. An increase in southerly migrating individuals may be observed within the Hydrocarbon Area between the North West Cape and the Montebello Islands around November (Jenner *et al.,* 2001).

A significant proportion of the world's dugong population occurs in coastal waters from Shark Bay (WA) to Moreton Bay (QLD) (DEWHA 2008d). Shark Bay occurs outside of the EMBA and supports a significant population of dugongs, with an estimated 10,000 individuals (DEWHA 2008d). Dugongs are also known to feed and migrate through the Northwest Shelf Province, including regions within the Hydrocarbon Area, Exmouth Gulf, around North West Cape and offshore on the NWS.

The Exmouth Gulf dugong population is considered stable and the only one not in decline (Oceanwise 2019). Exmouth Gulf is important to this species, as it has been recorded as providing significant breeding and feeding habitat (Jenner and Jenner 2005, Oceanwise 2019). Seagrass is the preferred food of dugongs, but they are also known to eat algae and macroinvertebrates.

Table 4-9: Marine mammal species or species habitat that may occur within the Project Areas

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Whales and Dolphins							
Balaenoptera acutorostrata	Minke Whale			x	MO	MO	MO
Balaenoptera bonaerensis	Antarctic Minke Whale		x(M)	x	LO		LO
Balaenoptera borealis	Sei Whale	V	x(M)	x	FLO	MO	FLO
Balaenoptera edeni	Bryde's Whale		x(M)	x	LO	MO	LO
Balaenoptera musculus	Blue Whale	E	x(M)	x	FKO	LO	MKO
Balaenoptera physalus	Fin Whale	V	x(M)	x	FLO	MO	FLO
Caperea marginata	Pygmy Right Whale		x(M)	x	MO		
Delphinus delphis	Common Dophin			x	MO	MO	MO
Eubalaena australis	Southern Right Whale	E	x(M)	x	BKO		LO
Feresa attenuata	Pygmy Killer Whale			x	MO		MO
Globicephala macrorhynchus	Short-finned Pilot Whale			x	MO		MO
Globicephala melas	Long-finned Pilot Whale			x	MO		
Grampus griseus	Risso's Dolphin			x	MO	MO	MO
Hyperoodon planifrons	Southern Bottlenose Whale			x	MO		
Indopacetus pacificus	Longman's Beaked Whale			x	MO		MO
Kogia breviceps	Pygmy Sperm Whale			x	MO		MO
Kogia simus	Dwarf Sperm Whale			x	MO		MO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Lagenodelphis hosei	Fraser's Dolphin			x	MO		MO
Lissodelphis peronii	Southern Right Whale Dolphin			x	MO		
Megaptera novaeangliae	Humpback Whale	V	x(M)	x	BKO	KO	CKO
Mesoplodon bowdoini	Andrew's Beaked Whale			x	MO		
Mesoplodon densiro	Blainville's Beaked Whale			x	MO		MO
Mesoplodon ginkgodens	Gingko-toothed Beaked Whale			x	MO		MO
Mesoplodon grayi	Gray's Beaked Whale			x	MO		
Mesoplodon layardii	Strap-toothed Beaked Whale			x	MO		
Mesoplodon mirus	True's Beaked Whale			x	MO		
Orcaella brevirostris	Irrawaddy Dolphin			x	KO		
Orcaella heinsohni	Australian Snubfin Dolphin		x(M)		BKO		
Orcinus orca	Killer Whale		x(M)	x	MO	MO	MO
Peponocephala electra	Melon-headed Whale			x	MO		MO
Physeter macrocephalus	Sperm Whale		x(M)	x	MO		MO
Pseudorca crassidens	False Killer Whale			x	LO	LO	LO
Sousa chinensis	Indo-Pacific Humpback Dolphin		x(M)	x	BKO	MO	KO
Stenella attenuata	Spotted Dolphin			x	MO	LO	MO
Stenella coeruleoalba	Striped Dolphin			x	MO		MO
Stenella longirostris	Long-snouted Spinner Dolphin			x	MO		MO
Steno bredanensis	Rough-toothed Dolphin			x	MO		MO
Tursiops aduncus	Indian Ocean Bottlenose Dolphin			x	LO	MO	LO
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)		x(M)	x	KO	LO	KO

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Tursiops truncatus s. str	Bottlenose Dolphin			x	MO	MO	MO
Ziphius cavirostris	Cuvier's Beaked Whale			x	MO		MO
Pinnipeds							
Arctocephalus forsteri	Long-nosed Fur-seal			x	MO		
Neophoca cinerea	Australian Sea-lion	V		x	BKO		
Other							
Dugong dugon	Dugong		x(M)	x	BKO		

Threatened Species:
V Vulnerable
E Endangered

Migratory Species:
M Marine

Type of Presence:
MO Species of species habitat may occur within area
LO Species or species habitat likely to occur within area
KO Species or species habitat known to occur within area
FKO Foraging, feeding or related behaviour known to occur within area
BKO Breeding known to occur within area
MKO Migration route known to occur within area
CKO Congregation or aggregation known to occur within area

Table 4-10: Biologically important areas for relevant marine mammal species

Species	BIA Presence			Summary Description of BIA
	EMBA	Operational Area	Hydrocarbon Area	
Blue Whale, Pygmy Blue Whale (*Balaenoptera musculus*)	m,f,d		m,f,d	Offshore migration corridor, typically along shelf-edge at depths 500–1,000 m, occuring close to the coast around Exmouth. Presence may occur during northern migration past Exmouth area during April to August (whereas January to May past Perth Canyon area). Southern migration presence may occur October to late-December. Foraging along outer continental shelf from Cape Naturaliste to south of Jurien Bay (Nov-June, with peak in March-May).
Southern Right Whale (*Eubalaena australis*)	c			Seasonal calving habitat and buffer along south-western coast, south of Perth. Presence

Species	BIA Presence			Summary Description of BIA
	EMBA	Operational Area	Hydrocarbon Area	
				may occur late-autumn, winter and spring. Expected use is low.
Humpback Whale (*Megaptera novaeangliae*)	c,m, r		m	Migration corridor extends out to ~50–100 km from the coast. Migration along the WA coast occurs between May and late November. Winter resting areas identified within Exmouth Gulf and Shark Bay. Calving ground extending from Camden Sound to North West Cape.
Sperm Whale	f			Foraging area associated with abundant food source at Perth Canyon.
Dugong (*Dugong dugon*)	b,c,f ,m		b,c,f	Breeding, calving, nursing and foraging grounds within the Exmouth Gulf and North West Cape regions. Presence may occur throughout the year. Presence in Shark Bay BIAs may be more seasonal, between April and November.
Australian Sea Lion (*Neophoca cinereal*)	f			Oceanic foraging grounds along west coast and around Abrolhos Islands for resident populations. Presence may occur throughout the year.
Australian Snubfin Dolphin (*Orcaella heinsohni*)	b,c,f ,m			Presence in shallow coastal waters and estuaries along the Kimberley coast. Beagle and Pender Bays on the Dampier Peninsula and tidal creeks around Yampi Sound and between Kuri Bay and Cape Londonderry are important areas
Indo-Pacific humpback dolphin (*Sousa chinensis*)	b,c,f			Breeding grounds in King Sound North, Yampi Sound and Talbot Bay Fjord area. Foraging grounds in King Sound South and Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay and Augustus Island (Kuri Bay), as well as Pender Bay, Carnot & Beagle bays, Maret Island, Biggee Island, Admiralty Gulf & Parry Harbour. Significant habitat reported at Vansittart Bay, Anjo Peninsula
Indo-Pacific/Spotted Bottlenose dolphin (*Tursiops aduncus*)	b,c,f ,m			Calving grounds in Roebuck Bay and Camden Sound Area - - Walcott Inlet, Doubtful Bay, Deception Bay and Augustus Island (Kuri Bay). Breeding grounds in King Sound, Yampi Sound and Talbot Bay Fjord area.

Species	BIA Presence			Summary Description of BIA
	EMBA	Operational Area	Hydrocarbon Area	
Biologically Important Areas *b* *Breeding* *c* *Calving and/or Nursing* *d* *Distribution* *f* *Foraging* *m* *Migration* *r* *Resting*				

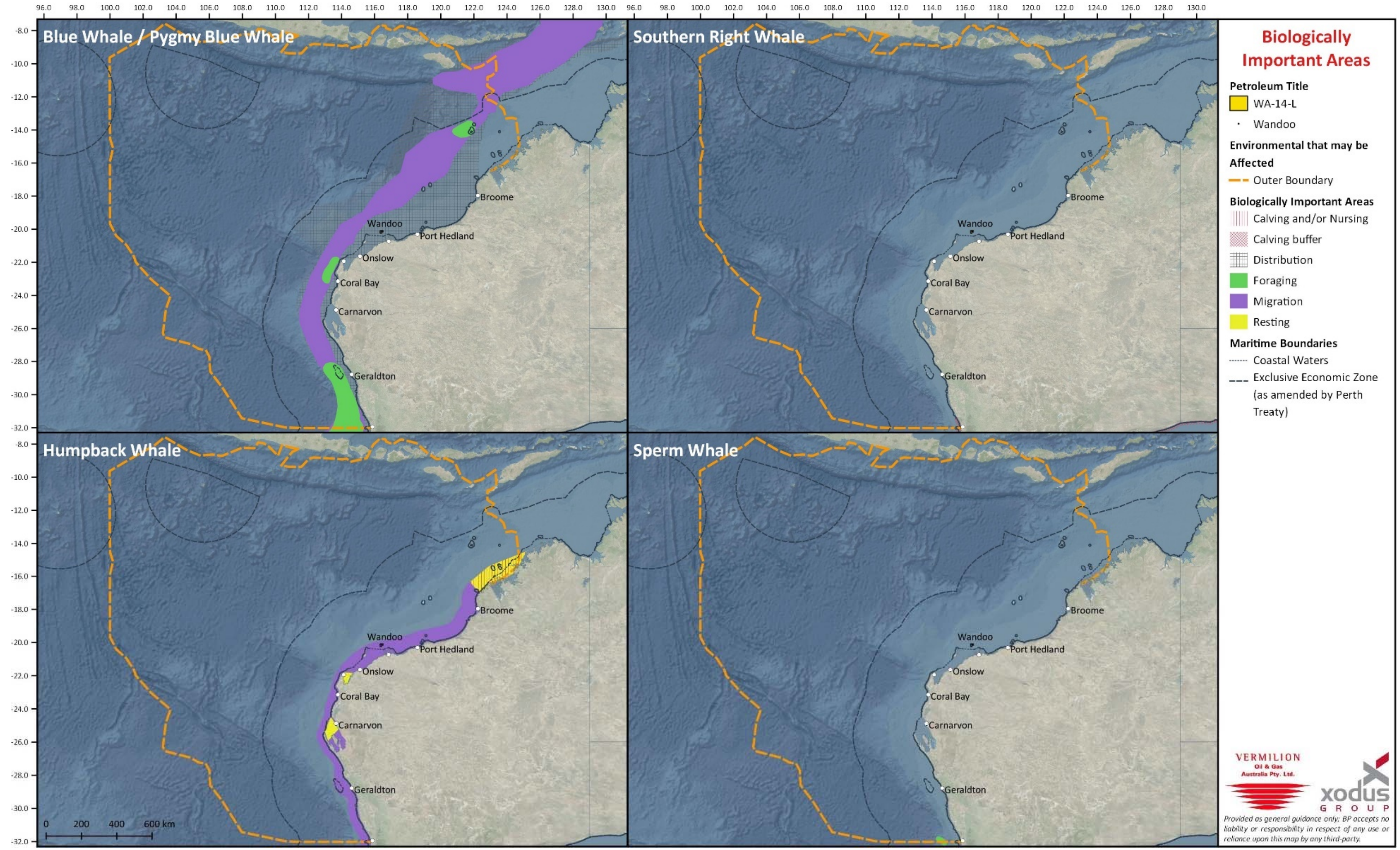


Figure 4-13: Biologically Important Areas for Whale Species

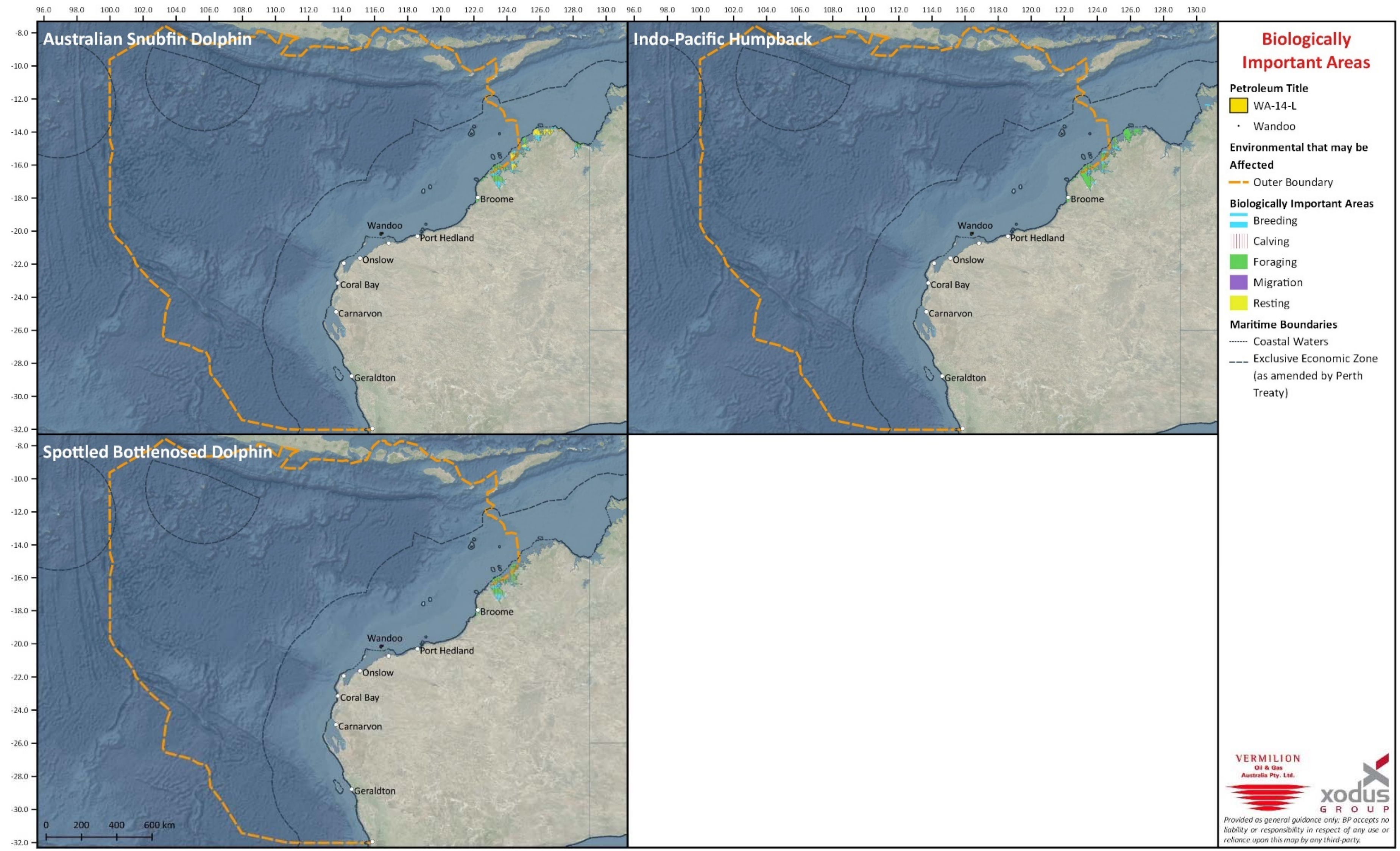


Figure 4-14: Biologically Important Areas for Dolphin Species

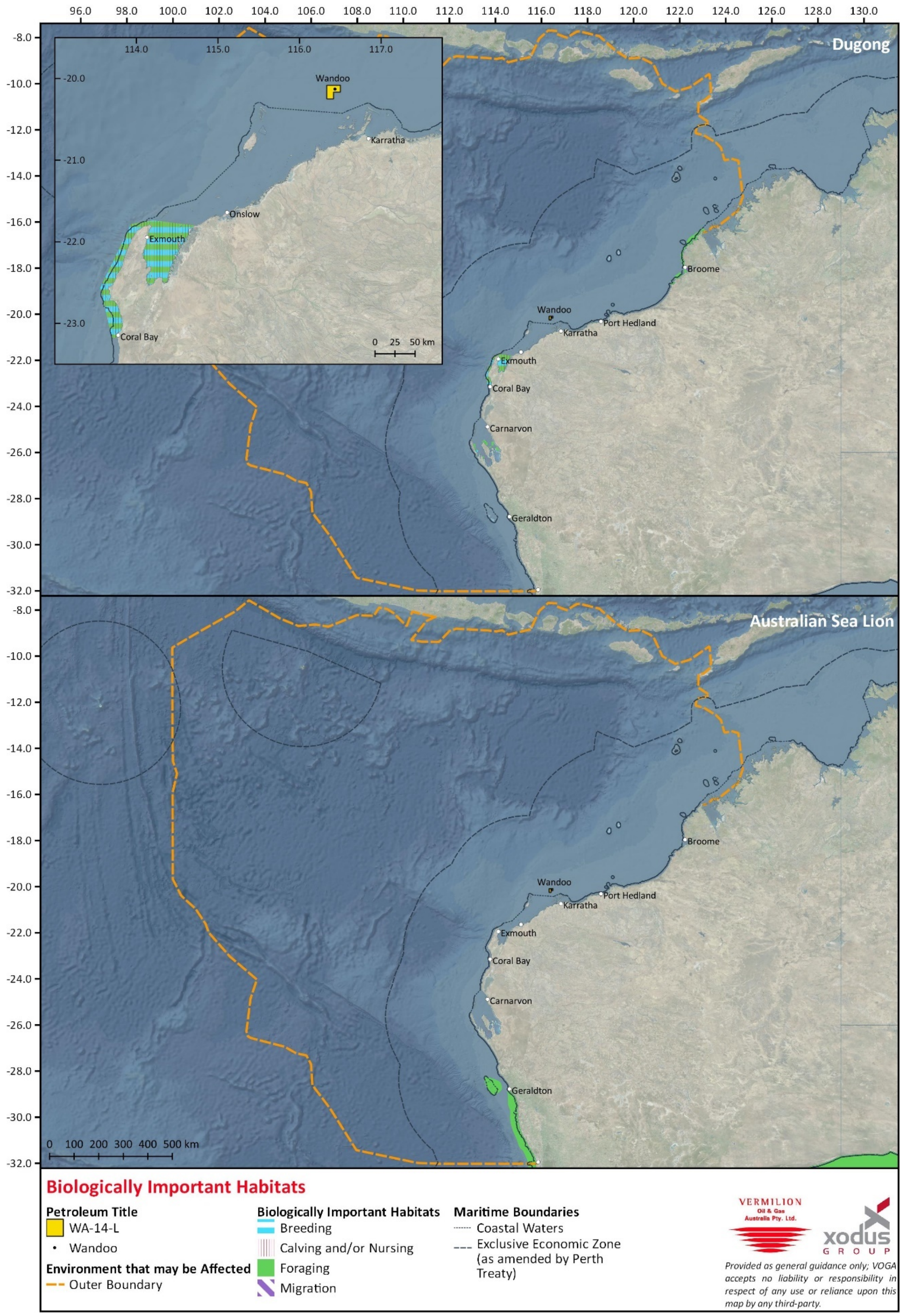


Figure 4-15: Biologically Important Area for Dugong and Pinniped Species

4.3.4.6 *Marine reptiles*

Marine reptiles are expected to occur within the EMBA. Table 4-1 identifies that marine reptiles may be affected within the Hydrocarbon Area and Operational Area during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to marine reptiles.

There are multiple species (or species habitat) of marine reptile that may occur within the EMBA (Table 4-12). The Operational Area for the Wandoo Well Contruction Program is within an internesting BIA and critical nesting habitat for the flatback turtle (Table 4-12, Figure 4-16). This part of the internesting buffer would be based around nesting locations within the Dampier Archiplego (Table 4-11) and occur within the Hydrocarbon Area. The presence of most species within the Operational Area and Hydrocarbon Area are expected to be of a transitory nature only.

Marine turtles have a highly migratory life history and rely on both marine and terrestrial habitats. North-west WA, including the offshore islands is known for supporting nesting and internesting habitat for turtle species. Nesting and internesting habitat critical to the survival of a species has been identified for genetic stocks present in WA (DoEE, 2017a). These important nesting locations occuri witin Hydrocarbon Area and include shorelines at Muiron and Serrurier Islands, the North West Cape and Ningaloo coast.

Table 4-11: Habitat critical to the survival of marine turtle species

Species (Genetic Stock)	Nesting locations	Internesting buffer	Nesting season
Flatback turtle (Pilbara)	Montebello Islands, Mundabullangana Beach, Barrow Island, Cemetery Beach, Dampier Archipelago (including Delambre Island and Huay Island), coastal islands from Cape Preston to Locker Island	60 km	October to March
Green turtle (NWS)	Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, North West Cape, Ningaloo coast	20 km	November to March
Hawksbill turtle (WA)	Dampier Archipelago (including Rosemary Island and Delambre Island), Montebello Islands (including Ah Chong Island, South East Island and Trimouille Island), Lowendal Islands (including Varanus Island, Beacon Island and Bridled Island), Sholl Island	20 km	October to February
Loggerhead turtle (WA)	Dirk Hartog Island, Muiron Islands, Gnaraloo Bay, Ningaloo coast	20 km	October to March
Olive ridley turtle	Cape Leveque, Prior Point and Llanggi, Darcy Island, Vulcan Island.	20 km	May to July

Table 4-12: Biologically Important Areas for relevant marine turtle species species

Species	BIA Presence			Summary Description of BIA
	EMBA	Operational Area	Hydrocarbon Area	
Loggerhead Turtle (*Caretta caretta*)	f,i, n		f,i, n	Nesting and interesting areas around rookeries, including Lowendal and Montebello islands, Ningaloo Coast, Muiron and Dampier Archipelago. Oceanic foraging area between De Grey River and Bedout Island may be use throughout the year by multiple turtle species.
Green Turtle (*Chelonia mydas*)	f,i, n,a ,b, m		f,i, n,a ,b, m	Nesting and interesting areas and rookeries including Barrow and Montebello Islands, North West Cape and Dampier Archipelago. Oceanic foraging grounds around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout Island.
Hawksbill Turtle (*Eretmochelys imbricate*)	f,i, n, m		f,i, n, m	Nesting and interesting areas around rookeries, including Montebello and Lowendal Islands, Ningaloo Coast, Thevenard, Barrow and Dampier Archipelago. Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout Island.
Flatback Turtle (*Natator depressus*)	f,i, n,a ,m	i	f,i, n,a ,m	Nesting and interesting areas around rookeries, including Barrow and Montebello Islands, Thevenard (and other Pilbara inshore islands) and Dampier Archipelago with the potential for presence during summer. Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout island.

Biologically Important Areas

a	*Aggregation*
b	*Basking*
f	*Foraging*
i	*Internesting*
m	*Migration*
n	*Nesting*

Table 4-13: Marine reptile species or species habitat that may occur within the Project Areas

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Turtles							
Caretta caretta	Loggerhead Turtle	E	x(M)	x	BKO	KO	BKO
Chelonia mydas	Green Turtle	V	x(M)	x	BKO	KO	BKO
Dermochelys coriacea	Leatherback Turtle,	E	x(M)	x	FKO	LO	KO
Eretmochelys imbricata	Hawksbill Turtle	V	x(M)	x	BKO	KO	BKO
Lepidochelys olivacea	Olive Ridley Turtle	E	x(M)	x	FLO		
Natator depressus	Flatback Turtle	V	x(M)	x	BKO	CKO	BKO
Seasnakes							
Acalyptophis peronii	Horned Seasnake			x	MO	MO	MO
Aipysurus apraefrontalis	Short-nosed Seasnake	CE		x	KO	LO	KO
Aipysurus duboisii	Dubois' Seasnake			x	MO	MO	MO
Aipysurus eydouxii	Spine-tailed Seasnake			x	MO	MO	MO
Aipysurus foliosquama	Leaf-scaled Seasnake	CE		x	KO		
Aipysurus foliosquama	Leaf-scaled Seasnake			x	KO		
Aipysurus fuscus	Dusky Seasnake			x	KO		
Aipysurus laevis	Olive Seasnake			x	MO	MO	MO
Aipysurus pooleorum	Shark Bay Seasnake			x	MO		
Aipysurus tenuis	Brown-lined Seasnake			x	MO	MO	MO
Astrotia stokesii	Stokes' Seasnake			x	MO	MO	
Disteira kingii	Spectacled Seasnake			x	MO	MO	MO
Disteira major	Olive-headed Seasnake			x	MO	MO	MO
Emydocephalus annulatus	Turtle-headed Seasnake			x	MO	MO	MO
Enhydrina schistosa	Beaked Seasnake			x	MO		
Ephalophis greyi	North-western Mangrove Seasnake			x	MO		MO
Hydrelaps darwiniensis	Black-ringed Seasnake			x	MO	MO	MO
Hydrophis coggeri	Slender-necked Seasnake			x	MO		

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Area
Hydrophis czeblukovi	Fine-spined Seasnake			x	MO	MO	MO
Hydrophis elegans	Elegant Seasnake			x	MO	MO	MO
Hydrophis mcdowelli	*Hydrophis macdowelli*			x	MO	MO	MO
Hydrophis ornatus	Spotted Seasnake			x	MO	MO	MO
Lapemis hardwickii	Spine-bellied Seasnake			x	MO		
Pelamis platurus	Yellow-bellied Seasnake			x	MO	MO	MO
Other							
Crocodylus porosus	Salt-water Crocodile		x(M)	x	LO		LO

Threatened Species:		*Type of Presence:*	
V	*Vulnerable*	*MO*	*Species of species habitat may occur within area*
E	*Endangered*	*LO*	*Species or species habitat likely to occur within area*
CE	*Critically Endangered*	*KO*	*Species or species habitat known to occur within area*
		FLO	*Foraging, feeding or related behaviour likely to occur within area*
Migratory Species:		*FKO*	*Foraging, feeding or related behaviour known to occur within area*
M	*Marine*	*BKO*	*Breeding known to occur within area*
		CKO	*Congregation or aggregation known to occur within area*

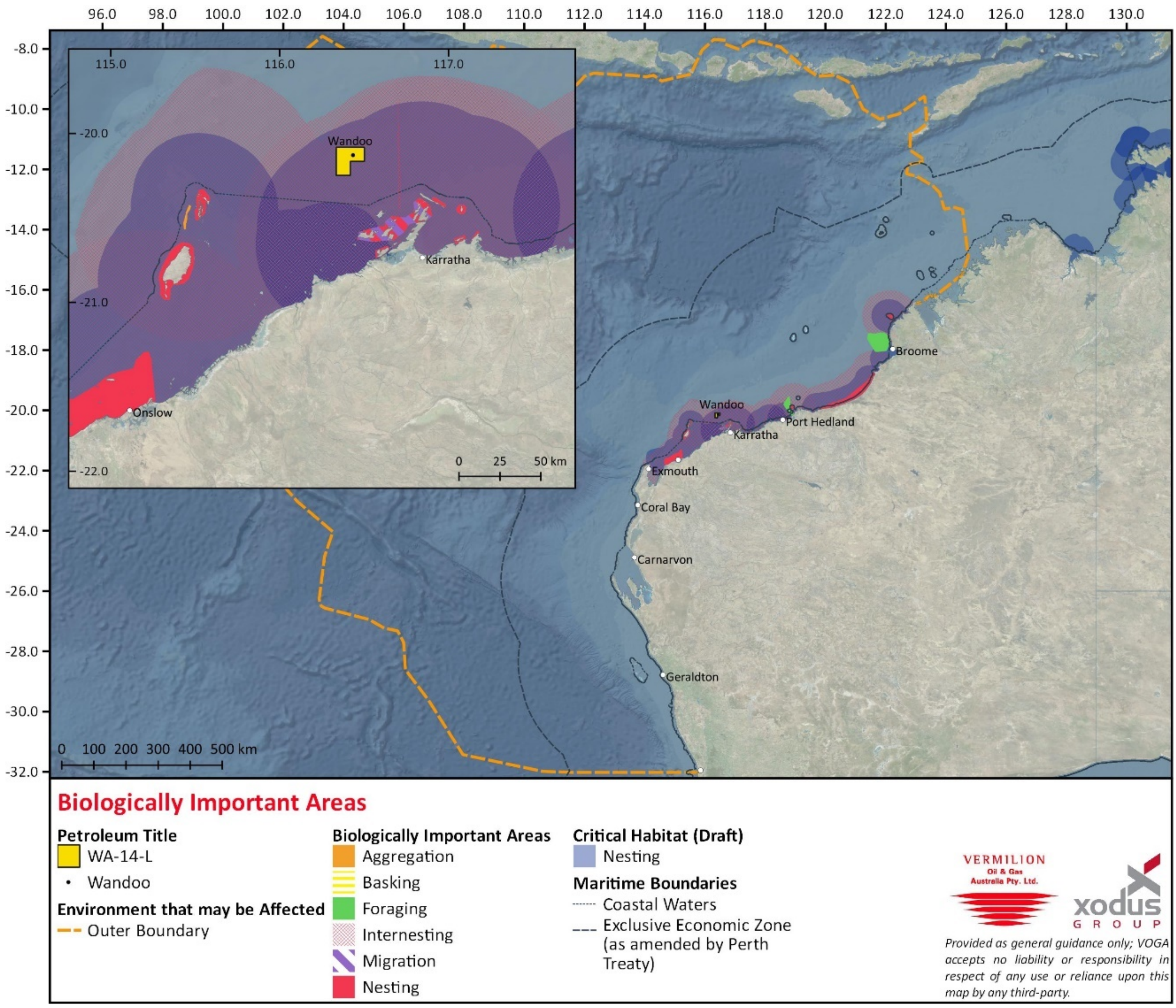


Figure 4-16: Biologically Important Areas for the Flatback Turtle

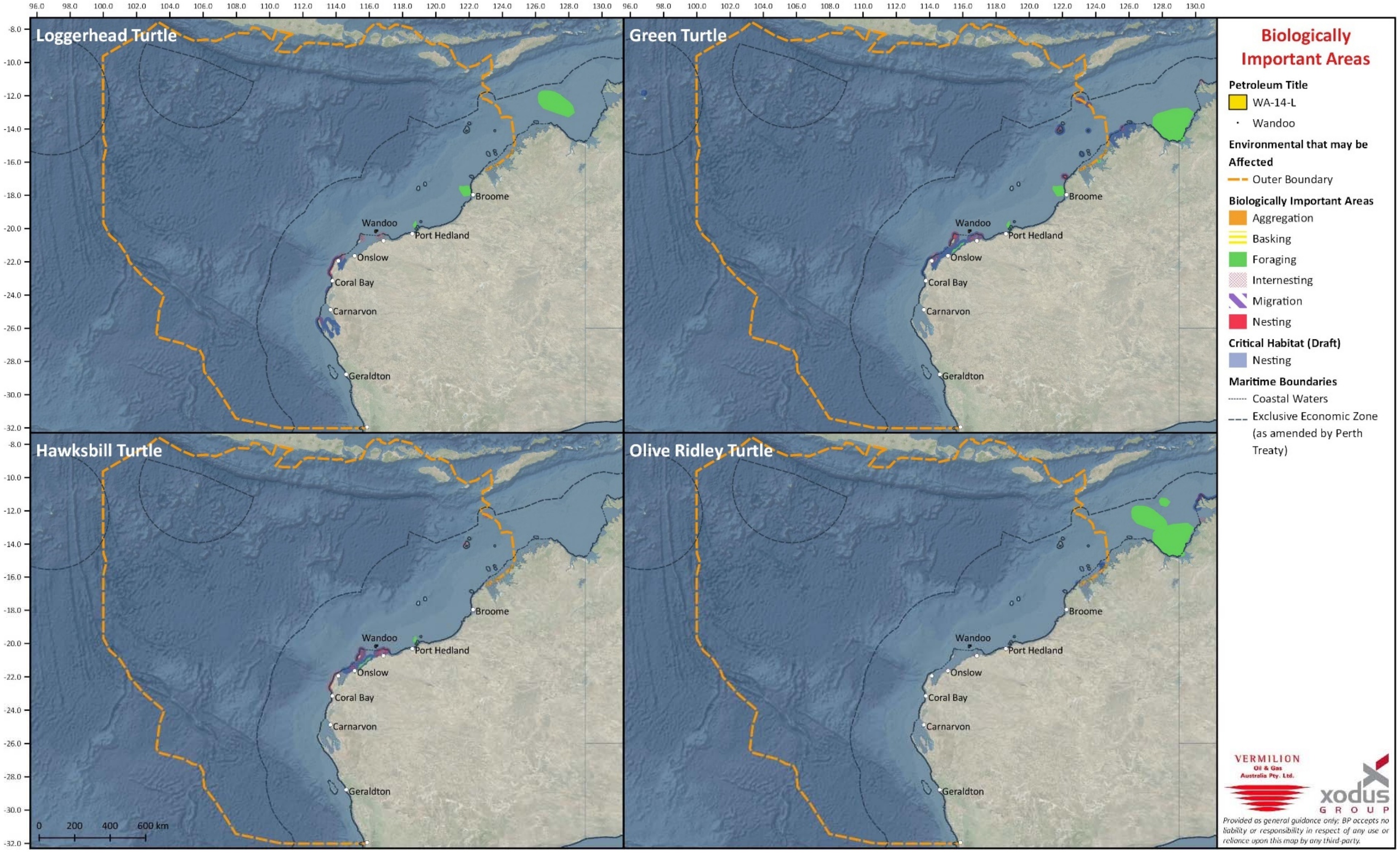


Figure 4-17: Biologically Important Areas for Turtle Species

4.3.5 Social and Economic Environment

4.3.5.1 *Commonwealth Managed Fisheries*

Table 4-1 identifies that Commonwealth managed fisheries may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to Commonwealth managed fisheries.

Commonwealth fisheries are those managed by the Australian Fisheries Management Authority (AFMA) and typically extend from 3 nm to 200 nm which is the extent of the Australian Fishing Zone (AFZ).

There are five Commonwealth managed commercial fisheries with management areas that intersect with the EMBA and Hydrocarbon Area. However, not all the fisheries are active within the full extents of the management areas; based on historical fishing effort data (Patterson *et al.,* 2019):

- North West Slope Trawl Fishery (NWSTF) is likely to be active in waters >200 m off the Pilbara and Kimberley coasts (Figure 4-18);
- Southern Bluefin Tuna Fishery (SBTF) is active within waters in the Great Australian Bight and south-eastern Australia; however, the spawning grounds for southern bluefin tuna are located in the north-east Indian Ocean (Figure 4-19);
- Western Deepwater Trawl Fishery (WDTF) is likely to be active in waters >200 m off the Gascoyne coast (Figure 4-20);
- Western Skipjack Tuna Fishery (WSTF), has had no active fishing operations since the 2008-2009 season;
- Western Tuna and Billfish Fishery (WTBF), is likely to be active in Commonwealth waters off the Gascoyne, Mid West and Southwest coasts (Figure 4-21).

Therefore, based on fishing effort, none of the Commonwealth managed fisheries are expected to be active within, or in the close vicinity of, the Operational Area. Additionally, no fishing effort can be expended within the bounds of the Operational Area given it is within a PSZ. A summary of the three fisheries that may be active within the EMBA are summarised in Table 4-15.

Table 4-14: Management Areas for Commonwealth Managed Fisheries within the EMBA relevant to the Wandoo Well Construction Program

Fishery	EMBA	Operational Area	Hydrocarbon Area
North West Slope Trawl Fishery	✓ (a)	*X*	✓ (a)
Southern Bluefin Tuna Fishery	✓ (n)	✓ (n)	✓ (n)
Western Deepwater Trawl Fishery	✓ (a)	*X*	✓ (n)
Western Skipjack Tuna Fishery	✓ (n)	✓ (n)	✓ (n)
Western Tuna and Billfish Fishery	✓ (a)	✓ (n)	✓ (n)

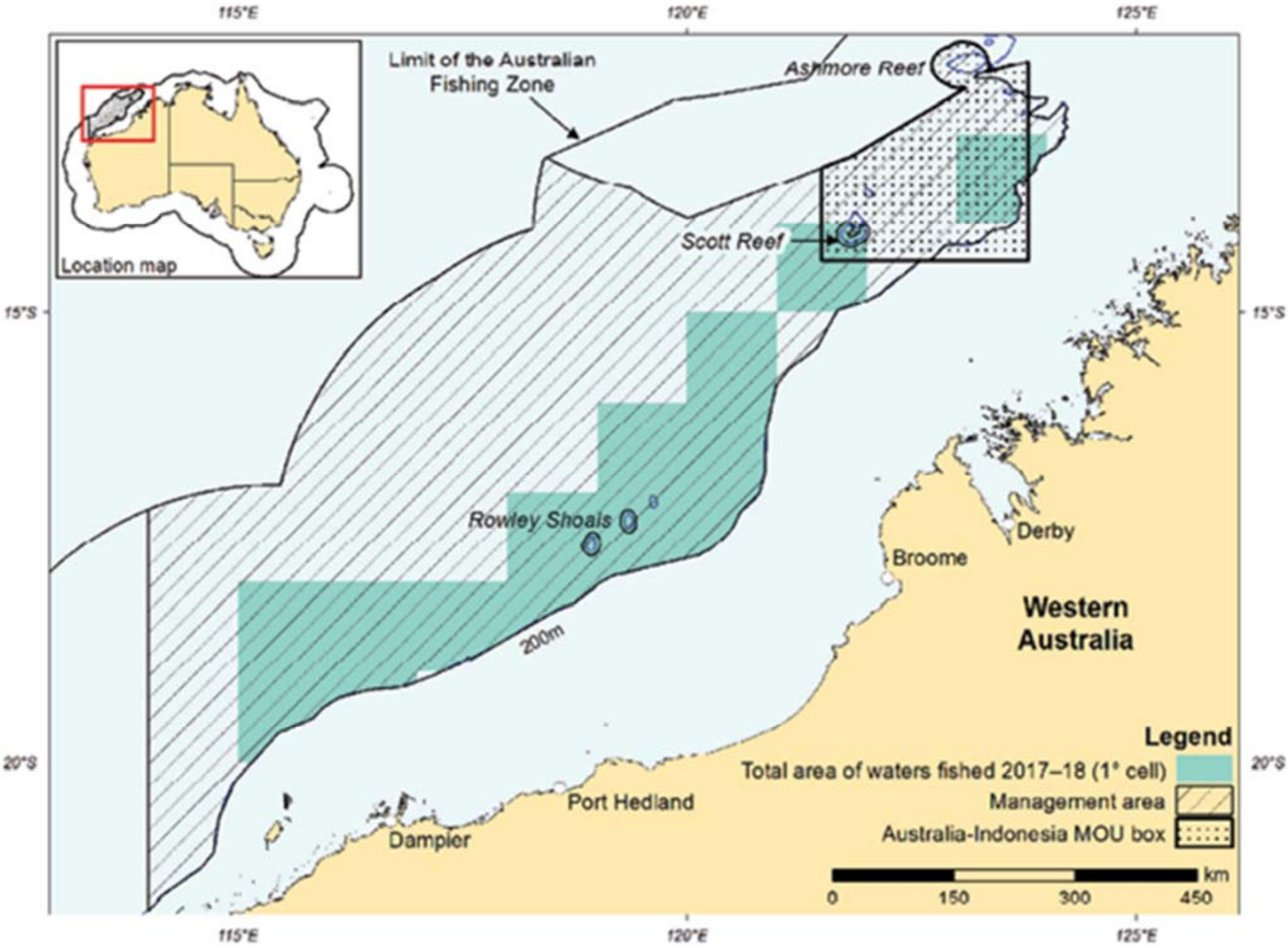
✓= Present within area; *X* = not present within area

(a) = Management area present and active fishing expected; (n) = Management area present and no active fishing expected

Table 4-15: Commonwealth Managed Fisheries with active fishing effort within the EMBA relevant to the Wandoo Well Construction Program

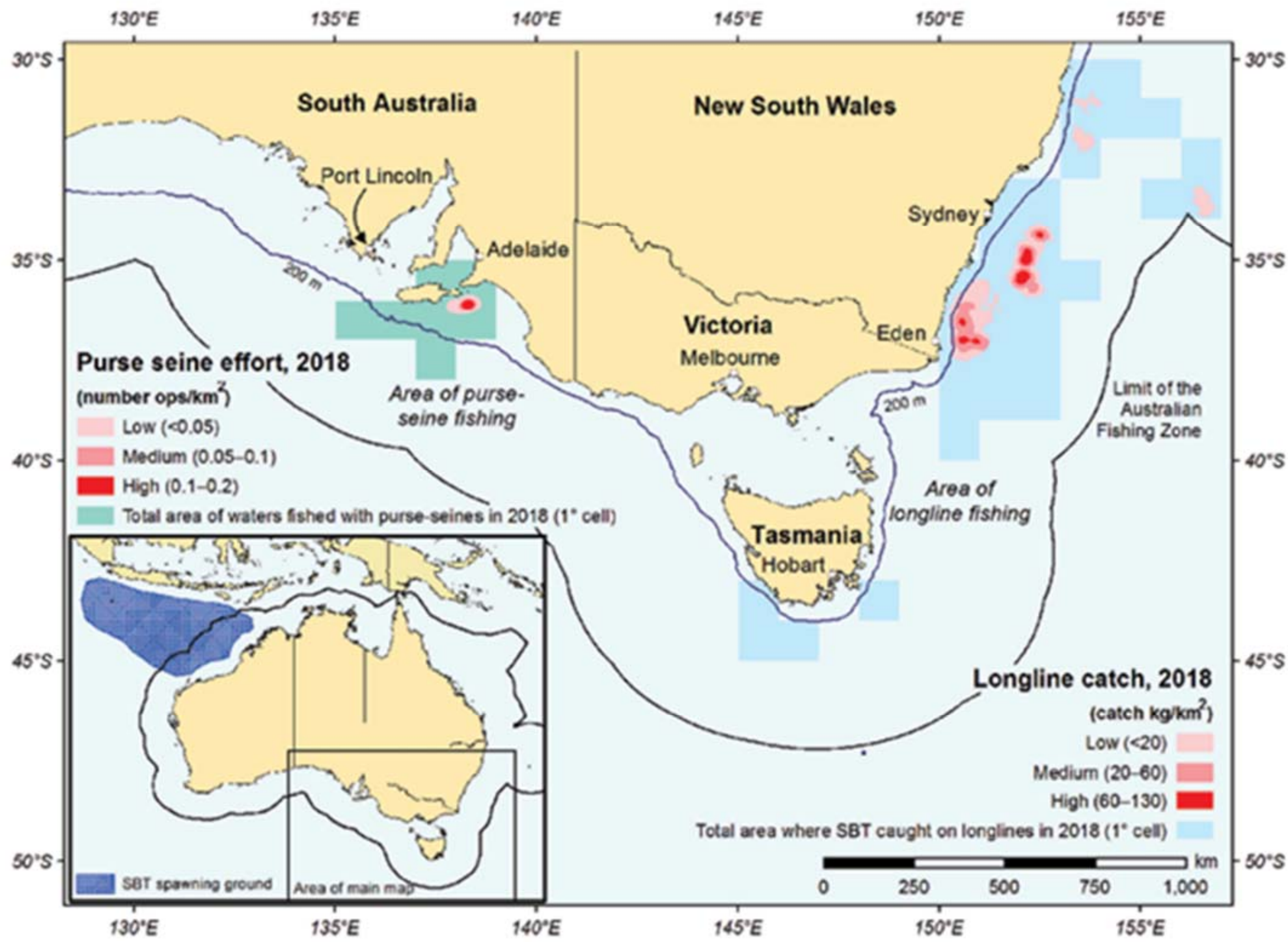
Fishery	Boundary	Method	Season	Target Species	Main Landing Ports
NWSTF	200 m isobath to AFZ, Exmouth to Mitchell Plateau	Demersal trawl gear	Year round	Scampi (*Metanephrops australiensis, M. boschmai, M. velutinus*)	Darwin (NT) Point Samson (WA)
WTBF	In the AFZ and high seas of the Indian Ocean, from Cape York to SA/VIC border	Pelagic longline, minor line and purse seine	Year round	Bigeye tuna (*Thunnus obesus*) Yellowfin tuna (*T. albacares*) Broadbill swordfish (*Xiphias gladius*) Striped marlin (*Tetrapturus audux*)	Fremantle (WA) Geraldton (WA)
WDTF	200 m isobath to AFZ, Exmouth to Augusta	Demersal trawl gear	1 July – 30 June	Deepwater bugs (*Ibacus* spp.) Ruby snapper (*Etelis carbunculus, Etelis* spp.)	Carnarvon (WA) Fremantle (WA)

SFR = Statutory fishing right



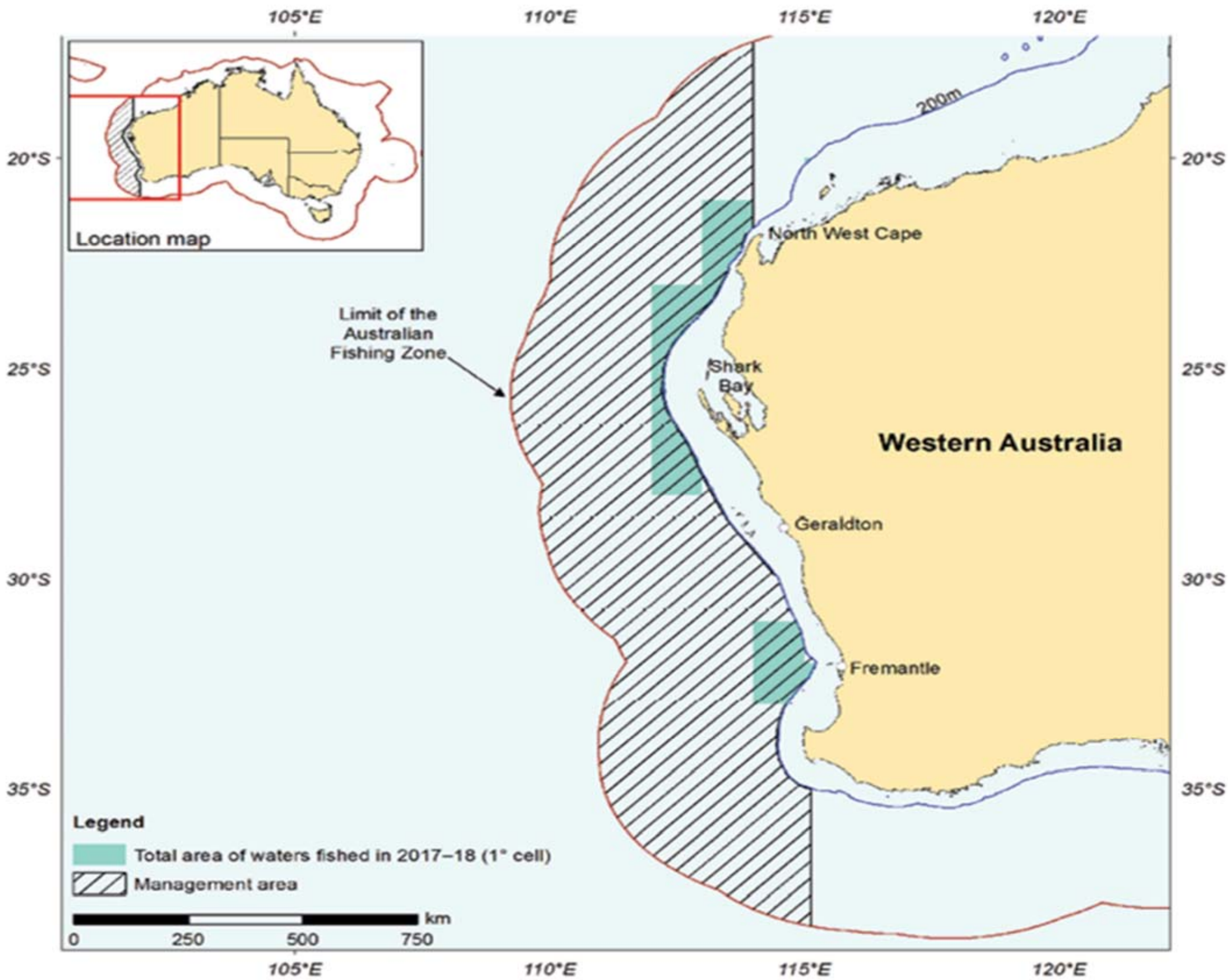
Source: Patterson et al., 2019

Figure 4-18: Management Area for the North West Slope Trawl Fishery, and area fished during 2017–2018



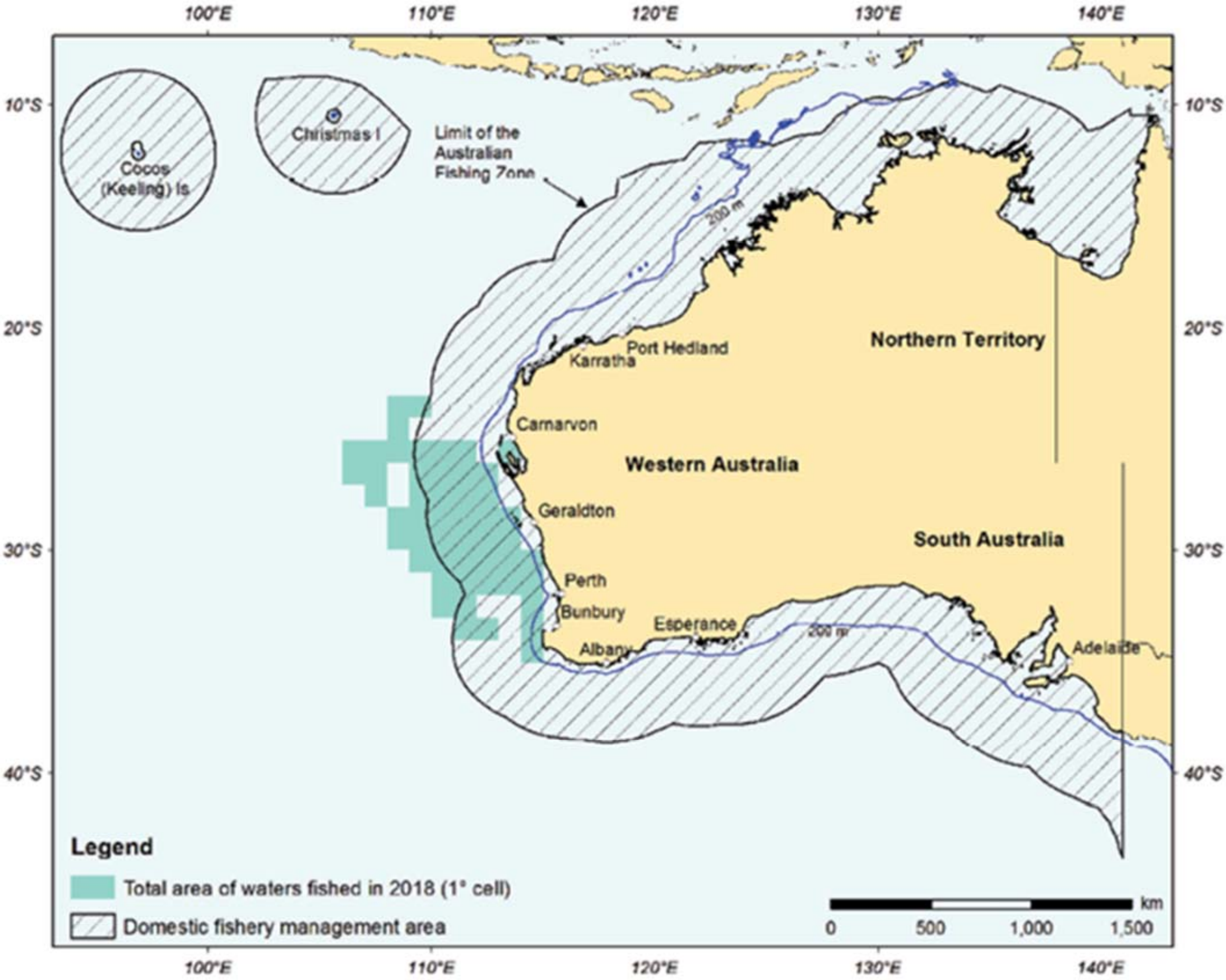
Source: Patterson et al., 2019

Figure 4-19: Management Area for the Southern Bluefin Tuna Fishery, with Indian Ocean spawning ground



Source: Patterson et al., 2019

Figure 4-20: Management Area for the Western Deepwater Trawl Fishery, and area fished during 2017–2018



Source: Patterson et al., 2019

Figure 4-21: Management Area for the Western Tuna and Billfish Fishery, and area fished during 2018

4.3.5.2 *State Managed Fisheries*

Table 3-3 identifies that State managed fisheries may be affected within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to State managed fisheries.

Western Australian fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD). The State fisheries are grouped into bioregions, with the Operational Area occurring within the North Coast fishing bioregion. Numerous State-based fisheries have management areas that inserct with the EMBA, including fisheries within the North Coast, Gascoyne and West Coast bioregions; however, not all fisheries are active throughout their entire management areas (Table 4-16).

The FishCube database indicates that six State fisheries may be active within the 60 nm grid block (No. 20160) that intersects with the Operational Area for the Wandoo Well Contruction Program:

- Mackerel Managed Fishery (MMF)
- Nickol Bay Prawn Managed Fishery (NBPMF)
- Pilbara Line Fishery (PLF)
- Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)
- Specimen Shell Managed Fishery (SSMF).

However, it is noted that this block from the FishCube database also includes the mainland coastal region, extending from Dampier Archipelago to south of Cape Preston. As such fishing effort within the block is not necessarily indicative of fishing activity within the Operational Area.

The SCF, MAFMF and SSMF occur within State waters only, and therefore no activity would occur within the Operational Area for either fishery as it is beyond the fisheries management area boundary.

The management boundary for the NBPMP is located to the east of the Operational Area, therefore no active fishing within the vicinity of Wandoo would occur.

The MMF focusses around reefs, shoals and headlands. As advised during consultation with WAFIC, fishers operate in water depths by and large from 70 metres to as shallow as the boat can go so it is considered that Mackerel fishing (Area 2) may overlap the Operational Area.

PLF and PTIMF may overlap the Operational Area: The southern part of the Operational Area is within the prohibited fishing area, however the northern Operational Area is within an area open to trawling.

Therefore, based on management boundaries and the previous reported fishing effort, minimal fishing activity from the State managed PLF and PFTIMF may occur within or in close proximity tothe Operational Area.

A summary of State commercial fishery management areas and fishery status (active/not active) for the EMBA, Operational Area and Hydrocarbon Area is provided in Table 4-16.

Table 4-16: Management Areas for State Managed Fisheries within the EMBA relevant to the Wandoo Well Construction Program

State Managed Fishery	EMBA	Operational Area	Hydrocarbon Area
North Coast Bioregion			
Kimberley Mud Crab Fishery	✓ (a)	X	✓ (a)
Pilbara Mud Crab Fishery	✓ (a)	X	✓ (a)
Beche-De-Mer (Sea Cucumber) Fishery	✓ (a)	X	✓ (a)
Pearl Oyster Fishery	✓ (a)	X	✓ (a)

State Managed Fishery	EMBA	Operational Area	Hydrocarbon Area
Mackerel Managed Fishery	✓ (a) Areas 1,2,3	✓ (a) Area 2	✓ (a) Areas 1,2,3
Kimberley Gillnet and Barramundi Fishery	✓ (a)	X	✓ (n)
North Coast Demersal Scalefish Fisheries			
Pilbara Fish Trawl (Interim) Managed Fishery	✓ (a)	✓ (a)	✓ (a)
Pilbara Trap Managed Fishery	✓ (a)	✓ (n)	✓ (a)
Pilbara Line Fishery	✓ (a)	✓ (a)	✓ (a)
North Coast Prawn Fisheries			
Onslow Prawn Managed Fishery (OPMF)	✓ (a)	✓ (n)	✓ (a)
Nickol Bay Prawn Managed Fishery (NBPMF)	✓ (a)	✓(n)	✓ (a)
Broome Prawn Managed Fishery (BPMF)	✓ (a)	X	✓ (a)
Kimberley Prawn Managed Fishery (KPMF)	✓ (a)	X	✓ (a)
Gascoyne Coast Bioregion			
Shark Bay Blue Swimmer Crab Fishery	✓ (a)	X	X
Inner Shark Bay Scalefish Fishery	✓ (a)	X	X
Gascoyne Demersal Scalefish Fishery	✓ (a)	X	✓ (a)
West Coast Deep Sea Crustacean Fishery	✓ (a)	✓ (n)	✓ (a)
Exmouth Gulf Prawn Fishery	✓ (a)	X	✓ (n)
Shark Bay Prawn and Scallop Managed Fisheries	✓ (a)	X	X
West Coast Bioregion			
Octopus Fishery	✓ (a)	X	X
West Coast Demersal Scalefish Fishery	✓ (a)	X	X
West Coast Purse Seine Fishery: • Northern Development Zone • Perth Metropolitan.	✓ (a)	X	X
West Coast Nearshore and Estuarine Finfish	✓ (a)	X	X
Abrolhos Island & Mid West, South West Trawl Fishery	✓ (a)	X	X
Roe's Abalone Fishery	✓ (a)	X	✓ (n)
West Coast Rock Lobster Fishery	✓ (a)	X	✓ (n)
State-wide Bioregion			
The Specimen Shell Managed Fishery (SSMF)	✓ (a)	X	✓ (a)
Marine Aquarium Fish Managed Fishery (MAFMF)	✓ (a)	X	✓ (a)
Pearling and Aquaculture			
Pearling / Aquaculture Leases	✓ (a)	X	✓ (a)

✓= Present within area; *X* = not present within area

(a) = Management area present and active fishing expected; (n) = Management area present and no active fishing expected

4.3.5.3 *Aquaculture*

Table 3-3 identifies that aquaculture may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to aquaculture.

No aquaculture activities take place within the Operational Area. There are aquaculture facilities located in near-shore waters of the EMBA, with the closest known facilities to the Operational Area being at the Dampier Archipelago (approximately 45 km from Operational Area) and Montebello Islands (approximately 85 km from Operational Area).

Aquaculture in the EMBA and Hydrocarbon Area is managed by the DPIRD and consists primarily of the culturing of hatchery reared and wild caught oysters (*Pinctada maxima*) for pearl production. Pearl aquaculture in the region currently consists of 110 pearl leases ranging from Onslow to Kununurra, including those in the waters around offshore islands such as the Montebellos. Leases typically occur in shallow coastal waters in depths of less than 20m and consist of oysters suspended in racks on subsurface ropes. Pearl aquaculture is a high value industry, estimated at $120 million in 2003 (DoF, 2012).

There is limited finfish culture in the region, with farming of Barramundi (*Lates calcarifer*) in sea cages undertaken in Roebuck Bay. Research and development into prawn farming is currently underway, with prawn hatcheries located at Exmouth and Broome (DoF, 2009).

4.3.5.4 *Traditional Indonesian Fishing*

A Memorandum of Understanding (MoU) between Australia and the Republic of Indonesia has existed since 1974 and allows traditional Indonesian fishers to fish in an area known as the 'MoU Box'. The MoU defines ‘traditional fishermen’ as fishers who have traditionally taken fish and sedentary organisms in Australian waters using traditional fishing methods and non-motorised sailing vessels. Under the MoU, the taking of protected wildlife including marine turtles, dugongs and clams is prohibited, as is fishing within the Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve. Fishers may access the reefs of Cartier Island, Scott Reef, Seringapatam Reef and Browse Island, and visit Ashmore Reef for access to fresh water and to visit graves (DEWHA, 2008).

4.3.5.5 *Recreational Fishing*

Table 4-1 identifies that recreational fishing may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to recreational fishing.

Recreational fishing within the EMBA is managed by the DPIRD and mainly occurs at near-shore locations such as the Dampier Archipelago and Montebello Islands and State waters adjacent to populated coastal areas (DoF, 2011).

Within the EMBA the North Coast bioregion is experiencing significant recreational fishing growth, with a distinct seasonal peak in winter when the local population increases significantly by way of tourists visiting the Exmouth/Onslow area and Dampier Archipelago (Fletcher and Santoro, 2011).

Increased recreational fishing has also been attributed to those involved in the construction or operation of developments within the region.

At a distance of approximately 35 km from the Dampier Archipelago and 85 km from the Montebello Islands, the Operational Area is unlikely to be visited by recreational fishers.

4.3.5.6 *Commercial shipping*

Table 4-1 identifies that commercial shipping may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to commercial shipping.

Significant commercial shipping activity occurs within the EMBA, the majority of which is associated with the WA oil and gas and mining industries.

AMSA has established a network of shipping fairways for the North West Shelf with the aim to reduce the risk of collision between transiting vessels and offshore infrastructure (AMSA, 2012). The fairways are intended to direct large vessels such as bulk carriers and LNG ships trading to the major ports into pre-defined routes to keep them clear of existing and planned offshore infrastructure.

The Operational Area is approximately 25 km from the northbound shipping fariway from Dampier (Figure 4-22). Significant vessel traffic uses this fairway travelling to or from the Port of Dampier.

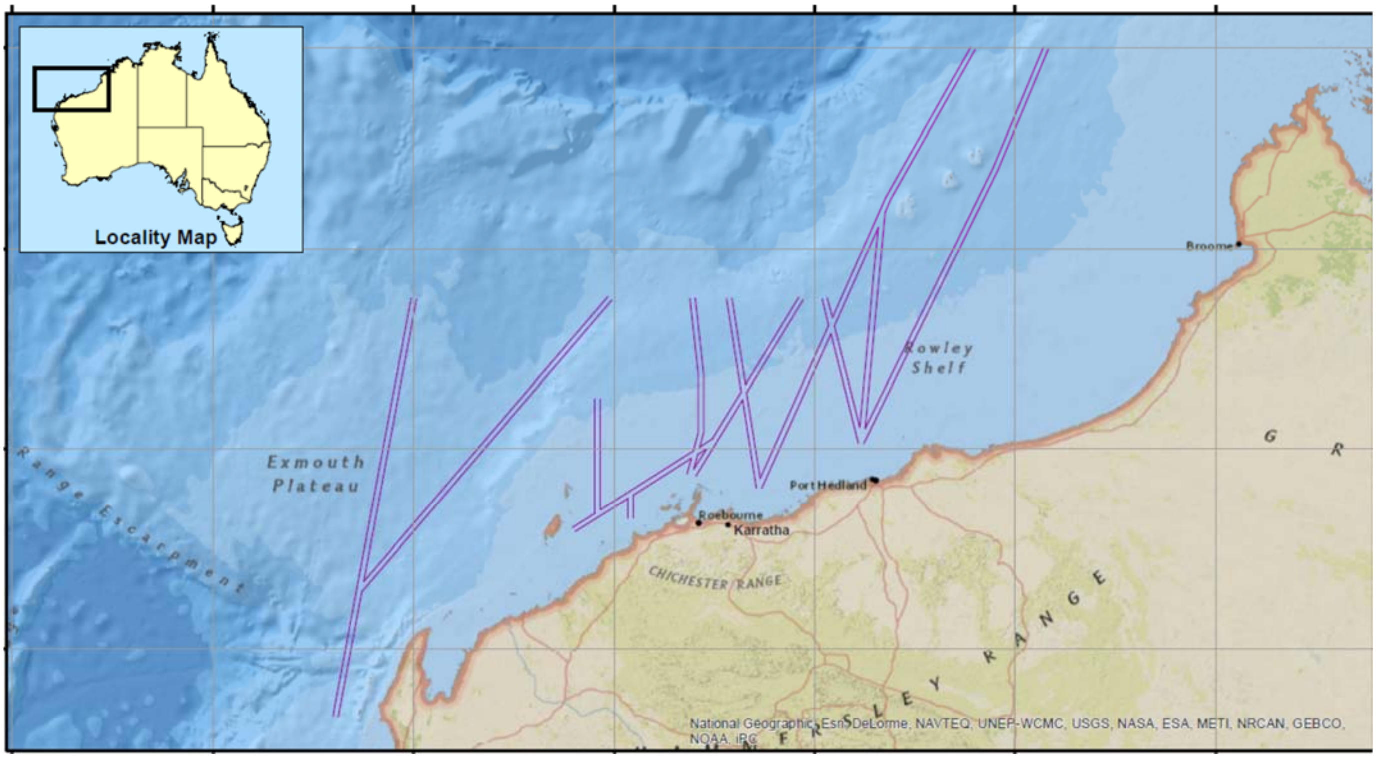


Figure 4-22: North West Shelf Shipping Fairways

4.3.5.7 *Defence*

Table 4-1 identifies that defence may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to defence.

There are no defence related uses within the Operational Area. The EMBA encompasses the military installations near Exmouth, including a naval communication station and a pier facility. The Department of Defence has several offshore training areas including the North West Exercise Area (NWXA) (approximately 95 km southwest of the Operational Area) and Learmonth Air Weapons Range (approximately 275 km west-southwest of the Operational Area) in the EMBA. These areas are used for Defence Force training operations, including live firing.

4.3.5.8 *Other users*

Table 4-1 identifies that other users may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to other users.

The petroleum exploration and production industry is a significant stakeholder in the region. Petroleum companies have been undertaking exploration and production activities on the NWS for a number of years. Petroleum activities within the vicinity of the Wandoo facility include Apache's Reindeer platform (~17 km northwest) and Jadestone Energy's Stag platform and Dampier Spirit FSO (~24 km southwest). There are also several submerged pipelines associated with petroleum fields and facilities with onshore processing hubs (e.g. the TL1 and TL2 export pipelines from the North Rankin Complex to the Karratha Gas Plant).

No tourist activities take place within the Operational Area, although tourist activities do occur within the EMBA and Hydrocarbon Area and tourism plays a significant role in the region. Tourism-related activities include:

- Whale watching;
- Recreational boating;
- Charter fishing;
- Snorkelling/diving;
- Surfing; and
- Recreational fishing.

Major tourism precincts within the EMBA include the Ningaloo Coast, the Exmouth Gulf and Broome. Tourism precincts in the Hydrocarbon Area also include Shark Bay and the Ningaloo Coast. It is estimated that approximately $127 million is spent per year by visitors to the Ningaloo Marine Park, with a large portion is this attributed to the whale shark tourism industry.

4.3.5.9 *Maritime Heritage*

Table 4-17 and Table 4-18 identifies that maritime heritage may be a relevant receptor to aspects of the activity occurring within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to maritime heritage.

The National Heritage List has been established under the EPBC Act to list natural, historic and Indigenous places of outstanding heritage significance to Australia. The National Heritage List is compiled and maintained by the Department of the Environment and Energy (DoEE). National Heritage properties are also considered a Matter of national environmental significance under the EPBC Act. There are no sites of National Heritage significance in the Operational Area; however seven are known to occur within the EMBA (Table 4-17).The Commonwealth Heritage List, also established under the EPBC Act, comprises natural, indigenous and historic heritage places which are either entirely within a Commonwealth area, or outside the Australian jurisdiction and owned or leased by the Commonwealth or a Commonwealth Authority. A Commonwealth Heritage Place might also be on the National Heritage List or the World Heritage List.

There are no Commonwealth heritage sites within the Operational Area; however five natural (Ashmore Reef National Nature Reserve, Christmas Island Natural Areas, Mermaid Reef – Rowley Shoals, Ningaloo Marine Area – Commonwealth Waters and Scott Reef and Surrounds – Commonwealth Area) and one historic (*HMAS Sydney II* and *HSK Kormoran* Shipwreck Sites) site are known to occur within the EMBA.Australia's underwater cultural heritage is protected under the *Underwater Cultural Heritage Act 2019*; this legislation protects shipwrecks, sunken aircraft and other types of underwater heritage. There are multiple known shipwreck and historic (>75 years old) shipwreck sites within the EMBA and Hydrocarbon Area; none have been recorded within the Operational Area. There are also 10 records of sunken aircraft within the EMBA (one offshore from 80 Mile Beach, eight within Roebuck Bay, and one off western Dampier Peninsula). There is also a single record of an insitu artefact (offshore of Point Samson) within the EMBA.

Table 4-17: National Heritage sites within the EMBA

Site	Listing	Description
Natural		
The Ningaloo Coast	Natural Listed Place	The Ningaloo Coast was included on the National Heritage List due to its extraordinary natural qualities and Indigenous significance, as per those listed in Section 3.6.1.
Shark Bay	Natural Listed Place	Shark Bay was included on the National Heritage List due to its abundant marine flora and fauna. Five mammals listed as Endangered are found here as well as 35% of Australian bird species. It is the meeting point of three major climatic regions. Further details are provided in Section 3.6.1.
The West Kimberley	Natural Listed Place	The West Kimberley is important due to its vast area of relatively undisturbed landscape with high biological richness and evolutionary history.
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	Indigenous Listed Place	The Dampier Archipelago (including Burrup Peninsula) was included on the National Heritage List due to the Indigenous rock engravings found there, including finely executed images of a wide range of terrestrial, avian and marine fauna that are unique and characteristic of the region.
Historic		

Site	Listing	Description
Dirk Hartog Landing Site 1616 – Cape Inscription Area	Historic Listed Place	Cape Inscription is the site of the earliest known landings of Europeans on the western coast of Australia and was included in the National Heritage List in 2006.
HMAS Sydney II and HSK Kormoran Shipwreck Sites	Historic Listed Place	HMAS Sydney II and KSG Kormoran are located 22km apart, 290km west-south-west of Carnarvon. The HMAS Sydney II sank after a battle with KSK Kormoran in November 1941.
Batavia Shipwreck Site and Survivor Camps 1629 – Houtman Abrolhos	Historic Listed Place	Oldest of the known Verenigde Oost-Indische Compagnie wrecks on the WA coast. Because of its relatively undisturbed nature it has a range of objects of considerable value to the artefact specialist and historian.

Table 4-18 National Heritage sites within the Project Areas

Receptor Group	Operational Area	Hydrocarbon Area-In Water	Hydrocarbon Area-Shoreline	EMBA
Natural				
The Ningaloo Coast	x	✓	✓	✓
Shark Bay	x	x	✓	✓
The West Kimberley	x	x	✓	✓
Indigenous				
Dampier Archipelago (including Burrup Peninsula)	x	✓	✓	✓
Historic				
Dirk Hartog Landing Site 1616 – Cape Inscription Area	x	x	x	✓
HMAS Sydney II and HSK Kormoran Shipwreck Sites	x	x	x	✓
Batavia Shipwreck Site and Survivor Camps 1629 – Houtman Abrolhos	x	x	x	✓

✓ = present within area, x = not present within area

4.3.6 Values and Sensitivities

Table 4-1 identifies that Values and Sensitivites may be relevant receptors to aspects of the activity occurring within within the Operational Area, Hydrocarbon Area or EMBA during the Petroleum Activity. The description below provides sufficient details to assess all impacts and risks to Values and Sensitivites.

4.3.6.1 *World Heritage Areas*

There are two World Heritage Areas (WHAs) in the region:

- Ningaloo Coast WHA (within EMBA and Hydrocarbon Area); and
- Shark Bay WHA (within EMBA and overlap with shoreline Hydrocarbon Area).

Figure 4-23 shows both the Ningaloo Coast WHA and the Shark Bay WHA.

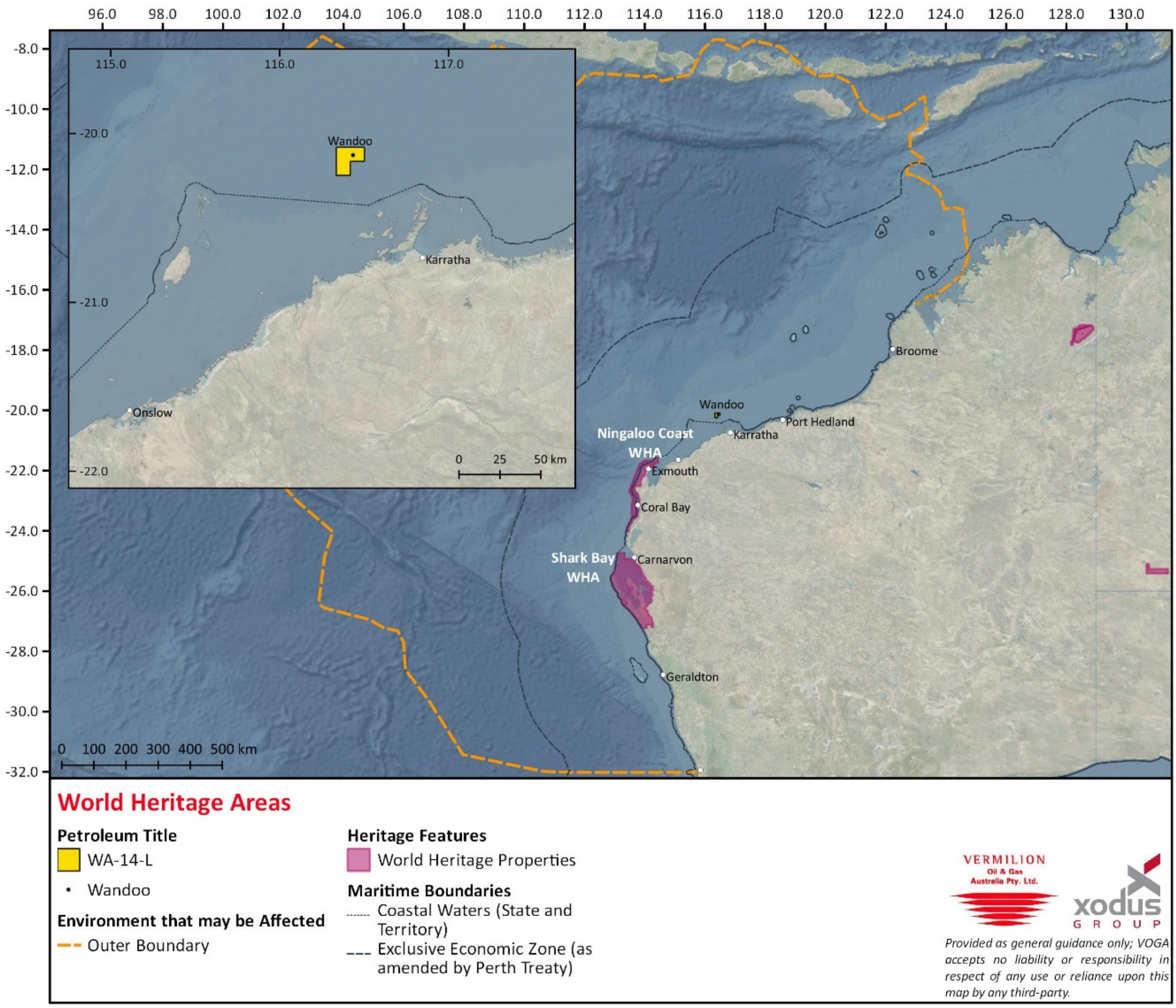


Figure 4-23: World Heritage Areas

The Ningaloo Coast was inscribed into the World Heritage List in 2011 under criteria (vii) and (x) of the United Nations Educational Scientific and Cultural Organisation (UNESCO) Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2014). The listing recognises the outstanding universal values of the Ningaloo Coast, particularly the following:

- Exceptional natural beauty:
    - Aesthetically striking coastal and terrestrial environment of the Ningaloo Reef adjacent to the Cape Range; and
    - The lush and colourful underwater scenery and its contrast with the arid and rugged land.

- Containing the most important and significant natural habitats for in-situ conservation of biological diversity:
  - One of the largest annual aggregation of whale sharks in the world;
  - Important aggregations of other fish species and marine mammals;
  - High marine diversity, including an unusual diversity of marine turtle species;
  - Rare and diverse subterranean creatures; and
  - Diversity of reptiles and vascular plants in the dry lands.

The Ningaloo Coast WHA has a high diversity of marine habitats, including coastal mangrove systems, lagoons, reef, open ocean, continental slope and the continental shelf and includes both the Commonwealth and State marine parks (CALM, 2005a). The most dominant habitat of the Ningaloo WHA is the Ningaloo Reef, the largest fringing reef in Australia. The Ningaloo Reef supports both tropical and temperate species of marine fauna and flora, and more than 300 species of coral (CALM, 2005a).

The Ningaloo Coast WHA is a very important nesting habitat for four species of marine turtle that are found in WA. The North West Cape and Muiron Islands are major nesting sites for loggerhead turtles, and North West Cape is also a major nesting habitat for hawksbill and green turtles. The Muiron Islands are also minor nesting sites for flatback and hawksbill turtles.

Each year, the largest congregation of whale sharks anywhere in the world takes place off the coast of the Ningaloo WHA (DEWHA, 2008). It is estimated that between 300 and 500 whale sharks visit the area each year between March and June, coinciding with mass coral spawning events. Several species of whales are also known to pass through or congregate in the area, (Jenner *et al.,* 2001) and the Muiron Islands provide suitable seagrass habitat for the dugong.

Shark Bay has the largest and richest seagrass beds in the world, covering an area of 4,800km^2, supporting an important dugong population. In addition, Shark Bay hosts some of the oldest forms of life on earth – stromatolites – which are colonies of algae that form hard dome-shaped deposits (UNESCO, 2013).

Shark Bay WHA covers an area of approximately 10,000 km^2 and was inscribed into the World Heritage list in 1991 for all four natural values (vii, viii, ix and x), summarised as follows (DSEWPaC, 2008):

- Outstanding example representing the major stages of the earth’s evolutionary history – such as containing divers and abundant stromatolites/microbial mats at Hamelin Pool;
- Outstanding example representing significant ongoing geological processes, biological evolution and man’s interaction with his natural environment, e.g. the high species diversity of and richness of seagrasses and containing one of the most extensive seagrass meadows in the world;
- Contain unique, rare or superlative natural phenomena, formation or features of exceptional beauty – such as the abundance of marine fauna (dugongs, dolphins, sharks, rays, turtles and fish); and
- Contain the most important and significant habitats where threatened species of plants and animals of outstanding universal value from the point of view of science and conservation still survive – such as marine mammals including the threatened species of humpback whales (*Megaptera noveangliae*), green turtle (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*).

The World Heritage criteria are periodically revised and the criteria against which the property was listed in 1991 are not necessarily identical with the current criteria.

A Statement of Outstanding Universal Value (SOUV) is the official statement adopted by the World Heritage Committee, normally at the time of inscription of a property on the World Heritage List. In the case of properties/sites that were inscribed before the requirement for a SOUV was introduced into the World Heritage Convention in 2005, a Retrospective SOUV is required. A Retrospective SOUV for Shark Bay WHA was adopted by the World Heritage Committee in June 2013 (UNESCO, 2013).

4.3.6.2 *Australian Marine Parks*

Australian Marine Parks (AMPs) occur within Commonwealth waters and have been proclaimed as Commonwealth reserves under the EPBC Act in 2007 and 2013. Within the EMBA, 17 AMPs are present; 13 within the North-west Marine Region, and four within the South-west Marine Region (Table 4-19, Figure 4-24). The closest AMPs to the Operational Area are the Montebello Marine Park (approximately 35 km west) and Dampier Marine Park (approximately 38 km southeast).

Table 4-19: Australian Marine Parks within the Wandoo Well Construction Program EMBA

Australian Marine Park	EMBA	Operational Area	Hydrocarbon Area
North-west Marine Region			
Kimberley	✓	x	x
Ashmore Reef	✓	x	x
Cartier Island	✓	x	x
Argo-Rowley Terrace	✓	✓	✓
Mermaid Reef	✓	✓	✓
Roebuck	✓	x	✓
Eighty Mile Beach	✓	✓	✓
Dampier	✓	✓	✓
Montebello	✓	✓	✓
Ningaloo	✓	✓	✓
Gascoyne	✓	✓	✓
Carnarvon Canyon	✓	✓	✓
Shark Bay	✓	x	x
South-west Marine Region			
Abrolhos	✓	x	x
Jurien	✓	x	x
Two Rocks	✓	x	x
Perth Canyon	✓	x	x

✓= Present within area, x = Not Present within area

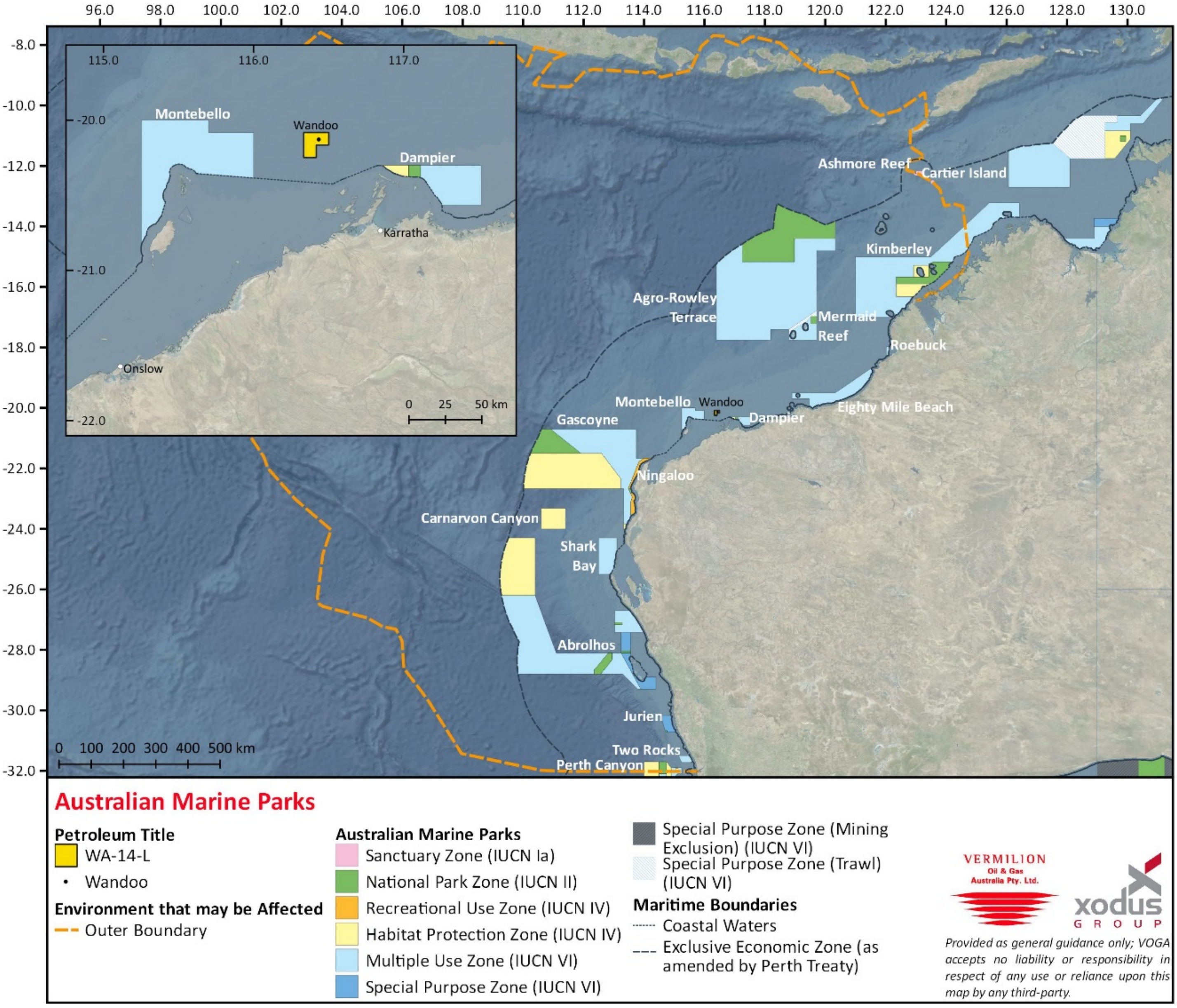


Figure 4-24: Australian Marine Parks

The following types of values have been identified for each of the marine parks within the respective management plans (DNP, 2018a, 2018b), and are summarised in Table 4-20:

- natural values, as habitats, species and ecological communities, and the processes that support their connectivity, productivity and function
- cultural values, as living and cultural heritage recognising Indigenous beliefs, practices and obligations for country, places of cultural significance and cultural heritage sites
- heritage values, as non-Indigenous heritage that has aesthetic, historic, scientific or social significance
- socio-economic values, as the benefits for people, businesses and/or the economy.

Table 4-20: Significance and values of Australian Marine Parks

North-west Marine Region
Kimberley Marine Park
The Kimberley Marine Park is located approx. 100 km north of Broome, extending from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. The Marine Park is adjacent to the State Lalanggarram/Camden Sound Marine Park and the North Kimberley Marine Park. The Marine Park covers an area of 74,469 km² and water depths from <15 m to 800 m. Marine Park includes three zones: National Park Zone (II), Habitat Protection Zone (IV) and Multiple Use Zone (VI). **Statement of significance** The Kimberley Marine Park is significant because it includes habitats, species and ecological communities associated with the Northwest Shelf Province, Northwest Shelf Transition and Timor Province, and includes two KEFs. The Marine Park provides connectivity between deeper offshore waters, and the inshore waters of the adjacent State North Kimberley and Lalang-garram/Camden Sound Marine Parks. **Natural values** • Examples of ecosystems representative of the: o Northwest Shelf Province, an area influenced by strong tides, cyclonic storms, long-period swells and internal tides. The region includes diverse benthic and pelagic fish communities, and an ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. o Northwest Shelf Transition, this area straddles the North-west and North Marine Regions and includes shelf break, continental slope, and the majority of the Argo Abyssal Plain and is subject to a high incidence of cyclones. Benthic biological communities in the deeper parts of the region have not been extensively studied, although high levels of species diversity and endemism occur among demersal fish communities on the continental slope. o Timor Province, an area dominated by warm, nutrient-poor waters. The reefs and islands of the region are regarded as biodiversity hotspots; endemism in demersal fish communities of the continental slope is high and two distinct communities have been identified on the upper and mid slopes. • Contains two KEFs: ancient coastline at the 125-m depth contour, and the continental slope demersal fish communities (Section 4.3.6.5). • Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. • BIAs within the Marine Park include breeding and foraging habitat for seabirds, internesting and nesting habitat for marine turtles, breeding, calving and foraging habitat for inshore dolphins, calving, migratory pathway and nursing habitat for humpback whales, migratory pathway for pygmy blue whales, foraging habitat for dugong and foraging habitat for whale sharks. **Cultural values** • Sea country is valued for Indigenous cultural identity, health and wellbeing. The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people have responsibilities for sea country in the Marine Park. • The Wunambal Gaambera people's country includes daagu (deep waters), with about 3,400 km² of their sea country located in the Marine Park. • The national heritage listing for the West Kimberley also recognises the following key cultural heritage values: o cultural tradition of the Wanjina Wunggurr people incorporates many sea country cultural sites o log-raft maritime tradition, which involved using tides and currents to access warruru (reefs) far offshore to fish; o interactions with Makassan traders around sea foods over hundreds of years o important pearl resources that were used in traditional trade through the wunan and in contemporary commercial agreements. **Heritage values**

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains over 40 known historic shipwrecks (Section 4.3.5.9).

Social and economic values

- Tourism, commercial fishing, mining, recreation, including fishing, and traditional use are important activities in the Marine Park.

Ashmore Reef Marine Park

The Ashmore Reef Marine Park is located approx. 630 km north of Broome and 110 km south of the Indonesian island of Roti. The Marine Park is located in Australia's External Territory of Ashmore and Cartier Islands and is within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box.

The Marine Park covers an area of 583 km² and water depths from less than 15 m to 500 m. The Marine Park contains three vegetated sand cays that are permanently above water: West, Middle and East islands. The Marine Park is assigned IUCN category Ia and includes two zones assigned under this plan: Sanctuary Zone (Ia) and Recreational Use Zone (IV).

Statement of significance

The Ashmore Reef Marine Park is significant because it includes habitats, species and ecological communities associated with the Timor Province. It includes two key ecological features: Ashmore Reef and Cartier Island and surrounding Commonwealth waters (valued for high productivity and breeding aggregations of birds and other marine life); and continental slope demersal fish communities (valued for high levels of endemism). Ashmore Reef is the largest of three emergent oceanic reefs in the region and the only one with vegetated islands. The Marine Park is an area of enhanced biological productivity and a biodiversity hotspot, supporting a range of pelagic and benthic marine species and an important biological stepping stone facilitating the transport of biological material to the reef systems along the Western Australian coast via the south-flowing Leeuwin Current which originates in the region. The Ashmore Reef Ramsar site is located within the boundary of the Marine Park. The site was listed under the Ramsar Convention in 2002 and is a wetland of international importance under the EPBC Act. An Ecological Character Description that sets out the Ramsar listing criteria met by the site, the key threats and knowledge gaps, is available on the Department's website.

Natural values

- Examples of ecosystems representative of the
  - Timor Province—a bioregion with a depth range from about 200 m near the shelf break to 5920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Ashmore Reef is an important feature of the bioregion. Endemism in demersal fish communities of the continental slope is high with two distinct communities identified: one on the upper slope, the other mid slope.
- Key ecological features:
  - Ashmore Reef and Cartier Island and surrounding Commonwealth waters—areas of enhanced productivity in an otherwise low-nutrient environment, of regional importance for feeding and breeding aggregations of birds and marine life; and
  - continental slope demersal fish communities—an area of high-diversity demersal fish assemblages. The marine environment of the Marine Park includes habitats associated with two extensive lagoons, sand flats, shifting sand cays, extensive reef flat and large areas of seagrass. The reef ecosystems are comprised of hard and soft corals, gorgonians, sponges and a range of encrusting organisms, with the highest number of coral species of any reef off the Western Australian coast.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- Biologically important areas within the Marine Park include breeding, foraging and resting habitat for seabirds, resting and foraging habitat for migratory shorebirds, foraging, mating, nesting and internesting habitat for marine turtles, foraging habitat for dugong, and a migratory pathway for pygmy blue whales.

- The Ashmore Reef Ramsar site includes the largest of the atolls in the region. West Island, Middle Island and East Island represent the only vegetated islands in the region. Ashmore Reef Ramsar site supports internationally significant populations of seabirds and shorebirds, is important for turtles (green, hawksbill and loggerhead) and dugong, and has the highest diversity of hermatypic (reef-building) corals on the West Australian coast. It is known for its abundance and diversity of sea snakes. However, since 1998 populations of sea snakes at Ashmore Reef have been in decline.

Cultural values

- Indigenous Australians Sea country is valued for Indigenous cultural identity, health and wellbeing.
- The Marine Park contains Indonesian artefacts and grave sites and Ashmore lagoon is still accessed as a rest or staging area for traditional Indonesian fishers travelling to and from fishing grounds within the MoU Box.

Heritage values

- No international or national heritage listings apply to the Marine Park at commencement of this plan.

Commonwealth heritage

- Ashmore Reef was listed on the Commonwealth Heritage List in 2004, meeting Commonwealth heritage listing criteria A, B and C.

Social and economic values

- Tourism, recreation and scientific research are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

Cartier Island Marine Park

The Cartier Island Marine Park is located approx. 45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, Western Australia. Both Marine Parks are located in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a MoU between Indonesia and Australia, known as the MoU Box.

The Marine Park covers an area of 172 km² and water depths from less than 15 m to 500 m. The Marine Park is assigned IUCN category Ia and includes one zone assigned under this plan: Sanctuary Zone (Ia).

Statement of significance

The Cartier Island Marine Park is significant because it includes habitats, species and ecological communities associated with the Timor Province. It includes two key ecological features: Ashmore Reef and Cartier Island and surrounding Commonwealth waters (valued for high productivity and breeding aggregations of birds and other marine life); and continental slope demersal fish communities (valued for high levels of endemism). Like the islands of Ashmore Reef, Cartier Island is a biodiversity hotspot and an important biological stepping stone, facilitating the transport of biological material to the reef systems along the Western Australian coast via the south-flowing Leeuwin Current which originates in the region.

Natural values

- Examples of ecosystems representative of the:
  - Timor Province—a bioregion with a depth range from about 200 m near the shelf break to 5920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Endemism of demersal fish communities of the continental slope is high with two distinct communities identified, one on the upper slope, the other mid slope.
- Key ecological features:
  - Ashmore Reef and Cartier Island and surrounding Commonwealth waters—areas of enhanced productivity in an otherwise low-nutrient environment, of regional importance for feeding and breeding aggregations of birds and marine life; and
  - Continental slope demersal fish communities—an area of high diversity in demersal fish assemblages. The Marine Park includes an unvegetated sand island (Cartier Island), mature reef flat, a small, submerged pinnacle (Wave Governor Bank), and two shallow pools to the north-east of the island. It is also an area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges and a range of encrusting organisms. The reef crests are

generally algal dominated, while the reef flats feature ridges of coral rubble and large areas of seagrass.

- The Marine Park supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- Biologically important areas within the Marine Park include breeding and foraging habitat for seabirds, internesting, nesting and foraging habitat for marine turtles and foraging habitat for whale sharks.
- Important for a range of other species and internationally significant for its abundance and diversity of sea snakes, some of which are listed species under the EPBC Act.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing.
- At the commencement of this plan, there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan.

Historic shipwrecks

- The Marine Park contains one known shipwreck listed under the Historic Shipwrecks Act 1976: the Ann Millicent (wrecked in 1888).

Social and economic values

- Scientific research is an important activity in the Marine Park.

Argo-Rowley Terrace Marine Park

The Argo–Rowley Terrace Marine Park is located approx. 270 km north-west of Broome. The Marine Park is adjacent to the Mermaid Reef Marine Park and the State Rowley Shoals Marine Park. The Marine Park covers an area of 146,003 km^2 and water depths of 220–6,000 m. The Marine Park includes three zones: National Park Zone (II), Multiple Use Zone (VI) and Special Purpose Zone (Trawl) (VI).

Statement of significance

The Argo–Rowley Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Transition and Timor Province, and includes two KEFs. The Marine Park is the largest in the North-west Network. It includes the deeper waters of the region and a range of seafloor features (e.g. canyons on the slope between the Argo Abyssal Plain, Rowley Terrace and Scott Plateau). These are believed to be up to 50 million years old and are associated with small, periodic upwellings that results in localised higher levels of biological productivity.

Natural values

- Examples of ecosystems representative of the:
  - Northwest Transition, an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Together with Clerke Reef and Imperieuse Reef, Mermaid Reef is a biodiversity hotspot and key topographic feature of the Argo Abyssal Plain.
  - Timor Province, an area dominated by warm, nutrient-poor waters. Canyons are an important feature in this area of the Marine Park and are generally associated with high productivity and aggregations of marine life.
- Contains two KEFs: Canyons linking the Argo Abyssal Plain with the Scott Plateau, and Mermaid Reef and Commonwealth waters surrounding Rowley Shoals (Section 4.3.6.5).
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include resting and breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains two known historic shipwrecks: Alfred (1908) and Pelsart (1908) (Section 4.3.5.9).

Social and economic values

- Commercial fishing and mining are important activities in the Marine Park.

Mermaid Reef Marine Park

The Mermaid Reef Marine Park is located approx. 280 km north-west of Broome, adjacent to the Argo–Rowley Terrace Marine Park and approx. 13 km from the WA Rowley Shoals Marine Park. The Marine Park covers an area of 540 km² and covers water depths from <15 m to 500 m. The Marine Park includes one zone: National Park Zone (II).

Statement of significance

The Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Transition and includes one KEF. Mermaid Reef is one of three reefs forming the Rowley Shoals; the others are Clerke Reef and Imperieuse Reef and occur to the south-west of the Marine Park. The Rowley Shoals have been described as the best geological examples of shelf atolls in Australian waters.

The reefs of the Rowley Shoals are ecologically significant in that they are considered ecological stepping-stones for reef species originating in Indonesian/Western Pacific waters, are one of a few offshore reef systems on the north-west shelf, and may also provide an upstream source for recruitment to reefs further south.

Natural values

- Examples of ecosystems representative of the Northwest Transition, an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Together with Clerke Reef and Imperieuse Reef, Mermaid Reef is a biodiversity hotspot and key topographic feature of the Argo Abyssal Plain.
- Contains one KEF: Mermaid Reef and Commonwealth waters surrounding Rowley Shoals (Section 4.3.6.5).
- Ecosystems are associated with emergent reef flat, deep reef flat, lagoon, and submerged sand habitats.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international or national heritage listings apply to the Marine Park.
- The Marine Park surrounds the Mermaid Reef – Rowley Shoals Commonwealth Heritage Place (Section 4.3.5.9).
- The Marine Park contains one known historic shipwreck: Lively (1810) (Section 4.3.5.9).

Social and economic values

- Tourism, recreation, and scientific research are important activities in the Marine Park.

Roebuck Marine Park

The Roebuck Marine Park is located approximately 12 km offshore of Broome, and is adjacent to the Western Australian Yawuru Nagulagun/Roebuck Bay Marine Park. The Marine Park covers an area of 304 km² and a water depth range of less than 15 m to 70 m.

The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Roebuck Marine Park on 9 October 2017. The Marine Park is assigned IUCN category VI and includes one zone assigned under this plan: Multiple Use Zone (VI). **Statement of significance** The Roebuck Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province, and consists entirely of shallow continental shelf habitat. The Marine Park is adjacent to the Roebuck Bay Ramsar site, recognised as one of the most important areas for migratory shorebirds in Australia; and the Western Australian Yawuru Nagulagun/Roebuck Bay Marine Park, providing connectivity between offshore and inshore coastal waters of Roebuck Bay. **Natural values** • Examples of ecosystems representative of the: o Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. • The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. • Biologically important areas within the Marine Park include breeding and resting habitat for seabirds, foraging and internesting habitat for marine turtles, a migratory pathway for humpback whales and foraging habitat for dugong. **Cultural values** • Sea country is valued for Indigenous cultural identity, health and wellbeing. • Yawuru people have always recognised the waters of Roebuck Bay as nagula (Yawuru sea country), and have customary responsibilities to care for it. They have a deep spiritual connection to offshore landscapes from Bugarrigarra (creator beings), and believe that snake-like metaphysical beings inhabit the sea. • Cultural sites in sea country are also a source of law. The Yawuru people harvest marine resources according to the six Yawuru seasons. They have harvested pearl shell for food and cultural purposes. Fish are a staple food source, and fishing a form of cultural expression, connecting people to their country, modelled on tradition and based in traditional law. Access to sea country by families is important to cultural traditions, livelihoods and future socio-economic development opportunities. • The Yawuru Native Title Holders Aboriginal Corporation is the Prescribed Body Corporate representing traditional owners with native title over coastal areas adjacent to the Marine Park, and is the point of contact for sea country in the Marine Park. The Kimberley Land Council is the Native Title Representative Body for the Kimberley region. **Heritage values** • No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the West Kimberley National Heritage Place. **Social and economic values** • Tourism, commercial fishing, pearling and recreation, including fishing, are important activities that occur in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Eighty Mile Beach Marine Park
The Eighty Mile Beach Marine Park is located approx. 74 km north-east of Port Hedland, adjacent to the State Eighty Mile Beach Marine Park. The Marine Park covers an area of 10,785 km² and covers water depths from <15 m to 70 m. The Marine Park includes one zone: Multiple Use Zone (VI). **Statement of significance**

The Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province and consists of shallow shelf habitats, including terrace, banks and shoals. The Marine Park is adjacent to the Eighty Mile Beach Ramsar site, recognised as one of the most important areas for migratory shorebirds in Australia; and the State Eighty Mile Beach Marine Park, providing connectivity between offshore and inshore coastal waters of Eighty Mile Beach.

Natural values

- Examples of ecosystems representative of the Northwest Shelf Province, a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides, the region includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding, foraging and resting habitat for seabirds, internesting and nesting habitat for marine turtles, foraging, nursing and pupping habitat for sawfish and a migratory pathway for humpback whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Nyangumarta, Karajarri and Ngarla people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains three known historic shipwrecks: Lorna Doone (1923), Nellie (1908) and Tifera (1923) (Section 4.3.5.9).

Social and economic values

- Tourism, commercial fishing, pearling and recreation are important activities in the Marine Park.

Dampier Marine Park

The Dampier Marine Park is located approx. 10 km north-east of Cape Lambert and 40 km from Dampier extending from the WA state water boundary. The Marine Park covers an area of 1,252 km² and a water depth range from <15 m to 70 m. The Marine Park includes three zones: National Park Zone (II), Habitat Protection Zone (IV) and Multiple Use Zone (VI).

Statement of significance

The Dampier Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province. The Marine Park provides protection for offshore shelf habitats adjacent to the Dampier Archipelago, and the area between Dampier and Port Hedland, and is a hotspot for sponge biodiversity. The Marine Park includes several submerged coral reefs and shoals including Delambre Reef and Tessa Shoals.

Natural values

- Examples of ecosystems representative of the Northwest Shelf Province, a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides, the region includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding and foraging habitat for seabirds, internesting habitat for marine turtles and a migratory pathway for humpback whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Ngarluma, Yindjibarndi, Yaburara, and Mardudhunera people have responsibilities for sea country in the Marine Park.

Heritage values

• No international, Commonwealth or national heritage listings apply to the Marine Park. Social and economic values • Port activities, commercial fishing and recreation, including fishing, are important activities in the Marine Park.
Montebello Marine Park
The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the WA State water boundary. The Marine Park covers an area of 3,413 km^2 and water depths from <15 m to 150 m. The Marine Park includes one IUCN zone: Multiple Use Zone (IUCN VI). **Statement of significance** The Montebello Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province. The Marine Park includes one KEF, the ancient coastline at the 125-m depth contour (Section 4.3.6.5). The Marine Park provides connectivity between deeper waters of the continental shelf and slope, and the adjacent State Barrow Island and Montebello Islands Marine Parks. A prominent seafloor feature in the Marine Park is Trial Rocks consisting of two close coral reefs; these reefs are emergent at low tide. **Natural values** • Examples of ecosystems representative of the Northwest Shelf Province, a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides, the region includes diverse benthic and pelagic fish communities. • Contains one KEF: the ancient coastline at the 125-m depth contour. • Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. • BIAs within the Marine Park include breeding habitat for seabirds, internesting, foraging, mating, and nesting habitat for marine turtles, a migratory pathway for humpback whales and foraging habitat for whale sharks. **Cultural values** • Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park. **Heritage values** • No international, Commonwealth or national heritage listings apply to the Marine Park. • The Marine Park contains two known historic shipwrecks: *Trial* (1622) and *Tanami* (unknown date) (Section 4.3.5.9). **Social and economic values** • Tourism, commercial fishing, mining and recreation are important activities in the Marine Park.
Ningaloo Marine Park
The Ningaloo Marine Park stretches approx. 300 km along the west coast of the Cape Range Peninsula, and is adjacent to the State Ningaloo Marine Park and Commonwealth Gascoyne Marine Park. The Marine Park covers an area of 2,435 km^2 and occurs over a water depth range of 30 m to >500 m. The Marine Park contains zones designated as National Park Zone (IUCN II) and Recreational Use Zone (IUCN IV). **Statement of significance** The Ningaloo Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Shelf Transition, Central Western Transition, Northwest Province, and Northwest Shelf Province; and contains three KEFs. The Marine Park provides connectivity between deeper offshore waters of the shelf break and shallower coastal waters. It includes some of the most diverse continental slope habitats in Australia, in particular the continental slope area between North West Cape and the Montebello Trough. Canyons in the Marine Park are important for their role in sustaining the nutrient conditions that support the high diversity of

Ningaloo Reef. The Marine Park is located in a transition zone between tropical and temperate waters and sustains tropical and temperate flora and fauna, with many species at the limits of their distributions.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Shelf Transition, an area of continental shelf of water depths up to 100 m, and a significant transition zone between tropical and temperate species
  - Central Western Transition, characterised by large areas of continental slope, a range of topographic features (e.g. terraces, rises and canyons), seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species
  - Northwest Province, an area of continental slope comprising diverse and endemic fish communities
  - Northwest Shelf Province, an area influenced by strong tides, cyclonic storms, long-period swells and internal tides; this region includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
- Contains three KEFs: Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula, Commonwealth waters adjacent to Ningaloo Reef, and Continental slope demersal fish communities.
- Ecosystems are influenced by the Leeuwin and Ningaloo currents, and the Leeuwin undercurrent.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding and or foraging habitat for seabirds, internesting habitat for marine turtles, a migratory pathway for humpback whales, foraging habitat and migratory pathway for pygmy blue whales, breeding, calving, foraging and nursing habitat for dugong and foraging habitat for whale sharks.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Gnulli people have responsibilities for sea country in the Marine Park.

Heritage values

- The Marine Park is within the Ningaloo Coast World Heritage Property, adjacent to the Ningaloo Coast National Heritage Place, and within the Ningaloo Marine Area (Commonwealth waters) Commonwealth Heritage Place (Section 4.3.5.9).
- The Marine Park contains over 15 known historic shipwrecks (Section 4.3.5.9).

Social and economic values

- Tourism and recreation (including fishing) are important activities in the Marine Park

Gascoyne Marine Park

The Gascoyne Marine Park is located approx. 20 km off the west coast of the Cape Range Peninsula, adjacent to the State and Commonwealth Ningaloo Marine Parks. The Marine Park covers an area of 81,766 km^2 and over water depths between 15–6,000 m. The Marine Park contains zones designated as National Park Zone (IUCN II), Habitat Protection Zone (IUCN IV) and Multiple Use Zone (IUCN VI).

Statement of significance

The Gascoyne Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Shelf Transition, Central Western Transition, and Northwest Province, and includes four KEFs.

The Marine Park includes some of the most diverse continental slope habitats in Australia, in particular the continental slope area between North West Cape and the Montebello Trough. Canyons in the Marine Park link the Cuvier Abyssal Plain to the Cape Range Peninsula and are important for their role in sustaining the nutrient conditions that support the high diversity of Ningaloo Reef.

Natural values

- Examples of ecosystems representative of the:

- Central Western Shelf Transition, an area of continental shelf of water depths up to 100 m, and a significant transition zone between tropical and temperate species
- Central Western Transition, characterised by large areas of continental slope, a range of topographic features (e.g. terraces, rises and canyons), seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species
- Northwest Province, an area of continental slope comprising diverse and endemic fish communities.

- Contains four KEFs: Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula, Commonwealth waters adjacent to Ningaloo Reef, Continental slope demersal fish communities, and the Exmouth Plateau (Section 4.3.6.5).
- Ecosystems are influenced by the Leeuwin and Ningaloo currents, and the Leeuwin undercurrent.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding habitat for seabirds, internesting habitat for marine turtles, a migratory pathway for humpback whales, and foraging habitat and migratory pathway for pygmy blue whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Gnulli people have responsibilities for sea country in the Marine Park.

Heritage values

- The Marine Park is adjacent to Ningaloo Coast World Heritage Property and National Heritage Place, and the Ningaloo Marine Area (Commonwealth waters) Commonwealth Heritage Place (Section 4.3.5.9).
- The Marine Park contains over 5 known historic shipwrecks (Section 4.3.5.9).

Social and economic values

- Commercial fishing, mining and recreation are important activities in the Marine Park.

Carnarvon Canyon Marine Park

The Carnarvon Canyon Marine Park is located approximately 300 km north-west of Carnarvon. It covers an area of 6,177 km^2 and occurs over a water depth range of 1,500–6,000 m. The Marine Park includes one IUCN zone: Habitat Protection Zone (IUCN IV).

Statement of significance

The Carnarvon Canyon Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Transition, including deep-water ecosystems associated with the Carnarvon Canyon. The Marine Park lies within a transition zone between tropical and temperate species and is an area of high biotic productivity.

Natural values

- Examples of ecosystems representative of the Central Western Transition, which is a bioregion characterised by large areas of continental slope, a range of topographic features (e.g. terraces, rises and canyons), seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species.
- The Carnarvon Canyon is a single-channel canyon covering the entire depth range of the Marine Park.
- Ecosystems are influenced by tropical and temperate currents, deep-water environments and proximity to the continental slope and shelf.
- The soft-bottom environment at the base of the Carnarvon Canyon is likely to support species that are typical of the deep seafloor (e.g. holothurians, polychaetes and sea-pens).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

Social and economic values

- Commercial fishing is an important activity in the Marine Park.

Shark Bay Marine Park

The Shark Bay Marine Park is located approximately 60 km offshore of Carnarvon, adjacent to the Shark Bay world heritage property and national heritage place. The Marine Park covers an area of 7,443 km², extending from the WA state water boundary, over a water depth range of 15–220 m. The Marine Park includes one IUCN zone: Multiple Use Zone (IUCN VI).

Statement of significance

The Shark Bay Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Shelf Province and Central Western Transition. The Marine Park provides connectivity between deeper Commonwealth waters and the inshore waters of the Shark Bay world heritage property.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Shelf, which is a predominantly flat, sandy and low-nutrient area, in water depths of 50–100 m; this region is a transitional zone between tropical and temperate species
  - Central Western Transition, which is characterised by large areas of continental slope, a range of topographic features such as terraces, rises and canyons, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species.
- Ecosystems are influenced by the Leeuwin, Ningaloo and Capes currents.
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding habitat for seabirds, internesting habitat for marine turtles, and a migratory pathway for humpback whales.
- The Marine Park and adjacent coastal areas are also important for shallow-water snapper.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Gnulli and Malgana people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains approx. 20 known historic shipwrecks (Section 4.3.5.9).

Social and economic values

- Tourism, commercial fishing, mining and recreation are important activities in the Marine Park.

South-west Marine Region

Abrolhos Marine Park

The Abrolhos Marine Park is located adjacent to the Houtman Abrolhos Islands and extends from approx. 27 km south-west of Geraldton north to approx. 330 km west of Carnarvon. The Marine Park covers an area of 88,060 km² and a water depth range from <15 m to 6,000 m. The Marine Park includes four zones: National Park Zone (II), Habitat Protection Zone (IV), Multiple Use Zone (VI) and Special Purpose Zone (VI).

Statement of significance

The Abrolhos Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Province, Central Western Shelf Province, Central Western Transition and South-west Shelf Transition regions, and includes seven KEFs. The southern shelf

component of the Marine Park partially surrounds the State Houtman Abrolhos Islands Nature Reserve. The islands and surrounding reefs are renowned for their high level of biodiversity, due to the southward movement of species by the Leeuwin Current. The Marine Park contains several seafloor features including the Houtman Canyon, the second largest submarine canyon on the west coast. **Natural values** • Examples of ecosystems representative of the: o Central Western Province, characterised by a narrow continental slope incised by many submarine canyons and the most extensive area of continental rise in any of Australia's marine regions. A significant feature within the area are several eddies that form off the Leeuwin Current at predictable locations, including west of the Houtman Abrolhos Islands. o Central Western Shelf Province, a predominantly flat, sandy and low nutrient area, in water depths of 50–100 m. Significant seafloor features of this area include a deep hole and associated area of banks and shoals offshore of Kalbarri. The area is a transitional zone between tropical and temperate species. o Central Western Transition, a deep ocean area characterised by large areas of continental slope, a range of significant seafloor features including the Wallaby Saddle, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species. o South-west Shelf Transition, an area of narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species. • Contains seven KEFs: Commonwealth marine environment surrounding the Houtman Abrolhos Islands, Demersal slope and associated fish communities of the Central Western Province, Mesoscale eddies, Perth Canyon and adjacent shelf break, and other west-coast canyons, Western rock lobster, Ancient coastline between 90 m and 120 m depth, and the Wallaby Saddle (Section 4.3.6.5). • Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. • BIAs within the Marine Park include foraging and breeding habitat for seabirds, foraging habitat for Australian sea lions and white sharks, and a migratory pathway for humpback and pygmy blue whales. • The Marine Park is adjacent to the northernmost Australian sea lion breeding colony in Australia on the Houtman Abrolhos Islands. **Cultural values** • Sea country is valued for Indigenous cultural identity, health and wellbeing. The Nanda and Naaguja people have responsibilities for sea country in the Marine Park. **Heritage values** • No international, Commonwealth or national heritage listings apply to the Marine Park. • The Marine Park contains 11 known historic shipwrecks (Section 4.3.5.9). **Social and economic values** • Tourism, commercial fishing, mining, recreation including fishing, are important activities in the Marine Park.
Jurien Marine Park
The Jurien Marine Park is located approx. 148 km north of Perth and 155 km south of Geraldton, adjacent to the State Jurien Bay Marine Park. The Marine Park covers an area of 1,851 km² of continental shelf, and over water depths of 15–220 m. The Marine Park includes two zones: National Park Zone (II) and Special Purpose Zone (VI). **Statement of significance** The Jurien Marine Park is significant because it includes habitats, species and ecological communities associated with the South-west Shelf Transition and Central Western Province, and includes three KEFs.

The Marine Park contains a mixture of tropical species carried south by the Leeuwin Current, and temperate species carried north by the Capes Current. The Marine Park's shelf habitats are defined by distinct ridges of limestone reef with extensive beds of macroalgae. Inshore lagoons are inhabited by a diverse range of invertebrates and fish. Seagrass meadows occur in more sheltered areas as well as in the inter-reef lagoons along exposed sections of the coast. The Marine Park includes habitats connecting to and complementing the adjacent State Jurien Bay Marine Park.

Natural values

- Examples of ecosystems representative of the:
  - South-west Shelf Transition, an area of narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
  - Central Western Province, characterised by a narrow continental slope and influenced by the Leeuwin Current.
- Contains three KEFs: Demersal slope and associated fish communities of the Central Western Province, Western rock lobster and Ancient coastline between 90 m and 120 m depth (Section 4.3.6.5).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include foraging habitat for seabirds, Australian sea lions and white sharks, and a migratory pathway for humpback and pygmy blue whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Noongar people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains two known historic shipwrecks: SS Cambewarra (1914) and Oleander (1884)

Social and economic values

- Tourism, commercial fishing, mining and recreation, including fishing, are important activities in the Marine Park.

Two Rocks Marine Park

The Two Rocks Marine Park is located approx. 25 km north-west of Perth. The Marine Park covers an area of 882 km², over a water depth range from 15–120 m. The Marine Park includes two zones: National Park Zone (II) and Multiple Use Zone (VI).

Statement of significance

The Two Rocks Marine Park is significant because it includes habitats, species and ecological communities associated with the South-west Shelf Transition and includes three KEFs. The Marine Park is shallow and provides connectivity between offshore waters and the west coast inshore lagoons, which are key areas for the recruitment of rock lobster and other commercially and recreationally important fish species.

Natural values

- Examples of ecosystems representative of the South-west Shelf Transition, an area of narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
- The inshore lagoons are thought to be important areas for benthic productivity and recruitment for a range of marine species.

- Contains three KEFs: Commonwealth marine environment within and adjacent to the west-coast inshore lagoons, Western rock lobster and Ancient coastline between 90 m and 120 m depth (Section 4.3.6.5).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include foraging habitat for seabirds and Australian sea lions, a migratory pathway for humpback and pygmy blue whales, and a calving buffer area for southern right whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Swan River traditional owners have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

Social and economic values

- Tourism, commercial fishing, recreation, including fishing, and scientific research are important activities in the Marine Park.

Perth Canyon Marine Park

The Perth Canyon Marine Park is located approx. 52 km west of Perth and approx. 19 km west of Rottnest Island. The Marine Park covers an area of 7,409 km² and covers water depths of 120–5,000 m. The Marine Park includes three zones: National Park Zone (II), Habitat Protection Zone (IV) and Multiple Use Zone (VI).

Statement of significance

The Marine Park is significant because it includes habitats, species and ecological communities associated with the Central Western Province, South-west Shelf Province, Southwest Transition and South-west Shelf Transition; and also includes four KEFs. The Marine Park includes the majority of the Perth Canyon, Australia's largest submarine canyon, which is home to the largest feeding aggregations of blue whales in Australia. This unique feature is also of significance because it cuts into the continental shelf at approximately 150 m depth west of Rottnest Island, linking the shelf with deeper (up to 5,000 m) ecosystems. The Marine Park represents the southern end of the transition area from tropical to temperate marine environments.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Province, characterised by a narrow continental slope incised by many submarine canyons (including Perth Canyon), and the most extensive area of continental rise in any of Australia's marine regions. A significant feature within the area are several eddies that form off the Leeuwin Current at predictable locations (including the Perth Canyon).
  - South-west Shelf Province, an area of diverse marine life, influenced by the warm waters of the Leeuwin Current
  - South-west Transition, characterised by the submarine canyons that incise the northern parts of the slope and the deep-water mixing that results from the dynamics of major ocean currents when these meet the seafloor (particularly in the Perth Canyon).
  - South-west Shelf Transition, an area that consists of a narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
- Contains four KEFs: Perth Canyon and adjacent shelf break, and other west-coast canyons, Demersal slope and associated fish communities of the Central Western Province, Western rock lobster and Mesoscale eddies (Section 5.4.1.2).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.

- BIAs within the Marine Park include foraging habitat for seabirds, Antarctic blue, pygmy blue and sperm whales, a migratory pathway for humpback, Antarctic blue and pygmy blue whales, and a calving buffer area for southern right whales.

Cultural values

Sea country is valued for Indigenous cultural identity, health and wellbeing. The Swan River traditional owners have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

Social and economic values

- Tourism, commercial shipping, commercial fishing, recreation, including fishing, and defence training are important activities in the Marine Park.

4.3.6.3 *State Marine Protected Areas*

State Marine Protected Areas occur within State waters. There are 13 State marine protected areas within the EMBA, where 7 of the 13 State marine protected areas are within the Hdyrocarbon Area (Table 4-21, Figure 4-25):

Table 4-21: State Marine Protected Areas within the Wandoo Well Construction Program EMBA

State Marine Protected Areas	Operational Area	Hydrocarbon Area	EMBA
Montebello Islands Marine Park	x	✓	✓
Barrow Island Marine Management Area	x	✓	✓
Barrow Island Marine Park	x	✓	✓
Muiron Islands Marine Management Area	x	x	✓
Ningaloo Marine Park Area	x	✓	✓
Eighty Mile Beach Marine Park	x	✓	✓
Rowley Shoals Marine Park	x	✓	✓
Shark Bay Marine Park	x	x	✓
Roebuck Bay Marine Park	x	✓	✓
Hamelin Pool Marine Nature Reserve Park	x	x	✓
Lalang-garram/Camden Sound Marine Park	x	x	✓
Jurien Bay Marine Park	x	x	✓
Marmion Marine Park	x	x	✓

✓= Present within area; *X* = not present within area

The closest State marine parks and/or mananagement areas are associated with the Montebello (72 km from the Operational Area) and Barrow Islands and surrounding areas (85 km from the Operational Area).

The Montebello Islands/Barrow Island Marine Parks and Management Area display a complex seabed and island topography, with coastlines dominated by cliffs, beaches, sheltered lagoons and channels. As a result of this complexity, the reserves are characterised by a diverse range of habitats including subtidal coral reefs, macroalgal and seagrass communities, subtidal soft-bottom communities, rocky shores and intertidal reef platforms and mangrove communities (DEC, 2007a).

The parks provide important nesting and inter-nesting habitat for four of the six species of marine turtle found in WA, including flatback and green turtles, as well as being the northern limit for loggerhead turtle nesting (DEC, 2007a). Several species of whale have been recorded within the reserves. Humpback whales have been observed using the reserves as resting areas on their annual migration (DEC, 2007a). Dugong are found in the vicinity of the Montebello Islands, Lowendal Islands and the Barrow Shoals where they feed on seagrass and algae (DEC, 2007a). In addition, the reserves are important rookeries for numerous species of seabirds.

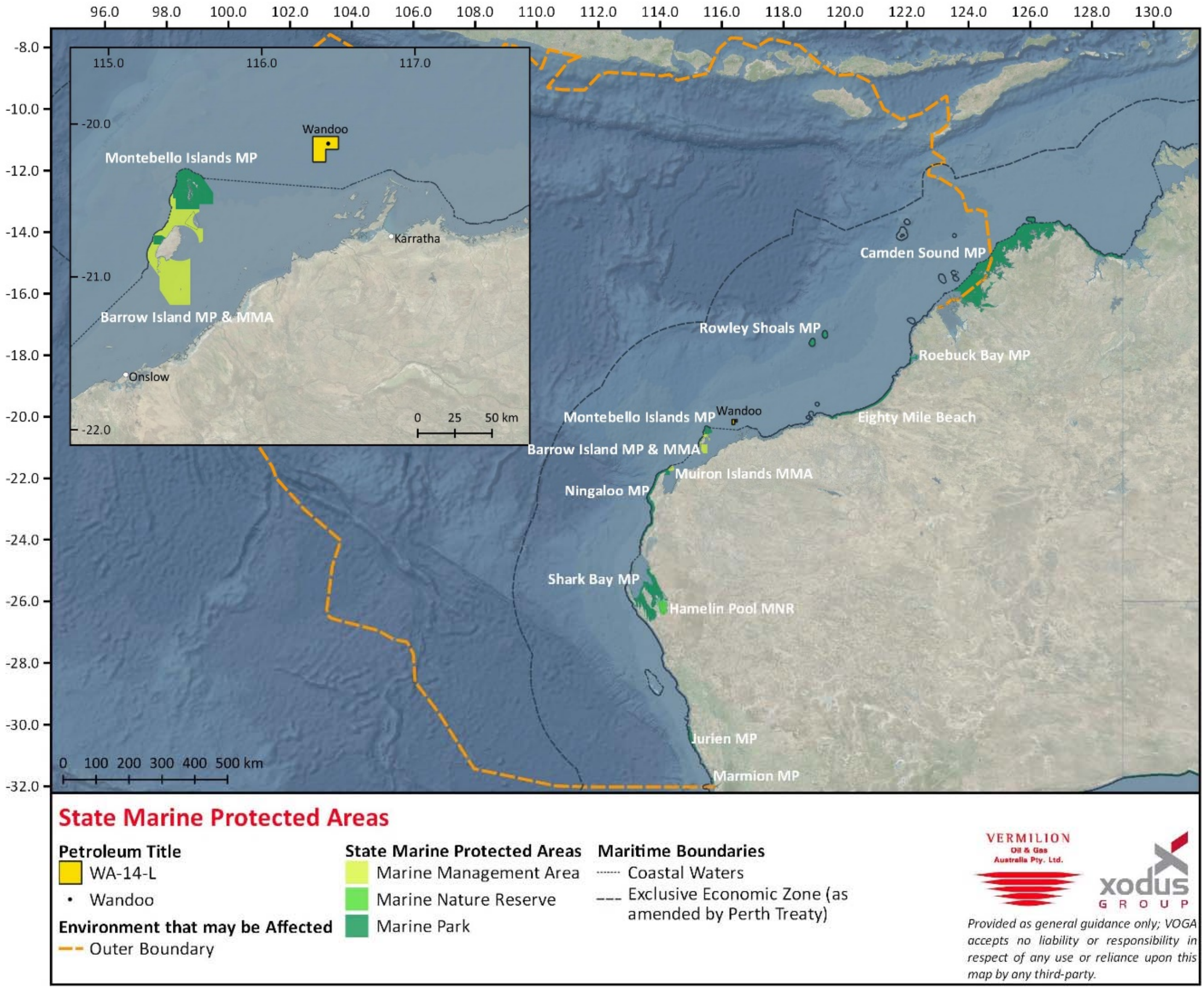


Figure 4-25: State Marine Protected Areas

4.3.6.4 *Wetlands of International Importance (Ramsar wetlands)*

Ramsar wetlands are recognised as a matter of national environmental significance under the EPBC Act. There are 9 criteria for identifying wetlands of international importance as detailed in Table 4-22.

Table 4-22: Criteria for identifying Wetlands of International Importance

Number	Basis	Description
Group A of the Criteria. Sites containing representative, rare or unique wetland types		
1		A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region. The application of this criterion must be considered in the context of the bioregion within which the site is located. As an offshore site, the appropriate bioregionalisation is the IMCRA v4.0 (Commonwealth of Australia 2006).
Group B of the Criteria. Sites of international importance for conserving biological diversity		
2	Species and ecological communities	A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities. In the Australian context, it is recommended that this criterion should only be applied with respect to nationally threatened species/communities, listed under the EPBC Act 1999 or the International Union for Conservation of Nature (IUCN) red list.
3	Species and ecological communities	A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region. Like criterion one, application of this criterion must be taken in the context of the appropriate bioregion, in this instance the IMCRA (v4). Guidance from the Convention indicates that this criteria should be applied to "hotspots" of biological diversity, centres of endemism, sites that contain the range of biological diversity (including habitat types) occurring in a region; and/or support particular elements of biological diversity that are rare or particularly characteristic of the biogeographic region.
4	Species and ecological communities	A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions. The basic description of this criterion implies a number of common functions/roles that wetlands provide including supporting fauna during migration and breeding as well as acting as a drought refuge.
5	Waterbirds	A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
6	Waterbirds	A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
7	Fish	A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

8	Fish	A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
9	Other taxa	A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

There are five Ramsar wetlands in the EMBA (Table 4-23):

- Ashmore Reef (Table 4-24)
- Eighty-mile beach (Table 4-26)
- Hosnies Spring (Table 4-27)
- Roebuck bay (Table 4-28)
- The Dales (Table 4-25)

No Ramsar wetlands are located within the Operational Area. The Dales (Christmas Island), Eighty-mile beach, Hosnies spring (Christmas Island) and Roebuck bay are located in the shoreline Hydrocarbon Area.

Table 4-23 Wetlands of Importance within the Project Areas

Receptor Group	Operational Area	Hydrocarbon Area-In Water	Hydrocarbon Area-Shoreline	EMBA
Ashmore reef national nature reserve	x	x	x	✓
The Dales, Christmas Island	x	x	✓	✓
Eighty-mile beach / Eighty Mile Beach System	x	x	✓	✓
Hosnies spring, Christmas Island	x	x	✓	✓
Roebuck bay	x	x	✓	✓

✓ = Present within Area, x = Not present within area

Table 4-24 lists the six Ramsar listing criteria met for the Ashmore Reef Ramsar site.

Table 4-24: Criteria met for Ashmore Reef Ramsar site (Hale and Butcher, 2013)

Number	Basis	Description
Group A of the Criteria. Sites containing representative, rare or unique wetland types		
1		Ashmore Reef is the largest of the atolls in the Timor Province bioregion and has been managed for the purposes of conservation for three decades. Each of the wetland types present at Ashmore Reef Ramsar site is in near natural condition, with low densities of coral predators and disease (Richards *et al.,* 2009). The Ashmore Reef Ramsar site also has the highest seagrass cover in the bioregion (Russell *et al.,* 2005). In addition, the three islands at Ashmore Reef Ramsar site (West, Middle and East) represent the only vegetated islands within the Timor Province bioregion (DEWHA 2008a). Thus, by definition the site contains bioregionally

		unique examples of wetland type E (sand, shingle or pebble shores).
Group B of the Criteria. Sites of international importance for conserving biological diversity		
2	Species and ecological communities	There are 64 threatened species that were supported by the Ashmore Reef Ramsar site at the time of listing, 41 species of hard, reef forming coral, one species of soft coral, two species of giant clam, five species of sea cucumber, eight fish, six reptiles and a mammal.
3	Species and ecological communities	Ashmore Reef Ramsar site represents a true “hotspot” of biological diversity within the Timor Province bioregion and within the broader north-west marine region (Wells and Allen 2005). The Ashmore Reef Ramsar site has the highest diversity of hermatypic (reef building corals) on the West Australian coast with 275 species from 56 genera recorded (Vernon 1993, Griffith 1997) and the highest diversity of non-reef building corals in the region (Marsh 1993). The site also has a higher diversity of molluscs than other reefs in the bioregion with over 600 species recorded (Wells 1993, Willan 2005). A total of 13 species of sea cucumber are known to occur at Ashmore Reef Ramsar site, which is higher than other reefs in the bioregion (Skewes *et al.,* 1999a). Ninety-nine species of decapod crustacean have been recorded at Ashmore Reef Ramsar site and Cartier Island, nearly twice that recorded at Scott and Seringapatam Reefs (Morgan and Berry 1993). The diversity of fish is also higher than other comparable reefs in the bioregion with over 760 species recorded (Russell *et al.,* 2005, Kospartov *et al.,* 2006).
4	Species and ecological communities	Ashmore Reef Ramsar site supports 47 species of waterbird listed as migratory under international treaties and three species of migratory turtles (green, hawksbill and loggerhead). The site also supports breeding of green and hawksbill turtles (Whiting and Guinea 2005a) dugongs (Whiting and Guinea 2005b) and 20 species of waterbird.
5	Waterbirds	The Ashmore Reef Ramsar site regularly supports over 40 000 waterbirds including large numbers of migratory shorebirds and breeding seabirds (Clarke *et al.,* 2011).
6	Waterbirds	Ashmore Reef Ramsar site regularly supports more than one per cent of the populations of five species of shorebird and one species of seabird: bar-tailed godwit (*Limosa lapponica*), grey-tailed tattler (*Tringa brevipes*), ruddy turnstone (*Arenaria interpres*), sanderling (*Calidris alba*), greater sand plover (*Charadrius leschenaultia*) and sooty tern (*Onychoprion fuscata*).

Table 4-25 lists the five Ramsar listing criteria met for The Dales Ramsar site.

Table 4-25: Criteria met for The Dales Ramsar site (Butcher and Hale, 2010)

Number	Basis	Description
Group A of the Criteria. Sites containing representative, rare or unique wetland types		
1		Christmas Island represents the only land mass within the bioregion and the wetlands associated with The Dales, particularly the karst system are unique in a bioregional context. As such The Dales Ramsar site met this criterion at the time of listing and continues to do so.
Group B of the Criteria. Sites of international importance for conserving biological diversity		

2	Species and ecological communities	A number of threatened species listed at the national and / or international level have been recorded within the boundary of The Dales Ramsar site. However, central to the application of this criterion are the words “a wetland” and “supports”. There are two threatened species supported by the wetlands within The Dales Ramsar site that contribute to the site meeting this criterion: • Abbott’s booby (Papasula abbotti) • Christmas Island frigatebird (Fregata andrewsi) This criterion was met at the time of listing and continues to be met.
3	Species and ecological communities	Christmas Island is recognised for its high conservation values and is specifically identified as an area for biodiversity conservation under Part 9 of the EPBC Act Regulations 2000. All native species on the island, as detailed in Schedule 12 of the Act, are considered protected. Of particular note is the land crab diversity, with Christmas Island supporting the greatest diversity of land crabs on an oceanic island in the world. All of the 20 species of land crab found on the island occur within the site, with the site particularly important for the blue crab (Discoplax hirtipes). In addition The Dales support a 10 hectare monodominant stand of Tahitian chestnut (Inocarpus fagifer), which is unique in the bioregion. This criterion was met at the time of listing and continues to be met.
4	Species and ecological communities	The Dales is a significant migratory route for red crabs (Gecarcoidea natalis), blue crabs (Discoplax hirtipes) and robber crabs (Birgus latro). The freshwater streams provide critical habitat for the blue crabs as the larvae emerge from the ocean and return inland. In addition the site provides important habitat for land crab spawning, with all 20 species which occur in the site, migrating to the ocean to spawn with their larval stages being marine. The red crab is the most numerous of the land crabs with estimates of 40-50 million crabs on the island. Within the Ramsar sites all the Dales are important migration pathways, but especially Sydney’s Dale and No. 1 Dale. A large number of migratory or vagrant waterbird have been recorded from the island, although the usage at The Dales is not documented, it can be assumed that some species utilise the site as a staging point during migration and a landfall for vagrant species outside their accustomed range (RIS 2002). This criterion was met at the time of listing and continues to be met.
8	Fish	Christmas Island is a significant area for whale sharks (Rhincodon typus) because the mass spawning and development of the larvae of red crabs corresponds to the arrival and aggregation of juveniles off shore of Christmas Island (Hobbs *et al.,* 2009b). Meekan *et al.,* (2009) confirmed whale sharks are feeding on the immature stages of red crabs through analysis of faecal matter from a single shark. Whale sharks have been observed feeding close to shore around

		most of the island in shallow waters (J-P Hobbs, James Cook University, pers. comm.) and almost certainly feed within the boundary of the Ramsar site. The whale sharks persist in the waters off Christmas Island for several months after the red crab larvae have left the water and therefore are not solely reliant on them as a food source. It has been postulated that other crab species spawning events and coral spawning also provide food for the sharks (J.P. Hobbs, James Cook University, pers. comm.). This criterion was met at the time of listing and continues to be met.

Table 4-26 lists the six Ramsar listing criteria met for the Eighty Mile Beach Ramsar site.

Table 4-26: Criteria met for Eighty Mile Beach Ramsar site (Hale and Butcher, 2009)

Number	Basis	Description
Group A of the Criteria. Sites containing representative, rare or unique wetland types		
1		Eighty-mile Beach represents the greatest extent of continuous intertidal mudflat in excellent condition within the Northwest (IMCRA) bioregion. In addition, Mandora Salt Marsh contains an important and rare group of wetlands within the arid Western Plateau bioregion (Semeniuk and Semeniuk 2000). In particular the peat mound springs can be considered both bioregionally rare and outstanding examples of this wetland type in Western Australia. This criterion was met at designation in 1990 and continues to be met at present.
Group B of the Criteria. Sites of international importance for conserving biological diversity		
2	Species and ecological communities	There are five threatened species that have been recorded within the boundary of the Eighty-mile Beach Ramsar site, one mammal, two waterbirds and two marine turtles: • Greater Bilby (*Macrotis lagotis*) • Nordmann's Greenshank (*Tringa guttifer*) • Australian Painted Snipe (*Rostratula australis*) • Flatback Turtle (*Natator depressus*) • Green Turtle (*Chelonia mydas*) This criterion is only met for the Flatback Turtle, for which the site is significant nesting habitat (DEWHA 2008c). This criterion was met at designation in 1990 and continues to be met at present.
3	Species and ecological communities	The Mandora Salt Marsh contains temporary and permanent wetlands in a predominantly arid bioregion (Western Plateau) and has been recognised as important refugia for biological diversity in arid Australia (Morton *et al.,* 1995). The inland Grey Mangroves (Avicennia marina) lining Salt Creek represent the most inland occurrence of this species (Semeniuk and Semeniuk 2000) and one of the only two inland occurrences in the Western Plateau. In 1999 a suspected new species of goby (Acentrogobius sp. nov.) was collected from Salt Creek in Mandora Marshes (A. Storey pers. comm.). The specimen has yet to be officially identified and catalogued. It is likely that this criterion was met at the time of listing and continues to be met.
4	Species and ecological communities	The Eighty-mile Beach Ramsar site is considered one of the most important sites for stop-over and feeding by migratory shorebirds in Australia; second only to Roebuck Bay in the total number of migratory species for which it is considered internationally important.

		Furthermore, Eighty-mile Beach represents the most important site internationally (in terms of total number of individuals) for nine species of migratory shorebird in the East Asian Australasian flyway (Bamford *et al.,* 2008). Mandora Salt Marsh supports the critical life stage of breeding for at least 13 species of waterbird, including large numbers of Australian Pelicans and Black Swans (Birds Australia 2008). In addition, the site is significant for the breeding of at least one species of marine turtle (Flatback). This criterion was met at the date of listing and continues to be met.
5	Waterbirds	Eighty-mile Beach is considered to regularly support in excess of 500,000 birds (Wade and Hickey 2008). Total counts (summer) for just a 60 km stretch of the 220 km intertidal site are generally greater than 200,000 (Shorebirds 2020 unpublished data). There is a record of 2.88 million Oriental Pratincoles on the beach in February 2004 (Sitters *et al.,* 2004). This criterion was met at the date of listing and continues to be met.
6	Waterbirds	This criterion is applied to the international population estimates as provided by Wetlands International. Eighty-mile Beach supports more than 1% of the flyway population (or 1% of the Australian population for resident species) of 21 waterbirds, including 17 migratory species and 4 Australian residents: Greater Sand Plover Charadrius leschenaultii, Oriental Plover C. veredus, Red-capped Plover C. ruficapillus (resident), Grey Plover Pluvialis squatarola, Bartailed Godwit Limosa lapponica, Red Knot Calidris canutus, Great Knot C. tenuirostris, Rednecked Stint C. ruficollis, Sanderling C. alba, Sharp-tailed Sandpiper C. acuminata, Curlew Sandpiper C. ferruginea, Eastern Curlew Numenius madagascariensis, Little Curlew N. minutus, Common Greenshank Tringa nebularia, Grey-tailed Tattler T. brevipes, Terek Sandpiper T.terek, Ruddy Turnstone Arenaria interpres, Pied Oystercatcher Haematopus longirostris (resident); Oriental Pratincole Glareola maldivarum, Black-winged Stilt Himantopus himantopus (resident) and Great Egret Adea alba (resident). This criterion was met at the date of listing and continues to be met.

Table 4-27 lists the three Ramsar listing criteria met for Hosnies Spring Ramsar site.

Table 4-27: Criteria met for Hosnies Spring Ramsar site (Hale and Butcher, 2010)

Number	Basis	Description
Group A of the Criteria. Sites containing representative, rare or unique wetland types		
1		Christmas Island represents the only land mass within the Christmas Island Province and the wetlands associated with Hosnies Spring, particularly the spring system and mangrove stand are unique in a bioregional (and in fact broader) context. As such Hosnies Spring Ramsar site met this criterion at the time of listing and continues to do so.
Group B of the Criteria. Sites of international importance for conserving biological diversity		
3	Species and ecological communities	The mangrove forest present at the site is unique within the bioregion and possibly worldwide. The stand comprises of two species; Bruguiera gymnorhiza and B. sexangula, both of which usually occur in intertidal zones. However, at Hosnies Spring the trees are located at the spring some 120 metres inland and 37 metres above sea level. It is thought that the stand is a relict of

		times when the site was inundated by the sea more than 120 000 years ago (Woodroffe 1988). This criterion was met at the time of listing and continues to be met.
4	Species and ecological communities	Hosnies Spring is one of a small number of permanent water sources on Christmas Island and one of even fewer water sources that have not been directly tapped for human consumption. The site is important for the blue crab (Discoplax hirtipes), which is reliant on the freshwater provided by the spring to maintain respiratory function (Hicks *et al.,* 1984). There is also anecdotal evidence that the site provides important dry season refuge for terrestrial species of birds, mammals and reptiles (Mike Misso, Parks Australia, pers. comm.). The expanded site provides a connection from the plateau to the ocean and as such is a migratory route for red crabs during breeding migrations. This criterion was met at the time of listing and continues to be met.

Table 4-28 lists the seven Ramsar listing criteria met for Roebuck bay Ramsar site.

Table 4-28: Criteria met for Roebuck Bay Ramsar site (Bennelongia, 2009)

Number	Basis	Description
Group A of the Criteria. Sites containing representative, rare or unique wetland types		
1		The site is a superb example of a tropical marine embayment within the Northwest (IMCRA) bioregion. It is one of only a dozen intertidal flats worldwide where benthic food sources are found in sufficient densities that they regularly support internationally significant numbers of waders.
Group B of the Criteria. Sites of international importance for conserving biological diversity		
2	Species and ecological communities	Loggerhead Turtles *Caretta caretta* (nationally endangered) and Green Turtles *Chelonia mydas* (nationally vulnerable) regularly use the site as a seasonal feeding area and as a transit area on migration. Flatback Turtles *Natator depressus* (nationally vulnerable) regularly nest in small numbers around Cape Villaret during the summer months. Sawfish *Pristis clavata* (nationally endangered) regularly use the tidal creeks and mangrove areas for breeding and refuge.
3	Species and ecological communities	The site supports a significant component of the regional (Northwest IMCRA bioregion) intertidal and shallow marine biodiversity in terms of the marine mammals (Dugong, turtles and dolphin), marine invertebrate infauna, and avian fauna across the site. The total density of macrobenthic animals (1,287 individuals/m^2) is high by global standards for a tropical mudflat and species richness is very high (estimated to be between 300 - 500 species).
4	Species and ecological communities	The site is one of the most important migration stopover areas for shorebirds both in Australia and globally. It is the arrival and departure point for large proportions of the Australian populations of several shorebird species, notably Bar-tailed Godwit *Limosa lapponica* and Great Knot *Calidris tenuirostris*. The site provides essential energy replenishment for many migrating species, some of which fly non-stop between continental East Asia and Australia.

5	Waterbirds	The site regularly supports over 100,000 waterbirds. The highest number of shorebirds counted at the site was 170,915 in October 1983 and allowing for turnover, the total number of shorebirds using the site may exceed 300,000 annually. It is the fourth most important site for waders in Australia in terms of absolute numbers and the most important in terms of the number of species it supports in internationally significant numbers (see Criterion 6).
6	Waterbirds	The site regularly supports 1% of the population of at least 22 wader species (20 migratory and 2 resident species): Large Sand Plover Charadrius leschenaultii, Oriental Plover C. veredus, Mongolian Plover C. mongolus, Red-capped Plover C. ruficapillus (resident), Grey Plover Pluvialis squatarola, Bar-tailed Godwit Limosa lapponica, Black-tailed Godwit L. limosa, Red Knot Calidris canutus, Great Knot C. tenuirostris, Red-necked Stint C. ruficollis, Curlew Sandpiper C. ferruginea, Sanderling C. alba, Eastern Curlew Numenius madagascariensis, Little Curlew N. minutus, Whimbrel N. phaeopus, Greenshank Tringa nebularia, Common Redshank T. totanus, Grey-tailed Tattler T. brevipes, Terek Sandpiper T. terek, Ruddy Turnstone Arenaria interpres, Asian Dowitcher Limnodromus semipalmatus, and Pied Oystercatcher Haematopus longirostris (resident).
8	Fish	The site is important as a nursery and/or breeding and/or feeding ground for at least five species of fish and for mudcrabs and prawns. The site‟s mangal system is particularly important as a nursery area for marine fishes and prawns.

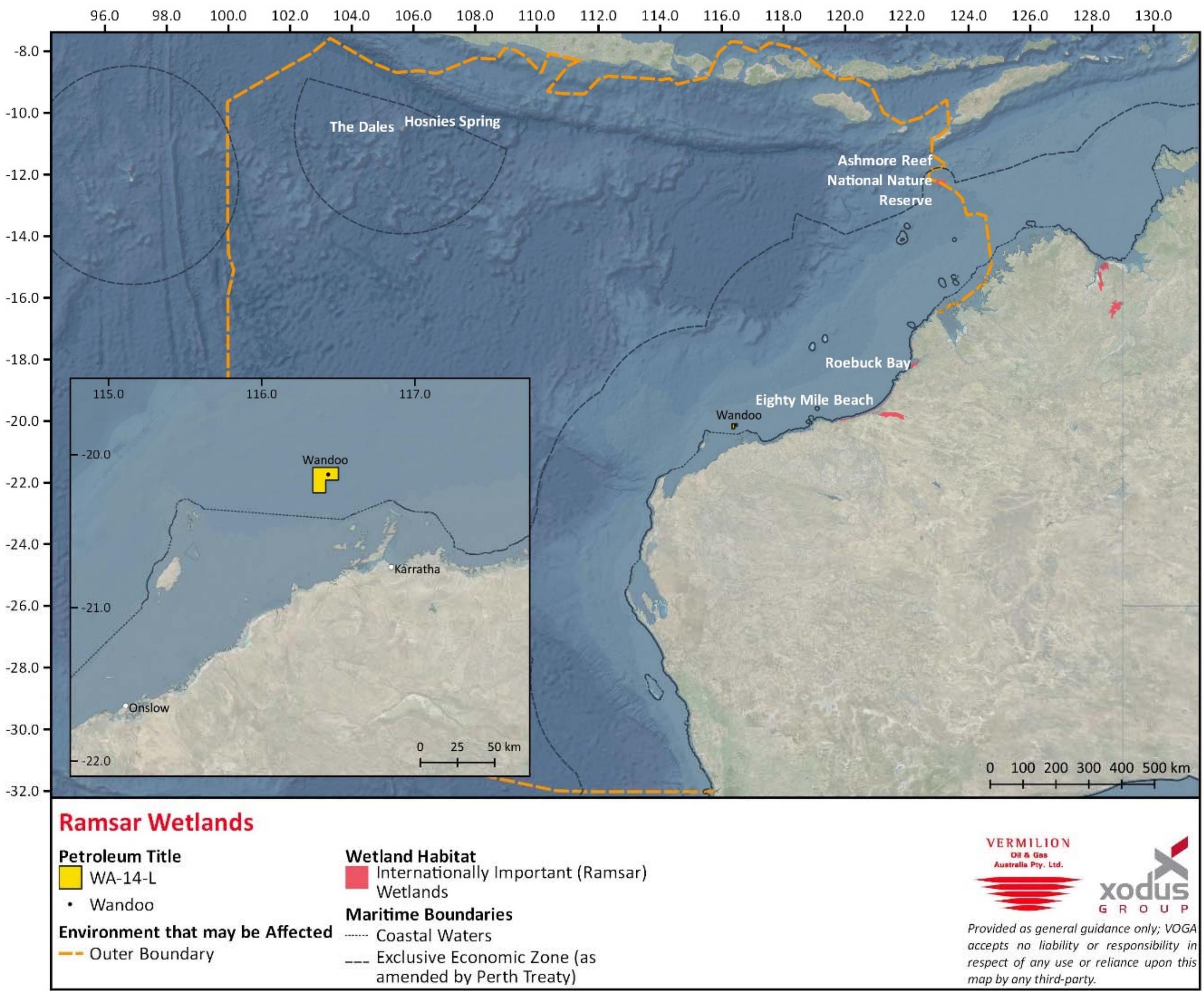


Figure 4-26: Ramsar Wetlands

4.3.6.5 *Key ecological features*

Key Ecological Features (KEFs) have been identified through the marine bioregional planning process and are described as those parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of a Commonwealth Marine Area (DEWHA, 2008).

Within the EMBA, 18 KEFs have been identified; 11 within the North-west Marine Region, and seven within the South-west Marine Region (Figure 4-27). Nine of these KEFs occur within the Hydrocarbon Area. The closest KEFs to the Operational Area are the 'Glomar Shoals' (approx. 37 km northeast) and the 'ancient coastline at 125 m depth contour' (approx. 53 km north) (Figure 4-27 and Table 4-29).

The importance and values have been identified for each of the KEFs within the SPRAT database (DoEE, 2019) and are summarised in Table 4-30.

Table 4-29 Key ecological features within the Project Areas

Receptor Group	Operational Area	Hydrocarbon Area-In Water	Hydrocarbon Area-Shoreline	EMBA
Ancient coastline at 125 m depth contour	x	✓	x	✓
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	x	x	x	✓
Canyons linking the Argo Abyssal Plain with the Scott Plateau	x	x	x	✓
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	x	✓	x	✓
Commonwealth waters adjacent to Ningaloo Reef	x	✓	x	✓
Continental Slope Demersal Fish Communities	x	✓	x	✓
Exmouth Plateau	x	✓	x	✓
Glomar Shoals	x	✓	x	✓
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	x	✓	✓	✓
Seringapatam Reef and Commonwealth waters in the Scott Reef complex	x	x	✓	✓
Wallaby Saddle	x	x	x	✓
Ancient coastline at 90-120m depth	x	x	x	✓
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	x	x	x	✓
Commonwealth marine environment within and adjacent to the west coast inshore lagoons	x	x	x	✓
Meso-scale Eddies	x	✓	x	✓
Perth Canyon and adjacent shelf break, and other west coast canyons	x	x	x	✓
Western demersal slope and associated fish	x	x	x	✓
Western rock lobster	x	x	x	✓

✓ = Present within Area, x = Not present within area

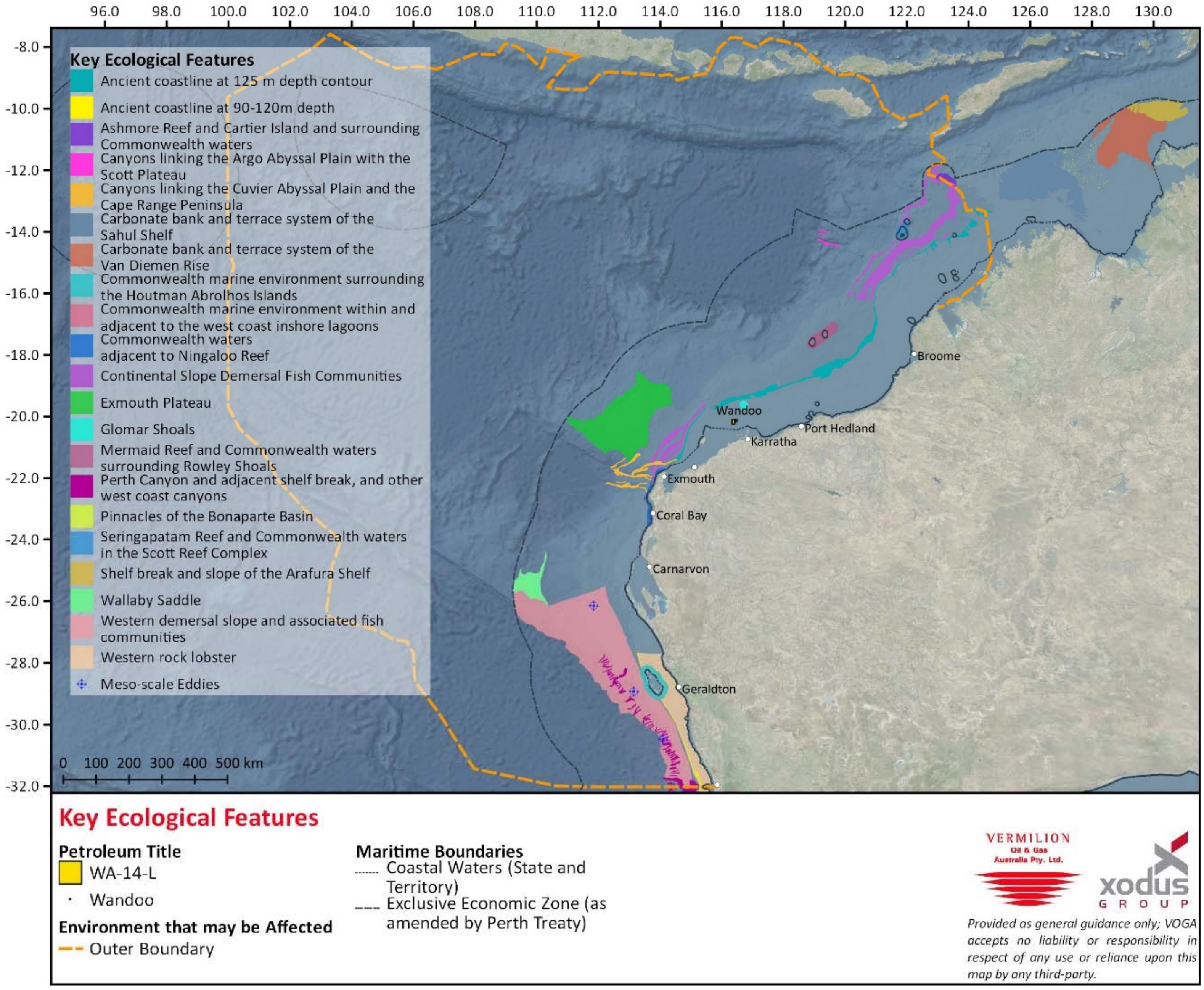


Figure 4-27: Key Ecological Features

Table 4-30: Importance and Values of Key Ecological Features

North-west Marine Region
Ancient coastline at 125m depth contour
National and/or regional importance The ancient coastline at 125 m depth contour is defined as a key ecological feature as it is a unique seafloor feature with ecological properties of regional significance. **Location** The shelf of the North-west Marine Region contains several terraces and steps which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs as an escarpment along the NWS and Sahul Shelf at a depth of 125 m. The spatial boundary of this KEF is defined by depth range 115–135 m in the Northwest Shelf Province and Northwest Shelf Transition IMCRA provincial bioregions. **Description and values**

The ancient submerged coastline provides areas of hard substrate and therefore may provide sites for higher diversity and enhanced species richness relative to surrounding areas of predominantly soft sediment. Little is known about fauna associated with the hard substrate of the escarpment, but it is likely to include sponges, corals, crinoids, molluscs, echinoderms and other benthic invertebrates representative of hard substrate fauna in the NWS bioregion.

The escarpment may also facilitate increased availability of nutrients off the Pilbara by interacting with internal waves and enhancing vertical mixing of water layers. Enhanced productivity associated with the sessile communities and increased nutrient availability may attract larger marine life such as whale sharks and large pelagic fish.

Humpback whales appear to migrate along the ancient coastline, using it as a guide to move through the region.

Ashmore Reef and Cartier Island and surrounding Commonwealth waters

National and/or regional importance

Ashmore Reef and Cartier Island and surrounding Commonwealth waters are defined as a key ecological feature for their high productivity, biodiversity and aggregations of marine life, which apply to both benthic and pelagic habitats.

Location

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf. They form part of a series of submerged reef platforms along the outer edge of the continental slope of the North-west Marine Region.

Ashmore contains a large reef shelf, two large lagoons, several channelled carbonate sand flats, shifting sand cays, an extensive reef flat, three vegetated islands—East, Middle and West islands—and surrounding waters. Rising from a depth of more than 100 m, the reef platform is at the edge of the North West Shelf and covers an area of 239 km². Ashmore Reef Commonwealth Marine Reserve encloses an area of about 583 km² of seabed.

Cartier Island Commonwealth Marine Reserve (Cartier) is located in the West Sahul region of the Indian Ocean. The island is about 350 km off Australia's Kimberley coast, 115 km south of the Indonesian island of Roti and 45 km south-east of Ashmore Reef Commonwealth Marine Reserve. Cartier Island Commonwealth Marine Reserve covers 167 km² and contains one unvegetated sand cay and mature reef flat with two shallow pools to the north-east of the cay.

Description and values

Ashmore Reef is the largest of only three emergent oceanic reefs in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. Ashmore Reef supports the highest number of coral species of any reef off the Western Australian coast and provide varied habitat that attracts a diverse range of primary and secondary consumers, including a particularly diverse fish fauna. Toothed whales, dolphins and whale sharks are found in the Commonwealth waters around these reefs, as is a genetically distinct dugong population at Ashmore Reef.

The marine habitats among the reefs are nationally and internationally significant supporting diverse and abundant marine reptile populations. Both Ashmore and Cartier reefs support highly diverse and internationally significant sea snake populations. Ashmore Reef and Cartier Island also support a genetically distinct breeding population of green turtles and provide foraging grounds for this species as well as for loggerhead and hawksbill turtles. The reef system is an important staging post for seabirds and migratory shorebirds and the area is home to some of the most important seabird colonies in the North-west Marine Region. The importance of Ashmore Reef for seabirds and shorebirds is reflected in its listing as a Ramsar Wetland of International Importance in 2003.

Canyons linking the Argo Abyssal Plain with the Scott Plateau

National and/or regional importance

The Canyons linking the Argo Abyssal Plain with the Scott Plateau are defined as a KEF for their high productivity and aggregations of marine life. These values apply to both the benthic and pelagic habitats within the feature.

Location

The spatial boundary of this KEF includes the three canyons adjacent to the south-west corner of Scott Plateau. The Bowers and Oates canyons are the largest canyons connecting the Scott Plateau with the Argo Abyssal Plain; they are situated in the Timor Province (IMCRA provincial bioregion), west of Scott Reef.

Description and values

The Bowers and Oats canyons are major canyons on the slope between the Argo Abyssal Plain and Scott Plateau. The canyons cut deeply into the south-west margin of the Scott Plateau at a depth of approx. 2,000–3,000 m, and act as conduits for transport of sediments to depths of more than 5,500 m on the Argo Abyssal Plain. Benthic communities at these depths are likely to be dependent on particulate matter falling from the pelagic zone to the sea floor.

The water masses at these depths are deep Indian Ocean water on the Scott Plateau and Antarctic bottom water on the Argo Abyssal Plain; both water masses are cold, dense and nutrient-rich. The ocean above the canyons may be an area of moderately enhanced productivity, attracting aggregations of fish and higher-order consumers such as large predatory fish, sharks, toothed whales and dolphins.

The canyons linking the Argo Abyssal Plain and Scott Plateau are likely to be important features due to their historical association with sperm whale aggregations. Noting that the reasons for these historical aggregations of marine life remains unclear.

Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula

National and/or regional importance

The Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula are defined as a key ecological feature as they are unique seafloor features with ecological properties of regional significance, which apply to both the benthic and pelagic habitats within the feature.

Location

The largest canyons on the slope linking the Cuvier Abyssal Plain and Cape Range Peninsula are the Cape Range Canyon and Cloates Canyon which are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef. The canyons are unusual because their heads are close to the coast of North West Cape.

Description and values

The canyons on the slope of the Cuvier Abyssal Plain and Cape Range Peninsula are connected to the Commonwealth waters adjacent to Ningaloo Reef, and may also have connections to Exmouth Plateau. The canyons are thought to interact with the Leeuwin Current to produce eddies inside the heads of the canyons, resulting in waters from the Antarctic intermediate water mass being drawn into shallower depths and onto the shelf; these waters are cooler and richer in nutrients and strong internal tides may also aid upwelling at the canyon heads. The narrow shelf width (approx. 10 km) near the canyons facilitates nutrient upwelling and this nutrient-rich water interacts with the Leeuwin Current at the canyon heads. Aggregations of whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds are known to occur in this area and are related to productivity.

The canyons, Exmouth Plateau and Commonwealth waters adjacent to Ningaloo Reef operate as a system to create the conditions for enhanced productivity seen in this region.

Commonwealth waters adjacent to Ningaloo Reef

National and/or regional importance

The Commonwealth waters adjacent to Ningaloo Reef are defined as a KEF for their high productivity and aggregations of marine life, which apply to both the benthic and pelagic habitats.

Location

Ningaloo Reef extends >260 km along Cape Range Peninsula with a landward lagoon 0.2–6 km wide. Seaward of the reef crest, the reef drops gently to depths of 8–10 m; the waters reach 100 m depth, 5–6 km beyond the reef edge. Commonwealth waters over the narrow shelf (10 km at its narrowest) and shelf break are contiguous with Ningaloo Reef and connected via oceanographic and trophic cycling.

Description and values

Ningaloo reef is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent; it is also globally significant as a seasonal aggregation site for whale sharks. The Commonwealth waters adjacent to Ningaloo Reef and associated canyons and plateau are interconnected and support the high productivity and species richness of Ningaloo Reef. The Leeuwin and Ningaloo currents interact on the seaward side of the reef, leading to areas of enhanced productivity which support aggregations and migration pathways of whale sharks, manta rays, humpback whales, seasnakes, sharks, large predatory fish and seabirds. Detrital input from phytoplankton production in surface waters and from higher-trophic consumers cycles back to the deeper waters of the shelf and slope. Deepwater biodiversity includes fish, molluscs, sponges, soft corals and gorgonians. Some of these sponge and filter-feeding communities appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters of Ningaloo Marine Park have some areas of potentially high and unique sponge biodiversity.

The outer reef is marked by a well-developed spur and groove system of fingers of coral formations penetrating the ocean with coral sand channels in between. The spurs support coral growth, while the grooves experience strong scouring surges and tidal run-off and have little coral growth.

Continental slope demersal fish communities

National and/or regional importance

This species assemblage is recognised as a key ecological feature because of its biodiversity values, including high levels of endemism.

Location

This KEF is defined as the area of slope found in the Northwest Province and Timor Province provincial bioregions, at the depth ranges of 220-500 m and 750-1,000 m.

Description and values

The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the Northwest Province is high compared to elsewhere along the Australian continental slope. The continental slope between North West Cape and the Montebello Trough has >500 fish species, 76 of which are endemic, which makes it the most diverse slope bioregion in Australia. The slope of the Timor Province and the Northwest Transition also contains >500 species of demersal fish of which 64 are considered endemic. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope.

The demersal fish species occupy two distinct demersal community types (biomes) associated with the upper slope (water depth of 225–500 m) and the mid-slope (750–1,000 m). Although poorly known, it is suggested that the demersal-slope communities rely on bacteria and detritus-based systems comprised of infauna and epifauna, which in turn become prey for a range of teleost fish, molluscs and crustaceans. Higher-order consumers may include carnivorous fish, deepwater sharks, large squid and toothed whales. Pelagic production is phytoplankton based, with hot spots around oceanic reefs and islands.

Bacteria and fauna present on the continental slope are the basis of the food web for demersal fish and higher-order consumers in this system. Loss of benthic habitat along the continental slope at depths known to support demersal fish communities may lead to a decline in species richness, diversity and endemism associated with this feature.

Exmouth Plateau

National and/or regional importance

The Exmouth Plateau is defined as KEF as it is a unique seafloor feature with ecological properties of regional significance, which apply to both the benthic and pelagic habitats.

Location

The Exmouth Plateau is located in the Northwest Province and covers an area of 49,310 km² in water depths of 800–4,000 m.

Description and values

Although the seascapes of this plateau are not unique, it is believed that the large size of Exmouth Plateau and its expansive surface may modify deep-water flow and be associated with the generation of internal tides; both of these features may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface. The topography of the plateau (with valleys and channels), in addition to potentially constituting a range of benthic environments, may provide conduits for the movement of sediment and other material from the plateau surface through the deeper slope to the abyss.

The Exmouth Plateau is generally an area of low habitat heterogeneity; however, it is likely to be an important area of biodiversity as it provides an extended area offshore for communities adapted to depths of around 1,000 m. Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna.

The plateau's surface is rough and undulating; the northern margin is steep and intersected by large canyons (e.g. Montebello and Swan canyons), the western margin is moderately steep and smooth and the southern margin is gently sloping and virtually free of canyons. Satellite observations suggest that productivity is enhanced along the northern and southern boundaries of the plateau and along the shelf edge, which in turn suggests that the plateau is a significant contributor to the productivity of the region.

Whaling records from the 19th century suggest that the Exmouth Plateau may have supported large populations of sperm whales.

Glomar Shoals

National and/or regional importance

The Glomar shoals are defined as a KEF for their high productivity and aggregations of marine life.

Location

The Glomar Shoals are a submerged littoral feature located approx. 150 km north of Dampier on the Rowley Shelf at depths of 33–77 m.

Description and values

While the biodiversity associated with the Glomar Shoals has not been studied, the shoals are known to be an important area for a number of commercial and recreational fish species such as rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish. These species have recorded high catch rates associated with the Glomar Shoals, indicating that the shoals are likely to be an area of high productivity.

The shoals consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells. The area's higher concentrations of coarse material in comparison to surrounding areas are indicative of a high-energy environment subject to strong sea-floor currents. Cyclones are also frequent in this area and stimulate periodic bursts of productivity as a result of increased vertical mixing.

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals

National and/or regional importance

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals is defined as a KEF for its enhanced productivity and high species richness, that apply to both the benthic and pelagic habitats.

Location

The Rowley Shoals are a collection of three atoll reefs (Clerke, Imperieuse and Mermaid) which are located approx. 300 km northwest of Broome. The KEF encompasses Mermaid Reef MP as well as waters from 3–6 nm surrounding Clerke and Imperieuse reefs.

Mermaid Reef lies approx. 29 km north of Clerke and Imperieuse reefs and is totally submerged at high tide. Mermaid Reef falls under Commonwealth jurisdiction; while the Clerke and Imperieuse reefs are within the Rowley Shoals Marine Park and under State jurisdiction.

Description and values

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals are regionally important in supporting high species richness, higher productivity and aggregations of marine life associated with the adjoining reefs. The Rowley Shoals contain 214 coral species, approx. 530 species of fish, 264 species of molluscs and 82 species of echinoderms; no seasnakes are known to occur.

The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the northwest. They have steep and distinct reef slopes and associated fish communities Enhanced productivity is thought to be facilitated by the breaking of internal waves in the waters surrounding the reefs, causing mixing and resuspension of nutrients from water depths of 500–700 m into the photic zone. The steep changes in slope around the reef also attract a range of migratory pelagic species including dolphins, tuna, billfish and sharks.

Rowley Shoals' reefs are different from other reefs in the chain of reefs on the outer shelf of the North-west Marine Region, both in structure and genetic diversity. There is little connectivity between Rowley Shoals and other outer-shelf reefs. Both coral communities and fish assemblages of Rowley Shoals differ from similar habitats in eastern Australia. In evolutionary terms, the reefs may play a role in supplying coral and fish larvae to reefs further south via the southward flowing Indonesian Throughflow.

Seringapatam Reef and Commonwealth waters in the Scott Reef complex

National and/or regional importance

Seringapatam Reef and Commonwealth waters in the Scott Reef complex are defined as a KEF as they support diverse aggregations of marine life, have high primary productivity relative to other parts of the region, are relatively pristine and have high species richness, which apply to both the benthic and pelagic habitats.

Location

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 m depth on the northwest continental slope within the Timor Province. Scott and Seringapatam reefs provide an important biophysical environment in the region as one of few offshore reefs in the northwest.

Scott Reef consists of two separate reef formations, North Reef and South Reef. The KEF encompasses the waters beyond 3 nm at South Scott Reef and the reefs and surrounding waters at North Scott and Seringapatam reefs. The total area of the KEF is approximately 2,418 km^2.

Description and values

Seringapatam Reef and Commonwealth waters in the Scott Reef complex are regionally important in supporting the diverse aggregations of marine life, high primary productivity and high species richness associated with the reefs themselves. As two of the few offshore reefs in the northwest, they provide an important biophysical environment in the region.

The coral communities at Scott and Seringapatam reefs play a key role in maintaining the species richness and subsequent aggregations of marine life. Scott Reef is a particularly biologically diverse system and includes >300 species of reef-building corals, approx. 400 mollusc species, 118 crustacean species, 117 echinoderm species and approx. 720 fish species. Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals. Recent studies suggest that the capacity for coral dispersal between Scott Reef and other offshore reefs in the region may be limited

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales (on their northerly migration) and numerous other cetacean species, whale sharks and several species of seasnake. Two species of marine turtle (green and hawksbill) nest during the summer months on Sandy Islet (South Scott Reef); the turtles also internest and forage in the surrounding waters. This KEF also provides foraging areas for seabird species such as the lesser frigatebird, wedge-tailed shearwater, brown booby and roseate tern.

Aggregations of marine life, high primary productivity and species richness on the reefs and in the surrounding Commonwealth waters are likely due to the steep rise of the reef from the seabed. This causes nutrient-rich waters from below the thermocline (approx. 100 m) to mix with the warmer, relatively nutrient-poor tropical surface waters via the action of internal waves and from mixing and higher productivity in the lee of emergent reefs.

Wallaby Saddle

National and/or regional importance

Wallaby saddle is defined as a KEF for its high productivity and aggregations of marine life; these values apply to both the benthic and pelagic habitats.

Location

The Wallaby Saddle covers 7,880 km² of seabed and is an abyssal geomorphic feature that connects the northwest margin of the Wallaby Plateau with the margin of the Carnarvon Terrace on the upper continental slope at a depth of 4,000–4,700 m.

Description and values

The Wallaby Saddle is regionally important in that it represents almost the entire area of this type of geomorphic feature in the North-west Marine Region. The Wallaby Saddle is located within the Indian Ocean water mass and is thus differentiated from systems to the north that are dominated by transitional fronts or the Indonesian Throughflow. Little is known about the Wallaby Saddle; however, the area is considered one of enhanced productivity and low habitat diversity.

Historical sperm whale aggregations in the area of Wallaby Saddle may be attributable to higher productivity and aggregations of baitfish.

South-west Marine Region

Ancient coastline at 90–120 m depth

National and/or regional importance

The Ancient coastline between 90–120 m depth is defined as a key ecological feature for its potential high productivity and aggregations of marine life, biodiversity and endemism. Both benthic habitats and associated demersal communities are of conservation value.

Location

The continental shelf of the South-west Marine Region contains several terraces and steps. A prominent escarpment occurs close to the middle of the continental shelf at a depth of approximately 90–120 m.

Description and values

The continental shelf of the South-west Marine Region contains several terraces and steps which reflect the gradual increase in sea level across the shelf that occurred over the past 12,000 years. Some of these occur as escarpments, although their elevation and distinctness vary throughout the region. Where they are prominent, they create topographic complexity; for example, through exposure of rocky substrates that may facilitate small, localised upwellings, benthic biodiversity and enhanced biological productivity.

While the ancient coastline is present throughout the region, it is particularly evident in the Great Australian Bight, where it provides complex habitat for a number of species.

Parts of this ancient coastline may support some demersal fish species travelling across the continental shelf to the upper continental slope, thereby supporting ecological connectivity. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment of exposed hard substrates.

Commonwealth marine environment surrounding the Houtman Abrolhos Islands

National and/or regional importance

The Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break) is defined as a KEF for its high levels of biodiversity and endemism in benthic and pelagic habitats.

Location

The Houtman Abrolhos Islands are a complex of 122 islands and reefs located at the edge of the continental shelf, approx. 60 km offshore from the Mid West coast of WA.

Description and values

The Houtman Abrolhos waters and reefs are noted for their high biodiversity and mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The area represents the southern limit in WA of many widespread Indo-Pacific tropical fish. The islands are the largest seabird breeding station in the eastern Indian Ocean, supporting

more than one million pairs of breeding seabirds, including sedentary and migratory species. Many of the islands' biodiversity features rely on the benthic and pelagic ecosystems in deeper, offshore waters; most notably, seabirds and rock lobster. The Houtman Abrolhos Islands lie in a transitional zone between major marine biogeographic provinces: the warm, tropical water of the Leeuwin Current and colder water more typical of the islands' latitude. The Leeuwin Current allows the Houtman Abrolhos Islands to support the highest-latitude coral reefs in the Indian Ocean. The reefs are composed of 184 known species of coral that support approx. 400 species of demersal fish, 492 species of molluscs, 110 species of sponges, 172 species of echinoderms and 234 species of benthic algae. In addition, the area provides important habitat for rock lobsters (*Panulirus cygnus*). The surrounding Commonwealth marine environment is also recognised as an important resting area for migrating humpback whales. The islands are the northernmost breeding site of the Australian sea lion, although sea lions are not thought to be an important component of this ecosystem because of their low population numbers.
Commonwealth marine environment within and adjacent to the west coast inshore lagoons
National and/or regional importance The Commonwealth marine environment within and adjacent to the west-coast inshore lagoons is defined as a KEF for its high productivity and aggregations of marine life. Both benthic and pelagic habitats within the feature are of conservation value. **Location** The spatial boundary of this KEF is based on waters <30 m depth, in Commonwealth waters, from Kalbarri to slightly south of Mandurah. **Description and values** A chain of inshore lagoons extends along the WA coast from south of Mandurah to Kalbarri. The lagoons are formed by distinct ridges of north–south oriented limestone reef with extensive beds of macroalgae (principally *Ecklonia* spp.) and extend to a depth of 30 m. Although macroalgae and seagrass appear to be the primary source of production, it is suggested that groundwater enrichment may supplement the supply of nutrients to the lagoons. Seagrass provides important habitat for many marine species, and epiphytes are the main food source in the lagoonal system. The lagoons are associated with high biodiversity and endemism, containing a mix of tropical, subtropical and temperate flora and fauna. The area includes breeding and nursery aggregations for many temperate and tropical marine species. They are important areas for the recruitment of commercially and recreationally important fishery species; extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon. The mix of sheltered and exposed seabeds form a complex mosaic of habitats. The inshore lagoons are important areas for the recruitment of western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone and many other reef species.
Meso-scale eddies
National and/or regional importance Meso-scale eddies are defined as pelagic KEF for their high productivity and aggregations of marine life. **Location** Eddies and eddy fields form at predictable locations off the western and south-western shelf break: southwest of Shark Bay; offshore of the Houtman Abrolhos Islands; southwest of Jurien Bay; Perth Canyon; southwest of Cape Leeuwin; and south of Albany, Esperance and the Eyre Peninsula. **Description and values** Driven by interactions between currents and bathymetry, persistent meso-scale eddies form regularly (three to nine eddies per year) within the meanders of the Leeuwin Current. These features range between 50–200 km in diameter and typically last more than five months. Meso-scale eddies are important food sources, particularly for mesozooplankton, given the broader region's nutrient-poor conditions, and they become prey hotspots for a complex range of higher trophic-

level species. Meso-scale eddies and seasonal upwellings have a significant impact on the regional production patterns.

The meso-scale eddies of this region are important transporters of nutrients and plankton communities, taking them far offshore into the Indian Ocean, where they are consumed by oceanic communities. They are likely to attract a range of organisms from the higher trophic levels, such as marine mammals, seabirds, tuna and billfish. The eddies play a critical role in determining species distribution, as they influence the southerly range boundaries of tropical and subtropical species, the transport of coastal phytoplankton communities offshore and recruitment to fisheries.

Perth Canyon and adjacent shelf break, and other west coast canyons

National and/or regional importance

The Perth Canyon forms a major biogeographical boundary and it is defined as a KEF because it is an area of higher productivity that attracts feeding aggregations of deep-diving mammals and large predatory fish. It is also recognised as a unique seafloor feature with ecological properties of regional significance.

Location

The west coast system of canyons spans an extensive area (8,744 km²) of continental slope offshore from Kalbarri to south of Perth. It includes the Geographe, Busselton, Pelsaert, Geraldton, Wallaby, Houtman and Murchison canyons and, most notably, the Perth Canyon (offshore of Rottnest Island), which is Australia's largest ocean canyon.

Description and values

The Perth Canyon is prominent among the west coast canyons because of its magnitude and ecological importance; however, the sheer abundance of canyons spread over a broad latitudinal range makes this feature important.

In the Perth Canyon, interactions between the canyon topography and the Leeuwin Current induce clockwise-rotating eddies that transport nutrients upwards in the water column from greater depths. Due to the canyon's depth and the Leeuwin Current's barrier effect, this remains a subsurface upwelling (depths >400 m), which confers ecological complexity that is typically absent from canyon systems in other areas. The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs.

The Perth Canyon marks the southern boundary of the Central Western Province. Deep ocean currents upwelling in the canyon create a nutrient-rich, cold-water habitat that attracts deep-diving mammals and large predatory fish, which feed on small fish, krill and squid. A number of cetaceans, predominantly pygmy blue whales, aggregate in the canyon during summer to feed on the prey aggregations. Arriving from November onwards, their numbers peak in March to May. The topographical complexity of the canyon is also believed to provide more varied habitat that supports higher levels of epibenthic biodiversity than adjacent shelf areas.

Western demersal slope and associated fish communities

National and/or regional importance

The demersal slope and associated fish communities are recognised as a KEF for their high levels of biodiversity and endemism.

Location

This KEF extends from the edge of the shelf to the limit of the exclusive economic zone, between Perth and the northern boundary of the South-west Marine Region.

Description and values

The western continental slope provides important habitat for demersal fish communities. In particular, the continental slope of the Central Western provincial bioregion supports demersal fish communities characterised by high diversity compared with other, more intensively sampled, oceanic regions of the world. Its diversity is attributed to the overlap of ancient and extensive Indo-west Pacific and temperate Australasian fauna. Approx. 480 species of demersal fish inhabit the slope of this bioregion, and 31 of these are considered endemic to the bioregion.

A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the seafloor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits.
Western rock lobster
National and/or regional importance The Western rock lobster is defined as a KEF due to its presumed ecological role on the west coast continental shelf. **Location** The spatial boundary of this KEF includes Commonwealth waters in the South-west Marine Region, to a depth of 150 m, north of Cape Leeuwin. **Description and values** Western rock lobster (*Panulirus cygnus*) is the dominant large benthic invertebrate in this bioregion, and can be found north of Cape Leeuwin to a depth of 150 m. It is also an important part of the food web on the inner shelf, particularly as a juvenile, when it is preyed upon by octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper, wirrah cod and breaksea cod. Western rock lobsters are also particularly vulnerable to predation during seasonal moults in November–December and to a lesser extent during April–May. The high biomass of western rock lobsters and their vulnerability to predation suggest that they are an important trophic pathway for a range of inshore species that prey upon juvenile lobsters. As an abundant and wide-ranging consumer, the western rock lobster is likely to play an important role in ecosystem processes on the shelf waters in the region. The ecological role of western rock lobster is best understood in shallow waters (<10 m) where it can significantly reduce the densities of invertebrate prey, such as epifaunal gastropods, through its varied and highly adaptable diet. However, there is a lack of similar studies in deeper water (>20 m). The little information available for deep-water populations suggests that lobsters forage primarily on animal prey, which is dominated by crustaceans such as decapod crabs and amphipods.

4.3.6.6 *Threatened Ecological Communities*

The EPBC Act provides for the listing of threatened ecological communities (TECs), and these are considered as MNES under the EPBC Act. There are two coastal TECs that occur within the EMBA (Figure 4-28):

- Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula
- Subtropical and temperate coastal saltmarsh.

The Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula also occurring within shoreline Hydrocarbon Area.

Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula

The Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community represents certain occurrences of monsoon vine thickets in the southwest Kimberley region of Western Australia. The ecological community is predominantly restricted to the coast of the Dampier Peninsula (Figure 4-28) and represents the most southern occurrences of rainforest type vegetation in Western Australia.

The Dampier Monsoon Vine Thickets occurs as discontinuous patches of dense vegetation and contains approximately 23% of vascular plant species that occur on the Dampier Peninsula.

Dampier Monsoon Vine Thickets are considered a rainforest subset ranging from semi-deciduous vine thickets to closed semi-deciduous vine forest. The ecological community provides an important habitat for a number of plant species. For example, the vine *Parsonsia kimberleyensis* is at the southern-most limit of its range within the ecological community along with *Glycosmis* sp. and the deciduous shrub *Croton habrophyllus* (Kenneally *et al.,* 1996). The small tree, *Vitex glabrata* (bush currant) is only known to occur on the Dampier Peninsula in the ecological community (Black *et al.,* 2010).

Compared to the adjacent open vegetation occurring over the majority of the Dampier Peninsula, the relatively dense, closed canopy of the Dampier Monsoon Vine Thickets provides a shady and humid microclimate. This relatively moist environment provides refuge for animals particularly during the dry season when fires in the landscape are more frequent (Johnstone and Burbidge, 1991; Kendrick and Rolf, 1991; Price, 2004). The abundance of fruiting plants within the ecological community also provides relatively rich food resources for many taxa. No fauna are known to be endemic to the ecological community on a national scale, but some species are endemic at a regional level and many species occur both in the ecological community and surrounding vegetation types.

The Dampier Monsoon Vine Thickets contains habitat for at least four threatened fauna species listed under the EPBC Act and at least five threatened flora species listed under the WA Biodiveristy Conservation Act 2016. The National Heritage listing of West Kimberley overlaps within the northern end of the Dampier Peninsula; however, the Dampier Monsoon Vine Thicket patches are not part of the Heritage listed area.

Subtropical and Temperate Coastal Saltmarsh

The Subtropical and Temperate Coastal Saltmarsh ecological community occurs within a relatively narrow margin of the Australian coastline, within the subtropical and temperate climatic zones south of the South-east Queensland IBRA bioregion boundary at 23° 37' latitude along the east coast and south of (and including) Shark Bay at 26° on the west coast (DSEWPC 2013).

The physical environment for the ecological community is coastal areas under regular or intermittent tidal influence. In southern latitudes saltmarsh is often the main vegetation-type in the intertidal zone and commonly occurs in association with estuaries (Adam 2002; Fairweather 2011). It is typically restricted to the upper intertidal environment, occurring in areas within the astronomical tidal limit, often between the elevation of the mean high tide and the mean spring tide (Saintilan *et al.,* 2009).

The Coastal Saltmarsh ecological community consists mainly of salt-tolerant vegetation (halophytes) including: grasses, herbs, sedges, rushes and shrubs. Succulent herbs, shrubs and grasses generally dominate and vegetation is generally of less than 0.5 m height (with the exception of some reeds and sedges) (Adam 1990). Many species of non-vascular plants are also found in saltmarsh, including epiphytic algae, diatoms and cyanobacterial mats (Adam 2002; Fotheringham and Coleman 2008; Green *et al.,* 2012; Millar 2012).

The ecological community is inhabited by a wide range of infaunal and epifaunal invertebrates, and low-tide and high-tide visitors such as prawns, fish and birds (Adam, 2002; Saintilan and Rogers, 2013). It often constitutes important nursery habitat for fish and prawn species. The dominant marine residents are benthic invertebrates, including molluscs and crabs that rely on the sediments, vascular plants, and algae, as providers of food and habitat across the intertidal landscape (Ross *et al.,* 2009).

Small isolated patches of the subtropical and temperate coastal saltmarsh habitat have been mapped along the WA coast (Figure 4-28).

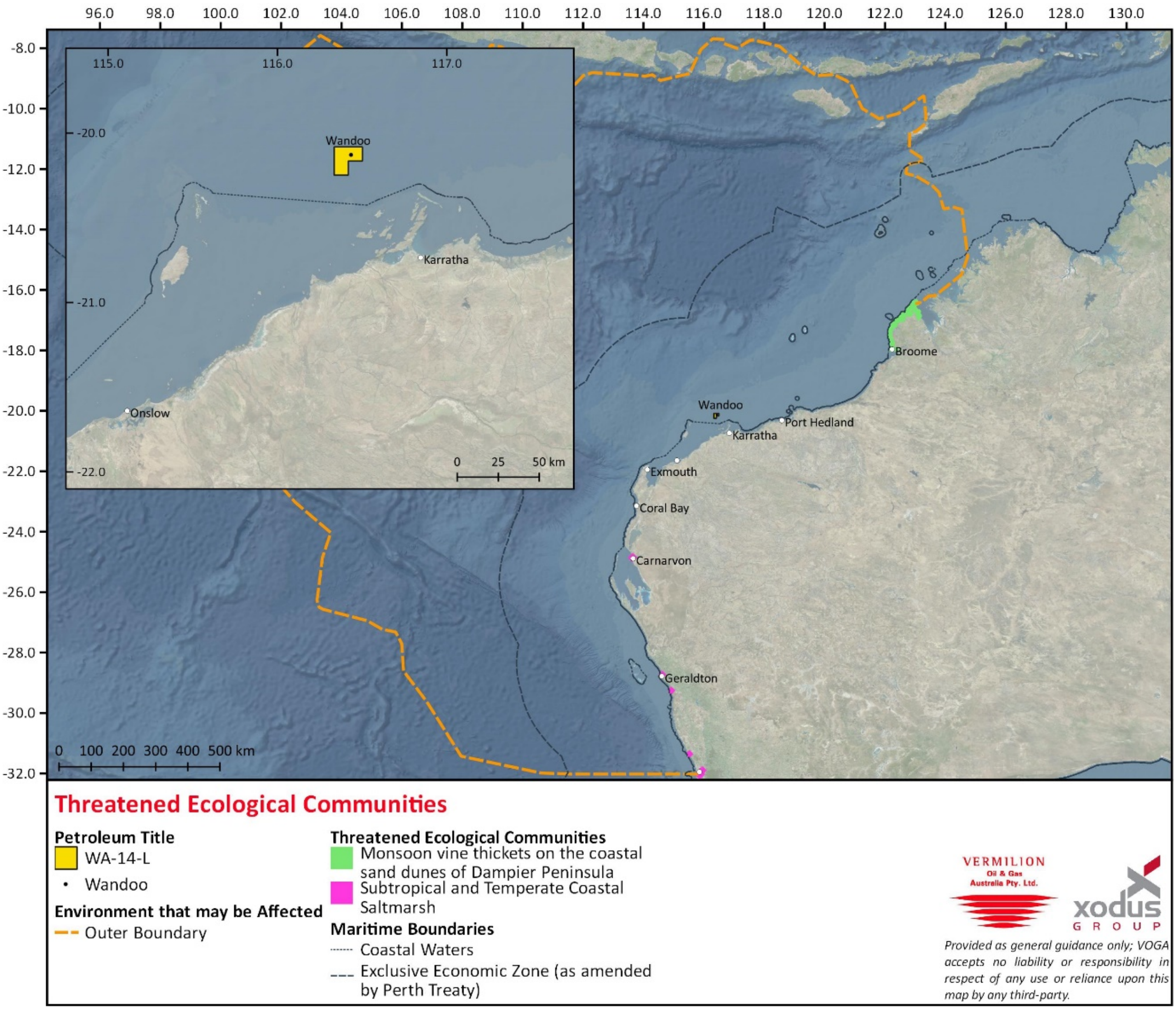


Figure 4-28: Threatened Ecological Communities

5 Risk assessment methodology

5.1 Overview

Environmental risk assessment is a key component of the environmental risk management process. Environmental risk is assessed by determining the consequence (impact) of an environmental hazard and the likelihood that the consequence will occur, taking consideration of both existing and additional proposed control measures.

Key terminology used in this section of the EP includes:

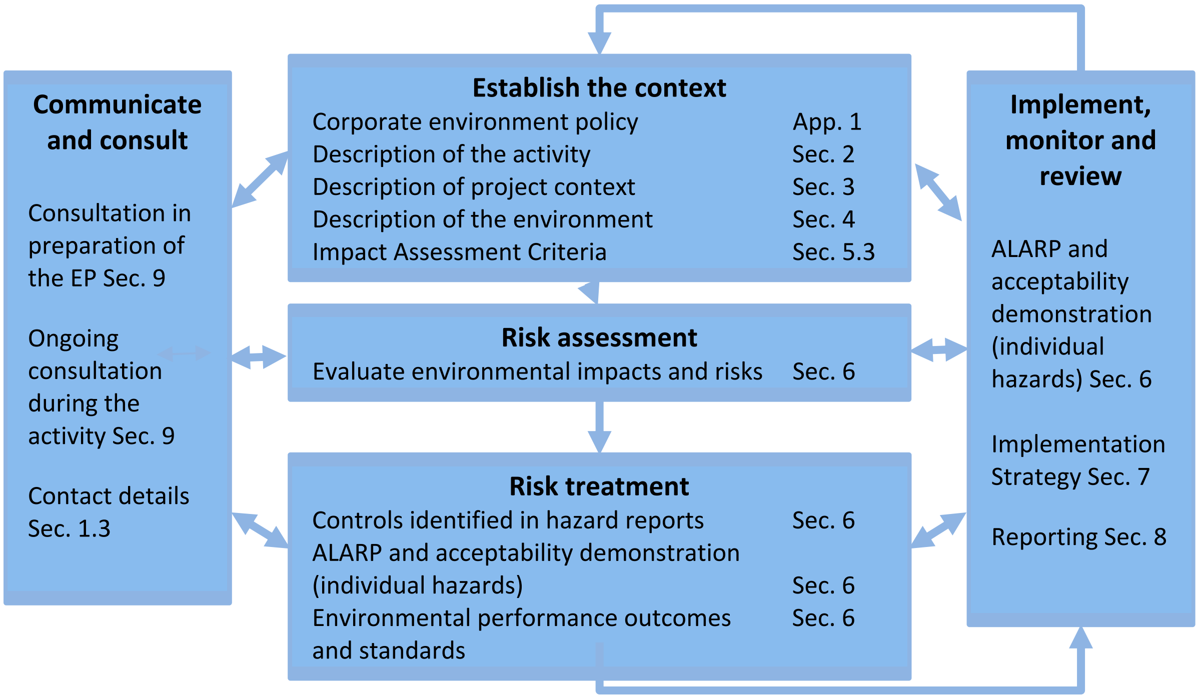
- **Acceptable:** a tolerable level of impact or risk (either quantitative or qualitative) when assessed in relation to the principles of Ecological Sustainable Development (ESD), internal and external contextual consideration and other relevant requirements (Section 5.5).
- **Activity:** An activity is a 'Petroleum Activity' as defined within sub-regulation 59C of the Offshore Petroleum and Greenhouse Gas Storage (Regulatory Levies) Regulations 2004. Specifically, in the context of this well construction EP, 'Activity' relates to a 'Drilling' activity.
- **ALARP:** A level of risk that is tolerable, where the cost of reducing it further (e.g. financial, time, effort) is grossly disproportionate to any risk reduction gained (as per VOGA Risk Management Manual VOG-2000-MN-0001). The methodology for demonstrating ALARP is described in further detail below (Section 5.8);
- **Catastrophic Environmental Event (CEE)**: any event which has an environmental impact ranked as "4 – Catastrophic" on the VOGA risk matrix (Section 5.3).
- **Cause:** The cause of a particular environmental impact. The cause may be an 'activity' or the cause could be an unplanned event, e.g. "vessel collision with facility";
- **Consequence ranking:** A measure of the severity of the environmental impact in accordance with the VOGA risk matrix (Section 5.3);
- **Control:** A means of reducing environmental risk by prevention, frequency reduction, or impact reduction. Controls take many forms including systems, procedures, people and equipment;
- **Critical Control:** a control that has a key role in preventing, detecting, controlling or mitigating a CEE (as assessed on the VOGA risk matrix [Section 5.4]).
- **Environment:** is and includes the social, economic and cultural features of:
  - ecosystems and their constituent parts, including people and communities; and
  - environmental assets such as:
    - natural and physical resources;
    - the qualities and characteristics of locations, places and areas; and
    - the heritage value of places.
- **Environmental hazard:** A situation with the potential for causing an environmental impact;

- **Environmental impact:** Any change to the environment arising from an environmental hazard;
- **Likelihood ranking:** A measure of the chance of an environmental impact occurring (expressed as an approximate frequency) in accordance with the VOGA risk matrix (Section 5.3);
- **Measurement criteria:** Tangible indicators, quantifiable where possible, that will be used to evaluate the achievement (or otherwise) of environmental performance standards and objectives;
- **Mitigation controls:** Controls which will be utilised in the event that the environmental hazard requires steps to be taken to return the activity and/or the environment to an acceptable state, i.e. consistent with the environmental objective;
- **Performance outcome:** A qualitative goal which summarises the objective of a control (or group of controls);
- **Performance standard:** A statement of the performance required of a control;
- **Preventive controls:** Controls which will prevent an environmental impact; and
- **Residual risk:** The residual risk rating taking into account the effectiveness and availability of controls (existing and additional).

5.2 Framework

The environmental risk assessment was undertaken in accordance with VOGA Risk Management Manual [VOG-2000-MN-0001] and in line with the requirements of the OPGGS(E)R. The framework adopted by VOGA in compiling this EP is consistent with the methodology described in AS/NZS ISO 31000 and NOPSEMA Guidance [N04750-GN1344]. Table 5-1 depicts this methodology with reference to relevant sections of this EP where the requirements are addressed.

Table 5-1: Content requirements of this EP (within the framework outlined in AS/NZS ISO 31000)



The scope of activities covered by this EP was confirmed in terms of its timing(s), extent, and the nature of the activities included within it. This scope is reflected in the activities described in Section 1.4.

Potential environmental hazards associated with activities and unplanned events were identified, and impacts determined in a qualitative manner in an environmental hazard review workshop. Existing controls were identified in the same workshop. Each hazard employs a hierarchy of controls which relies on the following (in order of preference):

- Elimination: Refers to the elimination of a hazard, for example the use of a renewable energy source eliminates the emissions associated with power generation;
- Substitution: This refers to scenarios where an alternative arrangement is used to reduce the risk levels. For example using a lower emission fuel type;
- Prevention: removing the causes of a particular impact or decrease their likelihood. As an example, a simpler plant with fewer leak points.
- Reduction: Limits the scale and consequence of a particular impact. For example, changes to process systems to reduce the size of hazardous inventories.
- Mitigation: Controls in place to respond to an incident, such as oil spill contingency planning.

In the case of complex or high hazard risks, environmental impact modelling was carried out to ensure that the impacts were thoroughly understood.

The severity, frequency, and subsequently the initial risk ranking was allocated to each hazard in accordance with the VOGA Risk Management Manual [VOG-2000-MN-0001]. The risk rankings were reviewed and additional controls were considered to reduce the residual risk to ALARP and acceptable levels.

The environmental performance outcomes, environmental performance standards and measurement criteria associated with the controls were developed in a series of performance standard workshops. The residual risk score for each environmental hazard was assigned taking into account the risk reduction from both the existing and additional controls. The implementation strategy (Section 7) describes how the additional controls will be implemented.

5.3 Impact assessment

An assessment of impact for each identified hazard was conducted by:

- Defining impact assessment criteria;
- Quantifying magnitude of the stressor, including where applicable, quantity, concentration of contaminant and level of disturbance;
- Consideration of timing and duration of the impact and other factors affecting the impact and risk (depth, temperature, tides, etc.);
- Consideration of environmental features affected either directly or indirectly; and
- Evaluation of the acceptability of the impact and risk.

5.4 Catastrophic Environmental Events and Critical Controls

In the context of the Wandoo well construction activity, an event with a consequence ranking of Catastrophic (5) as per Table 5-3 is defined as a CEE. A physical control, measure or procedure that has a key role in preventing, detecting, controlling or mitigating a CEE is defined as a Critical Control. Although environmental performance outcomes are developed for all environmental controls, Critical Controls are subjected to more stringent management. Management of critical controls is discussed in the Implementation Strategy (Section 7).

5.4.1 Identifying Catastrophic Environmental Events

Environmental hazards for the Wandoo well construction activities are discussed in Section 6. It is important to note that there will usually be a range of possible impacts resultant from each hazard and only some of these may have catastrophic potential. The overview of all environmental hazards (Section 6) and each individual hazard report identify the worst credible impact resultant from each hazard.

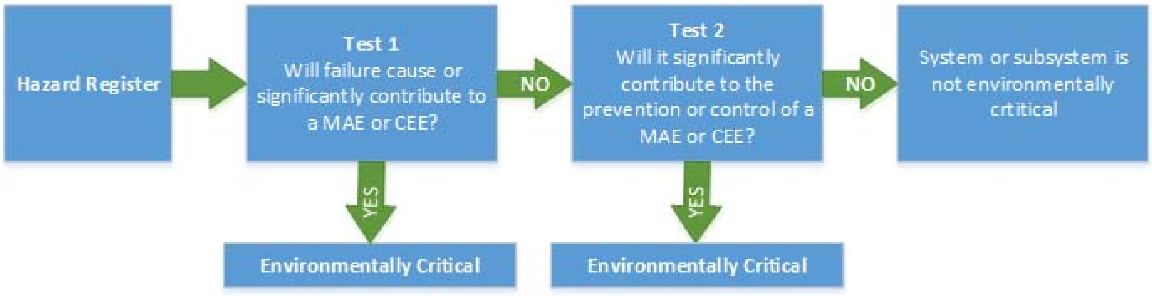
Based on the description of the hazard and the range of possible impacts for each hazard in Section 6 it is possible to determine those circumstances where a release would have catastrophic potential. It is only under these circumstances that a CEE would result. These events have been designated as a CEE and a CEE-XX numerical designator allocated.

5.4.2 Identifying Critical Controls

Once an event has been identified as a CEE the controls associated with that event must be assessed to determine which controls are considered critical. To confirm the applicability of a control measure as critical, it is necessary to apply a reasoned process as depicted in Table 5-2.

For identified CEEs, the controls associated with those events have been subjected to the above process and Critical Controls identified. Critical Controls, where identified have been defined in the relevant hazard assessments in Section 6.

Table 5-2: Critical Element identification process



5.5 Defining Acceptability Level

VOGA considers residual **risks** to be acceptable when potential environmental impacts are below the predicted level of Consequence ranked as Major (4) or Catastrophic (5) and these potential environmental impacts are considered either likely or almost certain i.e. Residual Risk I (RRI) as defined with the VOGA Environmental Risk Matrix (Table 5-3).

5.6 VOGA risk ranking

The risk ranking was carried out in accordance with VOGA Risk Management Manual [VOG-2000-MN-0001] and utilised through to Section 6.

Table 5-3 is the VOGA corporate risk matrix representing the environmental consequence evaluation in relation to the frequency rating of the occurrence of the environmental hazard, assuming identified controls are in place. The residual risk level is used to establish the actions required to manage potential impacts and risks to ALARP and acceptable levels, including the identification of critical controls as per Section 5.4 above; and provides Wandoo-specific supplementary environmental consequence definitions in the context of the nature of receptors potentially impacted by the petroleum activity as described in Section 2 of this EP.

Table 5-3: VOGA Environmental Risk Matrix

				LIKELIHOOD				
			Chance	Rare	Unlikely	Possible	Likely	Almost Certain
			Probability	1 in 10 000 - 100 000 (10^{-5})	1 in 1 000 - 10 000 (10^{-4})	1 in 100 - 1 000 (10^{-3})	1 in 10 - 100 (10^{-2})	1 in 1-10 (10^{-1})
			Frequency	Not known to have occurred, but believed to be a credible scenario	Has occurred within our own industry	Has occurred within Vermilion, or has occurred multiple times per year within our own industry	Has occurred several times within Vermilion	Has occurred typically once or more per year within Vermilion
	Environment			A	B	C	D	E
POTENTIAL CONSEQUENCE	Irreversible effects on habitat, ecological communities, land, air or water Persistent reduction in sensitive ecosystem function (extends beyond area abandonment timeframe) Effects extend beyond regional scale and/or operating area/district	5	Catastrophic					
	Persistent but reversible, long-term (>10 years) effects on habitat, ecological communities, land, air or water Effects are widespread within region and/or specific operating area	4	Major					
	Reversible, medium-term (5-10 years) effects on habitat, ecological communities, land, air or water Effects extend into the immediate surroundings of the operating area/lease and/or localized off-lease	3	Moderate					
	Reversible, short term (1-5 years) effects on habitat, ecological communities, land, air or water Effect within operating area/lease boundaries or localized off-lease	2	Minor					
	Reversible, short term (<1 year) effects on habitat, ecological communities, land, air or water Effect within operating area and/or contained on-lease	1	Incidental					

Table 5-4 Risk action table

Risk Level* ***(includes inherent risk in the event no safeguards are available)***	**Action to Reduce Risk to an Acceptable Level**
RRI or Extreme	Immediate implementation of temporary safeguard via Management of Change (MOC). Stop activities until risk controls/safeguards that will reduce the risk are implemented Implement permanent safeguard to reduce risk to acceptable level.
RRII or High	Immediate implementation of temporary safeguard. Establish a team for the: a) Evaluation of permanent safeguards, b) Implementation of permanent safeguards to reduce risk to an acceptable level.
RRIII or Medium	Safeguards are re-evaluated to determine suitability and acceptability. Establish a team for the evaluation and maintenance of current safeguards. Evaluate for ALARP. Implement permanent safeguards or accept risk as per defined authority.
RRIV or Low	Controls are reviewed to ensure effectiveness. No further risk treatment if ALARP.

Table 5-5: Wandoo-specific supplementary environmental consequence definitions

Term used	Definition in the context of this EP
Geographical extent of impact	
Regional scale	Extent of impact across multiple bioregional provinces (EMBA)
Widespread	Extent of impact beyond the Operational Area (<200 km)
Localised off lease	Extent of impact mostly within the Operational Area with some effect extending beyond the boundaries of the area (<40 km).
Within operating area	Extent of impact limited to the Operational Area (2km from the well location)
Socio-economic criteria: Environment criteria applies for impact and duration. Below are a range of examples for Socio-economic impacts and how they are applied to environment consequence ranking in the context of this EP	
5 Catastrophic	Widespread damage to or exclusion from commercial enterprise or collapse of commercial enterprise.
4 Major	Damage to or long term exclusion (>10 years) from large proportion of commercial or recreational enterprise (e.g. fishery closure)
3 Moderate	Medium-term (5-10 years) damage to or temporary exclusion from large proportion of commercial or recreational enterprise where recovery is expected to occur within 1 year of the activity stopping
2 Minor	Temporary or permanent exclusion to minor proportion of commercial or recreational enterprise.
1 Incidental	Very short-term exclusion to minor proportion of commercial or recreational enterprise; or community disturbance impact e.g. low-level noise, vibration, lighting.

5.7 Demonstrating ALARP of impact and risk

5.7.1 Ongoing operations demonstration of ALARP

Demonstrating ALARP has been undertaken in accordance with VOGA's Risk Management Manual [VOG-2000-MN-0001] and NOPSEMA Guidance Note N-04300-GN0166, ALARP [with the key principles of this Guidance Note (Health and Safety) also applies to Environmental Management]. Demonstrating that risks levels are ALARP is a two-step process. Firstly, residual risk levels must be tolerable, that is not within the "High" or "Extreme" risk area of the VOGA Risk Matrix as per Table 5-3. Secondly, once deemed tolerable further risk reduction measures must be identified and assessed for implementation as described below.

Following the identification of standard industry 'good practice' risk mitigation controls and recovery measures, VOGA reviews the residual risk and assesses whether there are any further measures required to reduce the residual risk to ALARP. For well construction activities and well intervention projects, risks are considered to have been reduced to ALARP if the risks are within the tolerable region of the VOGA Risk Matrix and have been subject to a detailed assessment process that has concluded that there are no additional reasonably practicable measures that can be implemented to further reduce the level of risk.

When deciding whether risks are managed to ALARP, the following items are considered:

- Duration and regularity of operations;
- Risk;
- Layers of protection;
- Feasibility of additional controls or alternative arrangements;
- Practicality of additional controls or alternative arrangements;
- Cost of additional controls or alternative arrangements;
- Effectiveness of additional controls or alternative arrangements;
- Impact on risks from additional controls or alternative arrangements; and
- Lessons learnt from past campaigns and industry.

This decision is valid where:

- All environmental hazards have been identified and assessed;
- Risk levels have been evaluated; and
- Residual risk levels are tolerable, compliant and ALARP.

Performance standards have been defined to ensure that the risks are reduced to ALARP on an ongoing basis. The VOGA risk matrix defines an upper threshold above which no risk is tolerable. Below this threshold is the ALARP region, where risks should be further reduced until the cost of any additional action outweighs the incremental benefit gained.

5.7.2 Concept evaluation ALARP demonstration

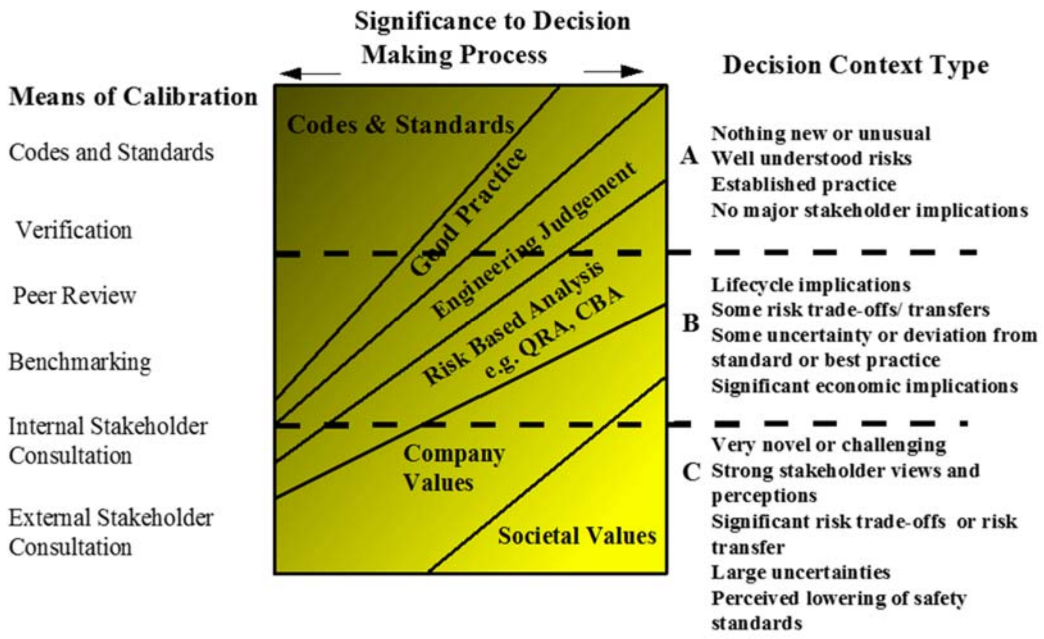
For evaluation of concepts a specific ALARP Demonstration Worksheets is completed in accordance with the processes defined in VOGA's Risk Management Manual [VOG-2000-MN-0001]. For concept evaluations demonstration of ALARP contains elements of the following process:

- Identification and consideration of a range of potential measures for further risk reduction;
- Systematic analysis of each of the identified risk reduction measures and a view formed on the HSE benefit associated with each of them;
- Evaluation of the reasonable practicability of the identified measures;
- The implementation (or planned implementation) of the identified RRMs; and
- Recording of the process and results.

The United Kingdom Offshore Operators Association (UKOOA) has produced guidelines for assisting with the ALARP decision-making process and for recording and demonstrating the robustness of the decision as depicted in Table 5-6. These are regarded as good practice internationally and have been adopted globally as the standard guidance for ALARP decision making.

The UKOOA guidelines describe a framework that is intended to help decision-makers identify the various decision factors and establish a basis for the decision based on these. The decision framework assesses the significance to the decision process of codes and standards, good practice, engineering judgement, risk analysis, cost benefit analysis, and company and societal values. They aim to encourage the development of transparent decision-making processes.

Table 5-6: UKOOA decision support framework



The first step in the decision-making process is to establish the decision context. This is done by assigning a decision context type (A-C), based on the categories and prompts detailed in Table 5-7.

Table 5-7: ALARP decision context type

Decision context	Description
A	Nothing new or unusual Well understood risks Established practice No major stakeholder implications
B	Lifecycle implications Some risk trade-offs/transfers Some uncertainty or deviation from standard or best practice Significant economic implications
C	Very novel or challenging Strong stakeholder views and perceptions Significant risk trade-offs or risk transfer Large uncertainties Perceived lowering of safety standards

The ALARP template provides questions around the decision context and prompts discussion to determine the appropriate context type.

Once the decision context has been established, Table 5-6 is then consulted to determine an appropriate method of decision making. For example, a design which involves nothing new or unusual, has well understood risks and no major uncertainties or shareholder implications, would be assigned a decision context in the middle of Type A as shown by the band in Table 5-7.

Reading across this band indicates the relative importance of each of the decision making criteria; that is, the decision should be primarily based on the requirements of codes and standards, then engineering judgement and finally good practice. Quantitative Risk Assessment (QRA) should not be allowed to have a great influence on the decision. Consulting the codes and standards provides an appropriate means to calibrate the decision.

However, if the costs associated with the problem were considerable, or there were significant risk uncertainties, this would push the context towards Type B. In this case, some use of QRA and consideration of the company values would be appropriate.

Table 5-8 provides further explanation of each of the decision making criteria.

Table 5-8: Decision criteria definitions

Decision criteria	Definition
Codes & Standards	Decision basis is to follow the requirements of relevant codes and standards. Codes and standards embody the lessons learnt over past years, and for well understood hazards and situations often provide an appropriate solution.
Good Practice	Decision basis is to follow what is generally accepted as current standard or good/best practice. Good practice embodies both the requirements of codes, etc. and other good engineering, analysis and management practices for common situations. Good practice may include solutions that have not yet found their way

Decision criteria	Definition
	into codes and standards. What is good practice may differ from situation to situation. Care should be taken to benchmark against the relevant good practice or emerging practice.
Engineering Judgement	Decision basis is to follow what sound engineering judgement indicates is the best solution. This would be expected to include a recognition of what is good/best emerging practice, and an understanding and application of sound engineering and scientific principles and methods. It could include: engineering analysis, consequence modelling, deterministic cases for hazard management as well as competent judgment and interpretation of these and other information.
Risk Based Analysis (QRA, cost benefit analysis (CBA), etc.)	Decision basis is to make use of the results of probabilistic analyses such as QRA, reliability analysis and CBA to support the decision making process. The assessment could be qualitative or quantitative. Uncertainties and the resolution of the analyses vs the needs of the decision will be key issues to address.
Company Values	Decision basis should take account of the views, concerns and perception of the stakeholders directly affected by the decision/option and the values of the company in terms of its safety commitment, image, etc.
Societal Values	Decision basis should take account of the views, concerns and perceptions of all the relevant stakeholders, including society at large.

The ALARP Demonstration Worksheet provides documentary evidence that the above process has been followed and requires a recommendation of the proposed solution that best meets the appropriate criteria.

5.8 Evaluating acceptability of residual impacts or risks

Regulation 13(5)(c) of the OPGGS(E)R requires demonstration that environmental impacts and risks are of an acceptable level.

VOGA only considers the level of residual impact or risk to be of an acceptable level when (in combination):

- The relevant principles of ESD have not been compromised;
- Both internal and external context requirements have been achieved;
- All other requirements have been met; and
- The predicted level of residual risk is below the level considered as unacceptable and is demonstrably ALARP.

To demonstrate that potential environmental impacts and risk associated with Wandoo well construction activities are of an acceptable level, the following process has been adopted to establish an acceptable level of residual risk for each aspect of the well construction activity (either qualitative or quantitative) considering:

- The Principles of Ecological Sustainable Development (ESD) - the activity must be carried out in a manner consistent with the relevant ESD principles, namely:
    - Decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations. This

principal is inherently applied via the risk assessment methodology, inclusive of the demonstration of ALARP, detailed within this EP, as such this principal is not evaluated separately within each hazard assessment.

  - 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. This principal is applied via the ALARP process in which a precautionary approach may be adopted where residual risks may be high-level or where there is a high degree of uncertainty in the outcomes of the activity.
  - 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. This principal is inherently applied via the risk assessment methodology, inclusive of the demonstration of ALARP, detailed within this EP, as such this principal is not evaluated separately within each hazard assessment.
  - The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making. This principal is applied by evaluating residual risks of well construction activities to particular values and sensitivities, including matters protected under Part 3 of the EPBC Act 1999 giving consideration to relevant recovery plans and species conservation advices as detailed within Table 1-2.

- Internal Context – the activity must be undertaken in a manner consistent with the objectives of the VOGA environmental policy and relevant procedural controls.
- External Context – where a relevant organisations' or persons' activity, function or interest may be affected by the well construction activity, any objections or claims that have been assessed as having merit and are relevant to the well construction activity should be considered when establishing the acceptable level of residual risk of the activity. The predicted level of residual risk presented within this EP shall be taken as acceptable in the context of external stakeholder expectations when:
  - The level of residual risk is equal to or below existing Stakeholder expectations in regard to their function, activity or interest; or
  - Where no objection or claim is received from a relevant organisation or person.
- Other requirements - the residual risks associated with the well construction activity are considered acceptable in the context of external requirements when they are within the bounds identified in relevant laws, policies, standards, conventions and do not compromise the objectives of relevant recovery plans and species conservation advices as detailed within Table 1-2.

5.9 Environmental performance outcomes, performance standards and measurement criteria

Environmental performance outcomes (EPOs), environmental performance standards (EPSs), and their measurement criteria, are defined for each control to ensure overall environmental performance is maintained at ALARP and acceptable levels.

The EPOs detailed within this well construction EP are consistent with the Principles of ESD as detailed in Section 5.8, provide for Matters Protected under Part 3 of the EPBC Act 1999, are relevant to the potential impacts and risks associated with the well construction activity and maintain potential impacts and risks to acceptable levels based upon the context described in Section 5.8.

The EPOs detailed within this EP can be measured in various ways depending on if the acceptable level of impact or risk is quantitative or qualitative.

Quantitative levels of performance embedded within EPOs can be directly monitored and measured either prior to or after an impact has occurred (either planned or unplanned), while qualitative levels of performance can be assessed by validating the EPO remains achievable, relevant, or that the EPO has been maintained (or breached).

Hazard report tables, included in Section 5.9, contain the performance outcome statement and associated standards and measurement criteria for each of the material controls identified.

Additionally, to ensure ongoing protection of Matters Protected under Part 3 of the EPBC Act, VOGA have developed a series of overarching EPOs that apply to all potential impacts and risks (both direct and indirect) that may result from the Wandoo well construction activity (Table 5-1). These EPOs are consistent with the Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies (Commonwealth of Australia, 2013) and consider relevant objectives from species Recovery Plans, conservation advices and Management Plans detailed in Table 1-3. These overarching EPOs do not replace the aspect-specific EPOs detailed within the individual hazard assessment (Section 6) of this EP.

Whilst the overarching EPOs presented in Table 3-4 ensure high-level protection is afforded to Matters Protected under Part 3 of the EPBC Act 1999, they alone do not represent an acceptable level of impact to Matters Protected under Part 3 of the EPBC Act 1999. The EPOs, however, represent a definitive level of impact and risk that is considered by VOGA to be unacceptable to Matters Protected under Part 3 of the EPBC Act 1999. A breach of an EPO would also constitute a Major (4) environmental consequence as per Table 5-4.

Within the detailed hazard assessment (Section 6), in order to ensure that control measures have a clear purpose, aspect-specific EPOs were determined for each receptor or receptor group. Each EPO is a qualitative or quantitative statement which typically links the control measure to an environmental outcome within acceptable levels of potential impact or risk. Where multiple controls protect against the same hazard, they may share a common performance outcome. By means of an example, for the control 'marine breakaway coupling on FHA', the environmental performance outcome could be 'to mitigate the release of crude due to offtake tanker station keeping failure'.

Once the performance outcome has been confirmed, a more specific statement on the level of performance required of the control is established – this is the performance standard. The performance standard may be a quantitative or qualitative statement of the functional requirement of a specific control. Again using the example from above, for the control ‘marine breakaway coupling on FHA, the associated performance standard could be ‘breakaway coupling shall be designed to ‘part at 28 tonnes’. Note that for administrative controls such as procedures, performance standards are typically less specific than those for physical equipment.

Once environmental performance outcomes and performance standards are developed, it is important that the performance of the control can be tracked or monitored in some way to confirm it continues to meet the performance standards. To achieve this, a measurement criterion or means of assurance is specified. The measurement criterion varies, depending on the nature of the control. Once again using the control ‘marine breakaway coupling on FHA’, the corresponding measurement criteria could be ‘Breakaway coupling test records are maintained’. VOGA would also accept internal or external audit records, maintenance and testing records, certificates, operations records, purchasing records, material specifications etc. as a means of assurance or measurement criteria.

5.10 Hazard report template

The risk assessment section of this EP is structured such that each of the hazards has a dedicated sub-section. Each sub-section commences with a “Hazard Report Table”, which is a tabular summary of the hazard, its causes, controls and impacts.

Each Hazard Report Table has multiple fields, which are described here. Each Hazard Report Table has three ‘heading rows’ containing:

- **Hazard**: This is a description of the hazard;
- **EP risk number**: This is a unique identification number applied to each risk;
- **CEE**: This is a unique identifier for those identified Catastrophic Environmental Events; and
- **Potential impacts**: This provides a high level summary of the impacts to the environment which the hazard may cause.

The remainder of the table is divides into six columns, which contain the following fields:

- **Activity/cause**: This field outlines the typical activity/cause of environmental hazards as defined in Section 5.1;
- **Existing management controls**: This contains a description of the controls currently in place to prevent the hazard from occurring or to mitigate the impacts as defined in Section 5.1;
- **ALARP Decision Context**, as defined in Section 5.7.2
- **Control hierarchy**: This provides further information about the control, with respect to where it sits in a hierarchy of controls as defined in Section 5.1. This is included to allow the reader to clearly determine the diversity of the controls in place for each particular scenario. The hierarchy of controls used in this assessment consisted of the following categories:
  - Elimination;
  - Substitution;
  - Prevention;
  - Reduction; and
  - Mitigation.

Controls are further categorised as either an engineering control (i.e. a physical element/system) or administrative control (i.e. procedures).

The remaining columns contain the performance outcomes, performance standards, and their measurement criteria, as defined in Section 5.1.

6 Hazard assessment

6.1 Overview

Well construction activities and unplanned events associated with the activity pose a range of different environmental risks. The risks have been assessed using the methodology outlined in Section 5 and are summarised in Table 6-1. Descriptions of these hazards and how they may occur at Wandoo, along with the measures to prevent and mitigate potential environmental impacts, are included in this section. Those events with a potential impact of Catastrophic have also been identified as CEEs and given a CEE-XX numerical designator.

Each hazard discussion comprises the following main parts:

- **Hazard report:** A table providing the description of the hazard, activity/cause, potential impacts, existing management controls, initial and residual risk ranking of the worst credible event, additional controls/demonstration of ALARP, performance outcomes, performance standards and measurement criteria for each control measure. A summary of the hazard report format is provided in Section 5.7.2. The Hazard Report essentially provides an executive summary of the hazard.
- **Description of hazard:** Describes the activity/cause of the hazard. This establishes the context for each individual hazard and aids in the risk assessment by providing maximum expected consequence extents. This section also includes a discussion of the management controls in place.
- **Impact assessment:** Describes the potential impact to receptors in the environment. This provides the risk assessment for each identified hazard.
- **CEE identification:** Identifies those circumstances where a release would have catastrophic potential and therefore a CEE would result. These events are designated as a CEE and a CEE-XX numerical designator allocated.
- **Critical Controls identification:** Once an event has been identified as a CEE the controls associated with that event must be assessed to determine which controls are considered critical.
- **Oil spill response strategy:** Only applies to those hazards which require activation of the oil spill response. This is a risk treatment specific to oil spill response.
- **Risk ranking:** All hazards are risk ranked in accordance with the process described in 5.6. For those hazards with a range of potential impacts are credible each impact is risk assessed separately. The worst credible risk is provided in the Hazard Report as a summary.
- **ALARP and acceptability demonstration:** Describes the factors VOGA has considered in determining that the potential impacts and risks are acceptable and ALARP. This section describes the potential additional risk treatment options and implementation strategies to maintain potential impacts and risks to ALARP and assesses acceptability of the impact or risk (Section 5.7). This section also provides this risk ranking for the identified hazard. Where there are a range of possible impacts assessed a risk ranking is provided for each separate impact.

A number of unplanned events may also occur during well construction activities which may result in the potential release of hydrocarbons to the marine environment. These spill scenarios have been grouped according to the type of hydrocarbon, i.e. diesel and crude oil, and the potential point of release (i.e. sea surface release versus subsea release).

Table 6-1: Summary of environmental risks for well construction activities

EP risk no.	Hazard	Activity										Residual risk ranking			Section ref.
		Moving a MODU onto location	Drilling and well interventions	Routine MODU and AHTS vessel operations	Source Control	Monitoring and Evaluation	Chemical Dispersion	Containment and Recovery	Mechanical Dispersion	Shoreline Clean-up	Oiled Wildlife Response	Consequence	Likelihood	Residual risk	
EP-WC-R01	Liquid hydrocarbon release from wells		x									5	A	RRIII	6.2
EP-WC-R02	Liquid hydrocarbon release from the MODU, export equipment or pipeline(s)	x		x	x							4	B	RRIII	6.3
EP-WC-R03	Diesel spill to sea			x								4	B	RRIII	6.4
EP-WC-R04	Environmental impacts of oil spill response				x	x	x	x	x	x	x	3	B	RRIII	6.5
EP-WC-R05	Noise		x	X	x							1	B	RRIV	6.6
EP-WC-R06	Atmospheric emissions			X								2	B	RRIV	6.7
EP-WC-R07	Artificial light			X								1	A	RRIV	6.8
EP-WC-R08	Discharge of cooling water/reject water			X								1	B	RRIV	6.9
EP-WC-R09	Deck drainage and bilge water discharge			X								1	B	RRIV	6.10
EP-WC-R10	Non-hazardous and hazardous waste			X								2	B	RRIV	6.11
EP-WC-R11	Discharge of drill cuttings, cement, steel shavings and well drilling and completions fluids		x		x							2	B	RRIV	6.12
EP-WC-R12	Discharge of sewage, grey water and putrescible wastes			X								1	B	RRIV	6.13
EP-WC-R13	Ancillary hydrocarbons or chemical spills		x	X	x	x		x				2	B	RRIV	6.14
EP-WC-R14	Physical presence of MODU and AHTS vessels	x		X				x	x	x		2	B	RRIV	6.15
EP-WC-R15	Seabed disturbance	x	x		x							1	B	RRIV	6.16
EP-WC-R16	Introduction of invasive marine species	x		x		x		x				3	A	RRIV	6.17

6.2 Liquid hydrocarbon release from wells

6.2.1 Hazard report

Table 6-2: Hazard report – Liquid hydrocarbon release from wells

HAZARD:	Liquid hydrocarbon release from wells (liquid hydrocarbon release of up to 25,555 m^3 over 43 days
EP risk number:	EP-WC-R01
CEE:	**CEE-01 – Well blowout (Full-bore blowout from oil-producers with low water cut that can flow naturally to surface)**
Potential impacts:	Temporary decrease in marine water quality. Increased toxicity of, and bioaccumulation in, marine organisms from the ingestion of hydrocarbons. Injury or death of exposed marine fauna (e.g. oiling of seabirds). Habitat impacts where the spill reaches sensitive marine areas such as coral reefs or the shoreline.

PREVENTION:

Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Loss of both primary and secondary well control during well construction activities when the reservoir pressure is being controlled by a hydrostatic fluid column Refer to Sections 2.4.2 to 2.4.5. **Context**: Primary well control is maintained if the hydrostatic pressure exerted by the drilling or completion fluid is sufficient to prevent well bore fluids from entering the well bore in a material way. Secondary well control fails if the pressure envelope created by the well bore, casing, tubing wellhead, Xmas tree and/or BOPs fails and is unable to contain an influx of well bore fluids.	Wells are designed in compliance with the VOGA Well Construction Standards Manual (WCSM) [VOG-5000-MN-003].	Engineering	No uncontrolled release of hydrocarbons to the environment from a well during well construction activities.	Well design shall comply with standards described in VOGA's WCSM.	Statement in Basis of Well Design document.
	VOGA standards require that casing and completion and wellhead components are manufactured to relevant API or ISO specifications.	Administrative		VOGA shall validate that well casing, completion and wellhead components are manufactured to relevant API specifications.	Purchase orders and contracts specify manufacturing standards.
				VOGA require third party Quality Assurance (QA) inspections on equipment prior to shipping offshore.	Third party QA inspection reports.
	VOGA standards require that third party well control equipment is designed and certified compliant with the relevant API or ISO specifications.	Administrative		VOGA shall validate that third party BOPs are compliant with relevant API specifications.	Pre-hire inspection records certify that third party well control equipment is designed and certified compliant with relevant API or ISO specifications.
	VOGA selects contractors based on evaluation of their ability to provide fit-for-purpose services in support of a well construction/intervention campaign.	Administrative		The well intervention contractor used on a campaign shall be assessed through VOGA's contractor evaluation process or equivalent.	Records of contractor evaluation process.
	VOGA standards require that all activities on a well after initial installation of a BOP require a minimum of two temporary barriers be in place unless exempted through a formal Management of Change process.	Engineering		Well Construction Program shall specify the barriers to be in place during well operations.	Well Construction Program signed off by VOGA Well Construction Manager.
	VOGA conduct Peer Review and Drill Well on Paper workshops to review well designs and operational plans.	Administrative		VOGA shall conduct Peer Review and Drill Well on Paper workshops to review well designs and operational plans.	Peer Review and Drill Well on Paper attendance records.
	VOGA prepares a detailed program for each well activity to outline the intended work scope and the well barriers to be in place during the campaign.	Administrative		Well Construction Program shall outline the intended work scope and well barriers to be in place during the campaign.	Well Construction Program signed off by VOGA Well Construction Manager.
	VOGA Drilling Supervisors, Completions Supervisors and Drilling Superintendents are required to hold current Well Control certification.	Administrative		VOGA Drilling Supervisors, Completions Supervisors and Drilling Superintendents shall hold current well control certification as required.	Drilling Superintendent confirms currency prior to operations commencing Certification records kept on file.
	VOGA require the MODU Contractor to ensure that drilling personnel with a position of derrickman and above to hold well control certification.	Administrative		Relevant MODU personnel shall hold current well control certification as required.	Certification kept on file by MODU Contractor. Drilling Superintendent confirms currency prior to operations commencing.

PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
	VOGA require a Barrier Verification Document to be completed prior to progressing beyond programmed check points in a well construction program.	Administrative		VOGA Barrier Verification Document shall be completed and signed off by senior VOGA and Drilling Contractor representatives prior to progressing beyond the programmed check points in a well construction program.	Signed Barrier Verification Document.
	VOGA require that BOPs are tested at regular intervals in accordance with API standard 53.	Administrative		VOGA shall validate that BOPs are tested at regular intervals in accordance with API standard 53 in accordance with VOGA requirements.	Signed Barrier Verification Document.
	Formation Integrity Tests (FITs) or Leak Off Tests (LOTs) are conducted after drilling out casing shoes or milling windows in existing casing if required under the WCSM.	Engineering		LOT or FIT shall be conducted after drilling out casing shoes or milling windows in existing casing when programmed.	LOT or FIT report.
	VOGA requires kick tolerances to be calculated for all pressure containing casing strings.	Engineering		Kick tolerance shall be calculated for all pressure containing casing strings in accordance with requirements of WCMS and Well Construction Program.	Kick tolerance noted in Daily Drilling Report if kick tolerance calculations are required during well construction activities.
	VOGA requires the Drilling Contractor and the mud logging service provider to independently monitor mud flows for variances.	Engineering		VOGA shall validate that the Drilling Contractor and the mud logging service provider monitor mud flows.	Daily mud reports.
	VOGA require drilling contractor to conduct drills demonstrating preparedness to act if unexpected mud flows occur.	Engineering		VOGA shall validate that kick and choke drills conducted.	Drills noted in Daily Drilling Report.
Drilling into another well. **Context**: Drilling in close proximity to other wells is required in order to optimise well production. A collision between wells may cause damage that could result in loss of primary well control.	Collision risk assessed for planned well path against existing wells. Where collision is outside well construction standards, an MoC will be implemented with mitigation and controls specified.	Engineering	No uncontrolled release of hydrocarbons to the environment from a well during well construction activities.	VOGA MoC hall be used to manage drilling operations where the well separation factor is <1.0.	Approved MoC form.
	VOGA prepare directional drilling plans for each new well designed to minimise the risk of a well bore collision.	Administrative		Well Construction Program shall include directional drilling plans for new wells and trajectories are checked for wellbore collision risk.	Well Construction Program signed off by VOGA Well Construction Manager.
	VOGA utilise a geological model of the reservoir to predict Formation Evaluation While Drilling (FEWD) tool responses.	Engineering		Drilling plans shall incorporate offset well log responses for potential collision points to enable collision avoidance using FEWD tool responses if required to mitigate collision risk.	Well Construction Program signed off by VOGA Well Construction Manager.
	VOGA prepare a Geosteering Plan to optimise well placement decisions.	Administrative		Geosteering Plan shall be incorporated into the Geological Evaluation Program.	Approved Geological Evaluation Program.
	VOGA shut in production wells when drilling occurs close to existing wells.	Engineering		Well Construction Program shall specify wells to be shut in prior to drilling in close proximity.	Wells which were shut in are noted in Daily Drilling Report.
	Anti-collision procedures used when wells are in close proximity to an existing well bore.	Administrative		Drilling plans shall specify use of anti-collision procedures when drilling in close proximity of other wells.	Well Construction Program signed off by VOGA Well Construction Manager.
Dropped object damaging infrastructure in well bay area. **Context**: A heavy load dropped onto a well, associated flowlines or gas lift lines could cause	VOGA require that lifting equipment used for drilling operations is certified in accordance with the VOGA Lifting Equipment Manual [WPA-7000-YM-0002] or MODU Safety Case.	Engineering	No dropped object causing an uncontrolled hydrocarbon release to the environment during well construction activities.	Lifting operations shall utilise equipment that is certified in accordance with VOGA Lifting Equipment Manual or MODU Safety Case requirements.	Lifting equipment certification retained by Wandoo Field Superintendent or Drilling Contractor as appropriate.
	VOGA operations require that all material transported offshore is certified in accordance with lifting standards quoted in the VOGA Lifting Equipment Manual [WPA-7000-YM-0002] or as amended by the MODU Safety Case Revision.	Engineering		VOGA shall verify rigging and container certification.	Container and rigging certification copies included with vessel manifests.

PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
damage resulting in an uncontrolled flow from a well.	VOGA operations on a platform are managed under a Permit to Work system that prohibits work tasks from commencing until task specific controls have been implemented.	Administrative		Permit to Work shall be issued for all heavy lifts onto or over platform infrastructure.	Permit to Work signed off and retained.
				Wells and production facilities that could be impacted on by a dropped object during a critical lift shall be shut in.	Wells to be shut in noted on the Work Permit and wells which were shut in are noted in Daily Drilling Report.
				Weather conditions shall be assessed as suitable for the lifting operations to take place.	Permit to Work signed off and retained.

MITIGATION:				
Existing control measures	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Wandoo Emergency Response Plan [VOG-2000-RD-0017]/Wandoo Field OSCP [WAN-2000-RD-0001].	Administrative	To mitigate the impact of hydrocarbons released to the marine environment.	Oil spill response strategies will be implemented in accordance with the Wandoo Field OSCP [WAN-2000-RD-0001].	Incident Action Plan (IAP) records.
Isolation of wells as part of the facility Emergency Shutdown (ESD) system. **Context**: In the event of a loss of well control incident, the ESD system will shut actuated process valves and production well Subsurface Safety Valves (SSSVs) to limit the escalation potential of the incident.	Isolation	To limit the volume of hydrocarbons released to the environment of in the event of a loss of well control.	Platform status complies with requirements of the MODU Safety Case Revision prior to a MODU obtaining permission to approach platform during rig move.	Field Superintendent will issue a signed pre-move checklist confirming that pre-move checks have been completed.
			Function testing of ESD system from rig remote stations prior to commencing well construction activities.	Successful test noted in Daily Drilling Report.

INITIAL RISK WITH EXISTING CONTROLS:		
Consequence	**Likelihood (of consequence)**	**Initial risk**
Catastrophic (5)	Rare (A)	Medium

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:

Following the adoption of standard industry good practice controls, a medium risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.

Additional control measures	Prevention/mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:		
Consequence	**Likelihood (of consequence)**	**Residual risk**
Catastrophic (5)	Rare (A)	RRIII (Medium)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA HSE / procedures met**	**Other Requirements met**	**RR < Extreme (I)**	**EPO(s) manage risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Risk managed in accordance with VOGA HSE policy and well planning aligned to VOGA Well Construction Standards Manual (WCSM) [VOG-5000-MN-003]. Potential spills to be managed in accordance with Wandoo Emergency Response Plan [VOG-2000-RD-0017]/Wandoo Field OSCP [WAN-2000-RD-0001].	Yes – MODU operations to be consistent with MODU Safety Case. Third party well control equipment designed and certified compliant with the relevant API or ISO specifications. BOPs are tested at regular intervals in accordance with API standard 53	Yes – RR = RRIII (Medium)	Yes – EPOs specify no uncontrolled release of hydrocarbons. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.2.2 Description of hazard

Reservoir data indicates that in the highly improbable event of a total loss of well control, a worst-case unconstrained flow scenario would be 25,555 m^3 of Wandoo Crude released over a 43-day period. Reservoir modelling indicates that after this time the reservoir pressure would deplete, and fluid composition change, to a point where fluid flow from the well would cease.

VOGA has conducted HAZID workshops to identify activities and causes which could result in a loss of well control. These workshops have determined that for such a well control event to occur, it would require multiple physical and administrative barriers to fail concurrently or sequentially.

Well control during well construction activity (associated with the process of drilling, completion, well intervention or well abandonment) can be considered at three levels: primary and secondary well control, and total loss of well control.

6.2.2.1 *Loss of primary well control*

Primary well control is achieved when the hydrostatic pressure exerted by fluids above a hydrocarbon source is greater than the pore pressure at the source.

Hydrostatic pressure is a function of the height of a column of fluid and its density, i.e. the hydrostatic pressure at the bottom of a well bore is a function of the depth of the well bore and the density of the fluid contained within it.

The reservoir pressure in the Wandoo Field is less than the hydrostatic pressure generated by a column of seawater from surface to the top of the reservoir.

All VOGA drilling and completion fluids have a density equal to or greater than that of seawater. The difference in pressure between the pore pressure and the hydrostatic pressure is known as the overbalance.

Drilling or completion fluids may dissipate slowly into the formation or more rapidly if a well that is being drilled intersects a fracture, fault or old well bore. If the fluid lost to the formation is unable to be replaced, then the fluid level in the well will drop, resulting in a reduction in hydrostatic pressure on the formation.

As the fluid level in a well drops, the overbalance acting on the formation also reduces; a process that normally reduces the rate at which fluid is lost. Experience at Wandoo is for fluid equilibrium to occur with the drilling or completion fluids becoming static at around 100m below the wellhead.

Well construction activities that could result in major fluid losses, with the potential to escalate to a loss of primary well control include:

- Drilling into a production well in which the pressure in the well bore is substantially less than the hydrostatic pressure of the drilling fluid, resulting in losses in the new well. Because “at risk” production wells will be shut in during drilling when there is a credible collision risk, the potential for the loss of fluid in the new well is reduced to a manageable level; or
- Drilling into a fault is a potential source of fluid losses. Within the reservoir, the fault is at reservoir pressure and bridging agents within the drilling fluid will stem the losses quickly by

plugging of the pores in the reservoir. There is no history of significant fluid losses during well construction operations due to faulting in the Wandoo reservoir.

Escalation of fluid losses into a loss of primary well control requires a substantial proportion of the residual drilling or completion fluid in the well bore to be replaced with a low-density fluid. This could be air, gas or oil. This is an extremely low probability event.

6.2.2.2 *Loss of secondary well control*

Secondary well control is provided by the systems of mechanical devices which form, or are able to form, a pressure-containing envelope around the well to ensure that the well fluids remain under control. Secondary well control components include well casing, tubing, wellhead, BOPs and Xmas Trees and their associated control systems.

These components are selected and tested in accordance with the VOGA Well Construction Standards Manual and offer a high degree of reliability.

Loss of secondary well control could occur if:

- BOPs fail to operate when required;
- A large object is dropped in the well bay area that damages the wellhead and/or flowlines. Noting that:
  - Procedures require that any wells that may be impacted by a dropped object are shut in prior to the operation commencing;
  - All wells are equipped with SSSVs that require constant pressure on a control line to remain open. Damage to wellhead infrastructure will probably cause the control line to vent, thus closing the SSSV; and
  - The platform has ESD controls which vent all SSSV lines, thus closing in all wells.
- The defined well barrier envelope suffers a failure of integrity.

6.2.2.3 *Total loss of well control*

Total loss of well control (blowout) occurs because of a loss in hydrostatic head over the reservoir and a subsequent failure of the pressure-control envelope on surface (loss of primary and secondary well control). Multiple levels of control must fail concurrently for this event to occur.

OGP's Risk Assessment Data Directory Report No. 434 – 2 (September 2019) provides blowout frequency data based on blowout information from operations carried out in the US Gulf of Mexico, UK Continental Shelf and Norwegian waters between 1 January 1980 and 1 January 2014. This report states that the likelihood of a blowout, while drilling normal oil development wells in offshore operations carried out to North Sea standards, is 3.4×10^{-5}. While it is not specifically stated, the OGP data will include data from oil wells drilled into known (producing) reservoirs with pressures probably ranging from sub-hydrostatic to substantially over-pressured (but not high pressure, high temperature reservoirs which are assessed separately). The report also states that the likelihood of a blowout when drilling normal oil exploration wells in offshore operations carried out to North Sea standards is 1.3×10^{-4}. Exploration wells typically drill into reservoirs that will probably range in pressure from hydrostatic to substantially over-pressure. The knowledge on the reservoir conditions for both categories may be well known, likely in development wells, or completely unknown, and more likely in exploration wells.

While it is difficult to make a direct comparison between this blowout frequency data and the level of risk associated with well construction operations in WA-14L, it is reasonable to draw some parallels.

The first parallel that can be drawn is the standard of operations. The OGP data is drawn from spheres of operation that are carried out to a similar standard, in this case, to offshore North Sea standards. VOGA's operations are carried out under the NOPSEMA regulatory regime which is similar to that applied in the offshore North Sea. It is therefore reasonable to assume that the standard of VOGA's operations will be similar to offshore North Sea standards.

The second parallel that can be drawn is in the data itself. The data demonstrates that the blowout frequency when drilling normal oil development wells is an order of magnitude lower than that associated with the drilling of normal oil exploration wells. Therefore, it is reasonable to assume that the risk of a blowout occurring when conducting well construction operations targeting the *M. australis* Sandstone reservoir in WA-14L will be substantially lower again. The primary justification for this statement is that the reservoir conditions and properties of the *M. australis* Sandstone reservoir in WA-14L are very well-known and have been proven to be sub-hydrostatic through a long history of well construction and production operations.

As such, while a loss of primary well control is possible, it is extremely unlikely, because the sub-hydrostatic nature of the reservoir requires a significant reduction in hydrostatic head to enable the well to flow. Similarly, a loss of secondary well control is possible, but unlikely, because of the controls applied during the planning and execution phases of VOGA's well construction operations.

Consequently, the total loss of well control during well construction or intervention operations in the Wandoo Field is an extremely low probability event with a frequency that is likely to be significantly below 3.4×10^{-5}.

6.2.3 Impact assessment

The potential impacts associated with a crude oil release from a well without the use of oil spill response strategies such as chemical dispersion, are provided in Table 6-3.

Table 6-3: Summary of environmental impacts due to a release of Wandoo Crude from a well

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
Marine habitats			
Corals	Entrained/ shoreline	Significant coral reefs within the EMBA include Ningaloo Marine Park, the Montebello/Barrow/Lowendal islands, Shark Bay, Muiron Island, the Dampier Archipelago, Glomar Shoals, Rankin Bank, Mermaid Reef and the Rowley Shoals (Section 4.3.2.2 and Figure 4-3). Ningaloo Marine Park, the Montebello/Barrow/Lowendal islands, Muiron Island, the Dampier Archipelago, Glomar Shoals, Rankin Bank, Mermaid Reef and the Rowley Shoal also occurring within Hydrocarbon Area. No coral reef communities are found in the Operational Area. The nearest area of significant corals reef to the Operational Area being the Glomar Shoals (approximately 37 km northeast) and Ningaloo Reef (approximately 250 km away). Spill modelling (Appendix 2) predicts that in the event of a loss of well control: • No moderate levels of dissolved aromatic hydrocarbons are expected to reach coral reef communities; • Moderate entrained hydrocarbon exposures within 0 to 20 m water depth layer are expected to reach Montebello Islands Marine Park, Glomar Shoals KEF, Barrow Island MMA, Muiron Islands MMA, Ningaloo Marine Park and Rankin Bank. • Moderate shoreline accumulation may occur at Rowley Shoals (Clerke Reef, Imperieuse Reef), Lowendal Island, Barrow Island, Mermaid Reef, Muiron Islands, Rowley Shoals and Dirt Hartog Island. Direct contact with entrained or shoreline hydrocarbons could lead to chemical toxicity across cellular structure leading to coral bleaching and colony death. Instead of acute mortality, it is more likely that oil effects occur in sub-lethal forms, such as reduced photosynthesis, growth or reproduction (NOAA, 2014). Shoreline hydrocarbon contact is limited to intertidal corals which will be periodically exposed to surface hydrocarbons as well as planktonic stages of corals in particular during periods of coral spawning. Intertidal coral reefs also have the potential for smothering due to shoreline accumulation. As described in Section 3.2.1, modelling outputs are an aggregate of all potential spill trajectories and therefore it is not credible that all receptors would be exposed at any one time. On this basis, impacts to these areas (including spawning) are likely to be limited and re-colonisation/recovery could be expected over time. In the event of a loss of well control there is a potential for hydrocarbon exposures to result in significant but recoverable (in >1 year) species or habitat damage.	Major (4)
Seagrasses	Entrained/ shoreline	The EMBA include seagrass habitats located in waters surrounding Shark Bay, Ningaloo Reef, Dampier Archipelago and Montebello and Barrow islands (Section 4.3.2.3 and Figure 4-3). Within the Hydrocarbon Area Ningaloo Reef, Dampier Archipelago and Montebello and Barrow islands exist. No seagrasses are found within the Operational Area. Noting seagrass species within the EMBA exhibit seasonal trends in abundance and distribution, in response to natural disturbance events and Dugong grazing.	Major (4)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
		Spill modelling (Appendix 2) predicts: • No moderate levels of dissolved hydrocarbons are predicted to impact seagrass habitats; and • Moderate entrained hydrocarbon exposures within 0 to 20 m water depth layer are expected to reach Montebello Islands Marine Park, Shark Bay, Barrow Island MMA and Ningaloo Marine Park. • Moderate shoreline accumulation may occur at Barrow Island and Dirt Hartog Island. Entrained and shoreline hydrocarbons may smother leaves of seagrass beds in shallow intertidal areas. Intertidal seagrass communities would theoretically be the most susceptible because the leaves and rhizomes may both be affected. When seagrass leaves are exposed to oil, sub-lethal quantities of the soluble fraction can be incorporated into the tissue, causing a reduction in tolerance to other stress factors (Zieman *et al.,* 1984). The toxic components of petroleum oils are thought to be the PAH, which are lipophilic and therefore able to pass through lipid membranes and tend to accumulate in the thylakoid membranes of chloroplasts (Ren *et al.,* 1994). In the event of a loss of well control there is a potential for hydrocarbon exposures to result in significant but recoverable species or habitat damage.	
Macroalgae	Entrained/ shoreline	Macroalgal habitat within the EMBA and Hydrocarbon Areas are widespread throughout shallower areas of the region, particularly where hard substrates occur. There are no specifically identified areas of significant environmental value (Section 4.3.2.4 and Figure 4-3). In the event of a loss of well control and subsequent spill, macroalgae in intertidal areas have the potential to be exposed to in-water and shoreline hydrocarbons. Residues may be left in the area as the tide ebbs, but will be flushed with each flood tide. Studies have shown that macroalgae appear to recover rapidly from oiling, irrespective of the degree of impact and level of oiling. This is attributed to the fact that most of the new algae growth is produced near the base of the plant while distal parts (which would be exposed to the oil contamination) are continually lost (Connell and Miller, 1981). In the event of a loss of well control there is a potential for hydrocarbon exposures to intertidal areas where macroalgae may occur, to result in temporary and recoverable impacts to macro-algal habitats.	Moderate (3)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
Mangroves	Shoreline	The shoreline occurring within EMBA and shoreline Hydrocarbon Area includes mangrove habitats located along the Dampier Archipelago, Montebello Islands, Ningaloo coastline and scattered areas along the coast between Onslow and just north of Port Hedland (Section 4.3.3.1 and Figure 4-4). No mangrove communities are found within the Operational Area. The closest regionally significant mangroves to the Operational Area are those occurring within the Dampier Archipelago (greater than 30 km from Operational Area). With notable belts of mangroves occurring between Coral Bay (within shoreline Hydrocarbon Area and approximately 400 km from Operational Area) and Eighty Mile Beach (approximately 300 km away from Operational Area and within shoreline Hydrocarbon Area). Spill modelling (Appendix 2) predicts moderate shoreline accumulation may occur at Dampier Archipelago, Montebello Islands and the Ningaloo coastline. Observations by Lin and Mendelssohn (1996), demonstrated that more than 1kg/m^2 of oil during the growing season would be required to impact marsh or mangrove plants significantly. However, mangroves can take more than 30 years to recover from severe oil spill impacts (NOAA, 2014). Subsequently the impact is significant but recoverable species of habitat damage.	Major (4)
Intertidal beaches/ mudflats/rocky shorelines/ intertidal reef platforms	Shoreline	Intertidal beaches, mudflats, rocky shorelines and reef platforms are widespread throughout the EMBA (Figure 4-5). Three intertidal beach/mudflat areas of international conservation significance occur within the shoreline Hydrocarbon Area (Bandicoot Bay, Eighty Mile Beach and Roebuck Bay) (Section 4.3.3.3 and 4.3.3.4). Notable rocky shorelines and intertidal reef platform areas within the shoreline Hydrocarbon Area occur along the Ningaloo coast and North West Cape (Section 4.3.3.4). No beaches, mudflats, rocky shorelines and reef are within Operational Area. Spill modelling (Appendix 2) predicts that moderate shoreline accumulation may occur at Barrow Island (Bandicoot Bay), Eighty Mile Beach, Roebuck Bay, Ningaloo Marine Park and coastline of the North West Cape. Oil has the potential to interfere with infaunal organisms in these areas either by modifying the habitat or smothering the feeding respiratory and/or locomotory structures of these organisms. Hydrocarbons may be left on the intertidal shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. Subsequently the impact is short term localised disruption of ecosystem.	Minor (2)
Sandy beaches	Shoreline	The values associated with sandy beaches are assessed with regard to the following environmental sensitivities: marine reptiles, seabirds and other users (Figure 4-5). Refer to these sections for further detail.	

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
Protected and threatened species			
Fish and sharks	Dissolved/ Entrained	Fish and sharks are expected to be present within the EMBA, in-water Hydrocarbon Area and Operational Area however their presence is generally transient and sporadic (Etkin, 2003). Four species of shark, three sawfish and two rays listed as Threatened or Migratory under the EPBC Act potentially occur in the Operational Area. Five shark, four sawfish and two ray species which are listed as Threatened or Migratory under the EPBC Act may potentially occur in the Hydrocarbon Area. Within the in-water Hydrocarbon Area, Ningaloo Reef is the main known aggregation area for whale sharks, waters off Exmouth is an identified aggregation area for grey nurse shark and endemic fish communities are found in water depths between 100 m to 300 m in Continental slope demersal fish communities and Western demersal slope KEFs (Section 4.3.4.4). Table 4-6 and Table 4-7 provides details of fish species or species habitat that may occur within the Project Areas. Studies indicate that the dissolved aromatic compounds (typically the mono-aromatic hydrocarbons and the two and three ring poly-aromatic hydrocarbons) are commonly the largest contributor to the toxicity of solutions generated by mixing oil into water (Di Toro *et al.,* 2007). Fish and sharks most likely to be exposed to entrained and dissolved hydrocarbons are pelagic free-swimming fish and sharks as they dwell in the surface layers of the water column (<20 m depth). Some shark species, such as the whale shark, tend to feed close to the surface and may be exposed to the presence of entrained hydrocarbons. A foraging BIA for the whale shark was identified as intersecting with the EMBA, in-water Hydrocarbon Area and Operation Area. Whale sharks are known to routinely move between surface and to depths of >30 m, and in offshore regions can spend most of their time near the seafloor (DSEWPaC 2011c). Nursing and foraging BIA for dwarf sawfish, freshwater sawfish and green sawfish was identified within EMBA. Demersal fish within the in-water Hydrocarbon Area are not expected to be impacted given the presence of in-water hydrocarbons is predicted in the surface layers (<20 m depth) only. Pelagic free-swimming fish and sharks exposed to entrained hydrocarbons within the surface layers are unlikely to suffer long-term damage from oil spill exposure because in-water hydrocarbons are typically insufficient to cause harm (ITOPF 2011). Pelagic species are also generally highly mobile and as such are not likely to suffer extended exposure (e.g. >40–96 hours) at concentrations that would lead to chronic effects due to their patterns of movement, therefore fish and shark kills as a result of a spill in open water are unlikely. The larval stages of fish species are more likely to be susceptible; however, in comparison to predation and natural loss, any impacts would be over a small proportion of the marine environment in which they may occur and any measurable impact at the population level is likely to be low. In addition, fish mortality from oil spills is rarely reported and it is unlikely that significant population level impacts will occur. Consequently, the spill is only expected to cause a very localised disruption of behaviours/ecosystem.	Minor (2)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
Marine mammals	Dissolved/ Entrained	Marine mammals may be present within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity and impacted by dissolved/ entrained hydrocarbons (Table 4-9). However, the presence of most species is expected to be of a transitory nature only, with a small number of species having an important behaviour (e.g. foraging, breeding) identified within the Hydrocarbon Area. Cetaceans listed as Threatened or Migratory under the EPBC Act may potentially occur in the EMBA and in-water Hydrocarbon Area (Section 4.3.4.5 and Table 4-9). The migration BIA for the humpback whale, and distribution BIA for the pygmy blue whale are located with the in-water Hydrocarbon Area and Operations Area. dolphins are also known to occur and transit through the EMBA and Hydrocarbon Area. Marine mammals can be exposed to oil externally (e.g. swimming through oil) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Impacts from ingested oil and subsequent lethal or sub-lethal toxicity are possible; however, the susceptibility of cetaceans varies with feeding habits. Toothed whales and dolphins gulp feed at depth (and are therefore less likely to be exposed to entrained/dissolved oil given its presence in surface water layers (<20 m) only). While mammals do not appear to exhibit avoidance behaviours, as highly mobile species, in general it is very unlikely that these animals will be constantly exposed to concentrations of hydrocarbons for continuous durations (e.g. >48–96 hours) that would lead to chronic effects. Some whales, particularly those with coastal migration and reproduction, display strong site fidelity to specific resting, breeding and feeding habitats, as well as to their migratory paths. There are migratory and distribution BIAs identified for humpback whales and pygmy blue whales, respectively. Oil in biologically important habitats may disrupt natural behaviours, displace animals, reduce foraging or reproductive success rates and increase mortality. Dugongs may occur within EMBA and Hydrocarbon Area with Breeding, calving, nursing and foraging grounds within the Exmouth Gulf and North West Cape regions. Presence may occur throughout the year. Presence in Shark Bay BIAs may be more seasonal, between April and November. Shark Bay falling within the EMBA and shoreline Hydrocarbon Area. Dugongs may also ingest oil (directly, or indirectly via oil-affected seagrass), and depending on the amount and type of oil, the effects could be short-term to long-term/chronic (e.g. organ damage). However, it is noted that reports on oil pollution damage to dugongs is rare (ITOPF 2014). Entrained and dissolved oil components may persist for periods of time; however, the duration of exposure is still expected to be limited. Given the predominantly transient nature of any presence of marine mammals within the in-water Hydrocarbon Area, any impact that did occur would be at an individual and not a population level for any receptor group. For those species where aggregations may occur (e.g. in BIAs), they are typically seasonal. Recovery of any impacted water column associated receptors is expected to occur. Given that the area of potential impact is relatively small in relation to the offshore environment, and cetaceans and other marine mammals would be transitory, any interface with in-water hydrocarbons is unlikely to cause an impact to	N/A

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
		significant numbers. However, there is potential for exposure to individual cetaceans and other protected fauna species, hence the impact is classified as major.	
	Surface	Marine mammals may be present within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity and impacted by surface hydrocarbons (Table 4-9). Modelling also predicts that moderate and high surface hydrocarbon exposures have the potential to extend across the EMBA including the migration and distribution BIAs for the humpback whale and pygmy blue whale, respectively. It is possible for whales to be exposed to surface hydrocarbons if the hydrocarbon release occurs during the migration period. Marine mammals are also likely to encounter surface oil as they return to the surface to breathe and baleen whales feed by surface skimming However, short-term inhalation of petroleum vapours or ingestion of surface hydrocarbons at concentrations similar to those found in oceanic spills may not be detrimental either in terms of structural tissue damage or respiratory gas exchange. Cetaceans are smooth skinned hairless mammals, so oil tends not to stick to their skin since they do not reply on fur for insulation, hence they will not be sensitive to the physical effects of oiling. Given that the area of potential impact is relatively small in relation to the offshore environment, and cetaceans and other marine mammals would be transitory, any interface with hydrocarbons is unlikely to cause an impact to significant numbers. However, there is potential for exposure to individual cetaceans and other protected fauna species, hence the impact is classified as major.	Major (4)
	Shoreline	Marine mammals are expected to be present within the EMBA and Hydrocarbon Area shoreline during the Petroleum Activity (Table 4-9). Shorelines do not occur within Operational Area. Oiling of pinnipeds (seals and sea lions) can cause removal of natural water repellent oils from their fur making them less buoyant and susceptible to hypothermia (Kucklick, 1997). However, given that oil will be significantly weathered and dispersed by the time it reaches the pinniped habitats, it is unlikely to result in significant exposure to a large population. The highest potential risks for dugongs are related to direct ingestion of seagrass or macroalgae exposed to acute or chronic toxicity and or drastic reduction on seagrass coverage due to hydrocarbon spills (Heinsohn *et al.*, 1977). However, as explained for these receptors, impacts are unlikely to be extensive and are recoverable. Given that oil will be significantly weathered and dispersed by the time it reaches the pinniped or dugong habitats, any interface with hydrocarbons is unlikely to cause an impact to significant numbers. However, there is potential for exposure to individual protected fauna species, hence the impact is classified as major.	Major (4)
Marine reptiles (turtles and seasnakes)	Surface	Marine turtles may be present within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity and impacted by surface hydrocarbons (Table 4-13). The presence of most marine reptile species within the Hydrocarbon Area and Operational Area are expected to be of a transitory nature only.	Major (4)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
		Species of sea snakes and marine turtles are known to occur in the Hydrocarbon Area. There are a number of BIAs for turtle species (flatback, green, hawksbill, loggerhead) that occur within the Hydrocarbon Area (Table 4-12). An internesting flatback turtle BIAs exist within Operational Area, based around nesting locations within the Dampier Archipelago (30 km from Operational Area) however flatback, green, hawksbill, loggerhead may occur in transit. Two species of sea snake listed as Protected may occur in the EMBA; Short-nosed Seasnake and Leaf-scaled Seasnake. The short-nosed sea snake may occur within the Operational Area however prefers the reef flats or shallow waters along outer reef edges in water depths to 10 m and generally stay within 50 m of the reef. The leaf-scaled seasnake occurs on the reefs of the with Sahul Shelf in Western Australia, particularly on Ashmore and Hibernia Reefs within the EMBA. Spill modelling results predicts zones of high and moderate surface hydrocarbon exposures in these areas in the event of a well blow out (Appendix 2). Marine reptiles are likely to come in contact with oil in the event of a spill as they surface to breathe. Marine turtles can be exposed to oil externally (e.g. swimming through oil slicks) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Several aspects of turtle biology and behaviour place them at particular risk, including a lack of avoidance (NOAA 2010b) and large pre-dive inhalations (Milton and Lutz 2003). Harmful effects may occur through ingestion of oil, inhalation of toxic vapours (e.g. close to the spill source) or irritation to the head, neck and flippers due to oil contact with the skin. Within the immediate vicinity of the spill event, where hydrocarbons are still fresh, this could lead to fatal impacts on individuals. No confirmed reports of impacts to marine wildlife were received or surveyed during the Montara oil spill scientific monitoring studies (UniQuest 2010). Given the presence of marine reptiles in the Hydrocarbon Area are expected to be transitory, the exposure of marine reptiles to surface hydrocarbons is unlikely to have a population effect. Subsequently the potential impact is single fatalities of protected species; hence the impact is classified as major.	
	Shoreline	Marine turtles and seasnakes may be present within the EMBA and Hydrocarbon Area shorelines during the Petroleum Activity and impacted by shoreline hydrocarbons (Table 4-13). The Hydrocarbon Area contains shoreline habitats critical to the survival of marine turtles where genetic stocks are present (Section 4.3.4.6). Critical shoreline habitats for marine turtles within the Hydrocarbon Area are listed in Table 4-11. Spill modelling results indicate that moderate shoreline accumulation may occur at nesting locations critical to the survival of marine turtles (Appendix 2). Shallow water habitats key to nesting and inter-nesting sites occur within Dampier Archipelago, Ningaloo Reef and offshore islands (e.g. Barrow Island, Montebello Islands) occur within Hydrocarbon Area (Table 4-12). In the unlikely event that hydrocarbons did accumulate at a turtle nesting area, there is potential for adult turtles and/or hatchlings to be impacted within Hydrocarbon Areas. Potential impacts include smothering of adults and hatchling and/	Major (4)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
		or avoidance behaviour of adult turtles. This could result in failed or aborted nesting attempts or a reduction in survival rates of hatchlings. As many turtle species do not nest exclusively within a single area, and as all of these areas would not be impacted for this scenario, the impact is unlikely to affect the viability of the species, but may result in a significant but recoverable impact to the population if hatchlings over a season are impacted. Seasnakes occurring on reef systems within shoreline Hydrocarbon Area may be impacted. As there is a potential for more than a single protected species fatality the impact is classified as Major.	
Birds	Surface	There are multiple species (or species habitat) of birds that may occur within the EMBA, Hydrocarbon Area and Operational Area (The wedge-tailed shearwater is a migratory visitor to WA and may occur within the EMBA and Hydrocarbon Area (Table 4-4). Estimates indicate more than one million shearwaters migrate to the Pilbara islands each year (DBCA 2017). The wedge-tailed shearwater will excavate burrows on vegetated islands for nesting. Known breeding locations in the North-west Marine Region. Breeding locations within the Hydrocarbon Area include Forestier Island (Sable Island), Bedout Island, Dampier Archipelago, Passage Island, Lowendal Island, islands off Barrow Island (Mushroom, Double and Boodie Islands), islands in the Onslow area (including Airlie, Bessieres, Serrurier, North and South Muiron and Locker Islands) (DEWHA 2008a) Breeding locations within the broader EMBA are inclusive of those with Hydrocarbon Area as well as islands in the Freycinet Estuary, and south Shark Bay (Slope, Friday, Lefebre, Charlie, Freycinet, Double and Baudin Islands) (DEWHA 2008a). The fairy, lesser crested and roseate terns may have both a resident sub-population and a migratory population present in the Pilbara (DBCA 2017). These tern species nest in open areas, typically sand scrapes/depressions on the sandy beaches of offshore islands. Within the EMBA these tern species are known to nest within the region of the Ningaloo Marine Park, Muiron and Sunday islands (CALM 2005). The Montebello Islands support the largest breeding population of roseate terns in WA (DEWHA 2008). Ningaloo Marine Park, Muiron and Sunday islands, and Montebello Islands occur within the Hydrocarbon Area. Caspian terns, little terns, and ospreys have also been known to breed on Serrurier Island and neighbouring inshore islands (DEWHA 2008) within the Hydrocarbon Area. Bedout Island (offshore from Port Hedland and within the Hydrocarbon Area) supports one of the largest colonies of brown booby in WA (Figure 3 10); the masked booby, lesser frigatebird, roseate tern and common noddy also breed in the area (DEWHA 2008). Tropicbird species spend most of their lives at sea, typically found in tropical and subtropical seas around northern Australia. A small sand cay at Bedwell Island, within Clerke Reef in Rowley Shoals Marine Park, is one of very few breeding areas in Western Australia for the Red-tailed tropicbird. Both locations occurring within the Hydrocarbon Area.	Major (4)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
		Table 4-4). The presence of most species, particularly within the Operational Area, are expected to be of a transitory nature only. A number of threatened and migratory birds may occur in parts of the EMBA where moderate and high surface hydrocarbons are predicted (Section 4.3.4.3 and Appendix 2) and include areas with recognised offshore foraging BIAs for seabird species listed in Table 4-5. Scholten *et al.,* 1996 indicates that a layer of 25µm thick would be harmful to birds that contact the slick. Estimates for the minimal thickness of oil that will result in harm to seabirds through ingestion from preening of contaminated feathers, or the loss of thermal protection of their feathers, has been estimated at 10µm (French, 2009) to 25µm (Koops *et al.,* 2004). Oil spills can have a variety of effects including fouling of the plumage, ingestion of oil, effects on reproduction and physical disturbance. Many of the species that occur offshore are surface-feeding or plunge-diving pelagic birds, so that oil slicks would potentially interfere with feeding and increase exposure risk. Seabirds are expected to be present within parts of the EMBA where moderate and high surface hydrocarbons are predicted but their presence is expected to be transient. Hence population level impacts are unlikely, but mortality of protected seabirds may occur.	
	Shoreline	Bird species (or habitat) may occur within the EMBA and Hydrocarbon Area shoreline areas (Table 4-4). The presence of most species are expected to be of a transitory nature only. Shorelines do not occur within Operational Area. A number of threatened and migratory birds may occur within the shoreline Hydrocarbon Area. The Hydrocarbon Area contains recognised onshore breeding and resting BIAs for seabird species listed in Table 4-5. Important seabird breeding sites within the region include the Montebello/Barrow islands group, Rowley Shoals, Eighty Mile Beach and Roebuck Bay. All areas are within the EMBA and Hydrocarbon Area (Section 4.3.4.3). Given these shorelines provide habitat for a range of species, a large number of seabird mortalities may potentially occur if an oil spill reaches these areas during critical periods. Given all areas will not be impacted, the impacts are not likely to affect species viability, the impact is classified as Major.	Major (4)
Socio-economic receptors			
Commonwealth and State Managed Fisheries and Aquaculture	Surface/ entrained	There are a number of Commonwealth and State fisheries with management areas that intersect the EMBA and Hydrocarbon Area (Section 4.3.5.1, 4.3.5.2, 4.3.5.3 Commonwealth managed fisheries (Table 4-15) and State managed (Table 4-16) may be a relevant receptor to aspects of the activity occurring within the Operational Area; however it is unlikely that fishing activity will occur in the Operational Area due to the restricted zones. No Aquaculture projects exist within Operational Area. Within the EMBA, the low threshold for floating oil and shoreline contact has potential for some socioeconomic impacts (NOPSEMA 2019), however these impacts are expected to be temporary.	Moderate (3)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
		In the event of a significant oil spill, surface oil is less likely to result in direct impacts to the fish but may interfere with fishing operations through damage to vessels and fishing gear, exclusion to areas during clean-up operations and any follow-up monitoring and surveillance activities. There is also a potential that perceptions of fish tainting due to the spill could indirectly result in economic impacts to the fishery. Fish species themselves, are more likely to be impacted by in-water hydrocarbons as they dwell in the water column. Refer also to impact assessments for related receptors, including fish and sharks. Tainting is a change in the characteristic smell or flavour of fish and may be due to oil being taken up by the tissues or contaminating the surface catch (McIntyre et al 1982). Taint in seafood renders it unfit for human consumption or unsellable due to public perception. Tainting may not be a permanent condition but will persist if the organisms are continuously exposed; but when exposure is terminated, depuration will quickly occur (McIntyre et al 1982). A major oil spill may result in the temporary closure of part of fishery management areas. It is unlikely that a complete fishery would be closed due to their large spatial extents, but the partial closure may still displace fishing effort. Given all areas will not be impacted, the impacts are expected to be limited to temporary closures, the impact is classified as moderate.	
Commercial Shipping	Surface	Commercial shipping may be a relevant receptor to aspects of the activity occurring within the EMBA, Hydrocarbon Area and Operational Area during the Petroleum Activity. The Operational Area is approximately 25 km from the northbound shipping fairway from Dampier (Figure 4-22). There are significant commercial shipping activities within the EMBA and Hydrocarbon Area (Section 4.3.5.6). The impact on shipping in the event of a well blowout is potential modification of shipping routes to avoid the area affected. Given all areas will not be impacted and impacts are expected to be limited to temporary exclusion of area affected, the impact is classified as minor.	Minor (2)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
Other users	Surface	A number of tourist destinations occur within the EMBA and Hydrocarbon Area, and include the Ningaloo Coast (Section 4.3.5.8). However, none occur within Operational Area. Within the EMBA, the low threshold for floating oil and shoreline contact has potential for some socioeconomic impacts (NOPSEMA 2019), however these impacts are expected to be temporary. In the event of a loss of well, there is the potential for temporary changes to socio-economic users occurring within the EMBA. Depending on the fate and trajectory of the oil, tourism activities which could have a temporary impact to the tourism industry. As persistent hydrocarbons are likely to dissipate from the environment over time, and as the volumes ashore suggest remediation may be difficult or expensive, impacts are expected to be extensive but temporary. More broadly in the region, the impacts to humans and the activities themselves are not likely to be significant; however, there is the potential for temporary closure of recreational activities, including diving, for risk to public health and safety. This would be short term and limited to the area immediately affected by a spill. There is a possibility of impacts to tourism operators due to actual or perceived impacts to aesthetics and the regional marine resources by the general public through negative media attention. Any closures would be short term in nature, as entrained hydrocarbons will naturally disperse, and any shoreline accumulation would breakdown due to natural weathering processes. As such, potential impacts are considered to be *extensive* but temporary.	Moderate (3)
Protected areas			
World Heritage Areas	Surface/ shoreline/ entrained	The Ningaloo Coast WHA and Shark Bay WHA occur within the EMBA (Section 4.3.6.1) may be impacted in the event of a well blowout. However, the Hydrocarbon Area only encompasses Ningaloo Coast WHA.The values associated with Ningaloo Coast WHA and Shark Bay WHA has been assessed in terms of the protected/threatened species and marine habitat and socioeconomic receptor sections outlined above.	As above
Australian Marine Parks	Surface/ shoreline/ entrained	Australian Marine Parks located within the EMBA and Hydrocarbon Area are listed in Table 4-19. There are no Australian Marine Parks within the Operational Area. The values associated with Australian Marine Parks have been assessed in terms of the protected/threatened species and marine habitat and socio-economic receptor sections outlined above.	As above
State Marine Protected Area	Surface/ shoreline/ entrained	State Marine Reserves located within the EMBA and Hydrocarbon Area are listed in Table 4-21. There are no State Marine Protected Area within the Operational Area. The values associated with State Marine protected areas have been assessed in terms of the protected/threatened species and marine habitat and socio-economic receptor sections outlined above.	As above
Ramsar Wetlands	Surface/ shoreline/ entrained	Eighty-mile beach Ramsar site is located within the EMBA and Hydrocarbon Area (Section 4.3.6.4). The values associated with Eighty-mile beach Ramsar site has been assessed in terms of the protected/threatened species and marine habitat and socio-economic receptor sections outlined above.	As above

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
Key ecological features			
Ancient coastline at 125m depth contour	No exposure	The EMBA and Hydrocarbon Area overlaps the Ancient coastline at 125m depth contour KEF (Section 4.3.6.5). However, modelling of in-water hydrocarbons was predicted to be limited to surface water depths of 0 to 20 m (Appendix 2). Subsequently there will be no hydrocarbon exposure to the seabed values of this KEF.	No exposure
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	Entrained	The EMBA and Hydrocarbon Area overlaps the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF (Section 4.3.6.5). However, modelling of in-water hydrocarbons was predicted to be limited to surface water depths of 0 to 20 m (Appendix 2). Subsequently there will be no hydrocarbon exposure to the sub-bottom habitat values of this KEF. There is potential for marine mammals, reptiles and seabirds transiting the KEF to be exposed moderate levels of entrained hydrocarbons. Potential impacts of Wandoo Crude on marine mammals, reptiles and seabirds are outlined above.	Moderate (3)
Commonwealth Waters adjacent to Ningaloo Reef	Surface	The EMBA and Hydrocarbon Area overlaps the Commonwealth Waters adjacent to Ningaloo Reef KEF (Section 4.3.6.5). There is potential for intertidal reefs in the area to be exposed to moderate levels of entrained and shoreline hydrocarbons. Potential impacts of Wandoo Crude on corals are outlined above. There is potential for marine mammals, reptiles and seabirds transiting the area to be exposed to moderate levels of entrained and surface hydrocarbons. Potential impacts of Wandoo Crude on marine mammals, reptiles and seabirds are outlined above.	Moderate (3)
Continental slope demersal fish communities	Surface	The EMBA and Hydrocarbon Area overlaps the continental slope demersal fish communities KEF (Section 4.3.6.5). Demersal fish communities associated with this KEF are found in water depths between 100 to 300 m (Section 4.3.4.4). Modelling of in-water hydrocarbons was predicted to be limited to surface water depths of 0 to 20 m (Appendix 2). Subsequently there will be no hydrocarbon exposure to the demersal fish communities values of this KEF. However commercial fishing operations within the area may be affected by exclusion zones in the event of a spill. Potential impacts of Wandoo Crude on commercial fisheries are outlined above.	Moderate (3)
Western demersal slope	No exposure	The Western demersal slope KEF occurs within the EMBA but is not located in the Hydrocarbon Area (Section 4.3.6.5). The values of this KEF are not exposed to levels of hydrocarbons that will illicit an impact.	No exposure
Exmouth Plateau	No exposure	The EMBA and Hydrocarbon Area overlaps the Exmouth Plateau. The Exmouth Plateau lies at water depth of approximately 500m to more than 5,000m (Section 4.3.6.5). Modelling of in-water hydrocarbons was predicted to be limited to surface water depths of 0 to 20 m (Appendix 2). There will be no exposure to Wandoo Crude at these depths. Subsequently there will be no hydrocarbon exposure to the seabed values of this KEF.	No exposure
Glomar Shoals	Surface	The Glomar Shoals KEF lies within the EMBA and Hydrocarbon Area (Section 4.3.6.5). Modelling of in-water hydrocarbons was predicted to be limited to surface water depths of 0 to 20 m (Appendix 2). The Glomar Shoals are a	Moderate (3)

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
		submerged littoral feature in water depths of 33 – 77m. Subsequently there will be no hydrocarbon exposure to the values of this KEF. However commercial fishing operations within the area may be affected by exclusion zones in the event of a spill. Potential impacts of Wandoo Crude on commercial fisheries are outlined above.	
Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals	Surface	Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals KEF is located within the EMBA and Hydrocarbon Area (Section 4.3.6.5). There is potential for intertidal reefs in the area to be exposed to moderate levels of entrained and surface hydrocarbons. There is potential for marine mammals, reptiles and seabirds transiting the area to be exposed to zones of low and medium sea surface exposure. Potential impacts of Wandoo Crude on marine mammals, reptiles and seabirds are outlined above.	Major (4)
Wallaby Saddle	No exposure	Wallaby Saddle is an area of seafloor in 4,000m to 4,700m water depths located within the EMBA but outside of the Hydrocarbon Area (Section 4.3.6.5). Modelling of in-water hydrocarbons was predicted to be limited to surface water depths of 0 to 20 m (Appendix 2). There will be no exposure to Wandoo Crude at these depths.	No exposure
Ancient coastline at 90m to 120m depth	No exposure	The Ancient coastline at 90m to 120m depth is located within the EMBA but outside of the Hydrocarbon Area (Section 4.3.6.5)., hence there will be no hydrocarbon exposure to values of this KEF that will illicit potential ecological impacts.	No exposure
Commonwealth marine environment surrounding Houtman Abrolhos Islands	No exposure	The Commonwealth marine environment surrounding Houtman Abrolhos Islands KEF lies within the EMBA but outside of the Hydrocarbon Area, hence there will be no hydrocarbon exposure to values of this KEF that will illicit potential ecological impacts.	No exposure
Perth Canyon and adjacent shelf break and other west coast canyons	No exposure	The Perth Canyon and adjacent shelf break and other west coast canyons KEF lies within the EMBA but outside of the Hydrocarbon Area, hence there will be no hydrocarbon exposure to values of this KEF that will illicit potential ecological impacts.	No exposure
Western rock lobster	No exposure	The Western rock lobster KEF lies within the EMBA but outside of the Hydrocarbon Area, hence there will be no hydrocarbon exposure to values of this KEF that will illicit potential ecological impacts.	No exposure

Environmental sensitivity	Exposure mechanism	Impact	Consequence classification
Commonwealth marine environment adjacent to the west coast inshore lagoons	No exposure	The Commonwealth marine environment adjacent to the west coast inshore lagoons KEF lies within the EMBA but outside of the Hydrocarbon Area, hence there will be no hydrocarbon exposure to values of this KEF that will illicit potential ecological impacts.	No exposure
Canyons linking Argo Abyssal Plain with Scott Plateau	No exposure	The Canyons linking Argo Abyssal Plain with Scott Plateau KEF lies within the EMBA but outside of the Hydrocarbon Area, hence there will be no hydrocarbon exposure to values of this KEF that will illicit potential ecological impacts.	No exposure

6.2.3.1 *Cumulative impacts*

Whilst none of the individual impacts detailed in Table 6-3 are ranked above Major (4) the cumulative impacts has been assessed as having Catastrophic (5) potential.

6.2.4 Catastrophic Environmental Event identification

As discussed in Section 6.2.3 above, catastrophic impacts would only result from a full-bore well release from a newly drilled well which still flow can naturally with a high oil cut. It is only under these circumstances that a release of 25,555 m^3 would result.

The identified CEE is therefore designated as CEE-01 – Well blowout (Full-bore blowout from oil-producers with low water cut that can flow naturally to surface).

6.2.5 Critical Controls identification

In accordance with the process described in Section 5.4.2 all controls for CEE-01 – Well Blowout have been assessed for criticality. This assessment has resulted in a concise listing of identified Critical Controls as provided in Table 6-4. The preventative measures are described in Section 7.3 and the mitigation measures in Section 6.2.6 below.

Table 6-4: CEE-01 Critical Controls

Hazard	Activity/Cause/Mitigation	Critical Control
CEE-01 Well blowout (Full-bore blowout from oil-producers with low water cut that can flow naturally to surface)	Loss of both primary and secondary well control during well construction activities when the reservoir pressure is being controlled by a hydrostatic fluid column	Primary well control systems.
		Secondary well control equipment.
		Well barrier envelope.
		Well construction/intervention program.
	Drilling collision.	Primary Well Control Systems.
		Secondary well control equipment.
		Well barrier envelope.
		Well construction/intervention program.
		MoC.
		Contractor/vendor selection and management.
	Dropped object damaging infrastructure in well bay area.	Permit to work system.
		Operations and maintenance of lifting equipment.
		Contractor/vendor selection and management.
	Mitigation.	Isolation of wells as part of the facility Emergency Shutdown (ESD).
		Wandoo Emergency Response Plan [VOG-2000-RD-0017]/ Source Control Contingency Plan [WNB-3000-PD-0007]/ Wandoo Field OSCP [WAN-2000-RD-0001].

6.2.6 Mitigation measures

Mitigation measures associated with a loss of well control centre around two primary activities: those focused on stopping flow from the well, source control; and those focused on protecting the environment from the impact of the spilt hydrocarbons.

6.2.6.1 *Source Control*

The management of resources, information and communications via the implementation of established procedures is absolutely essential for effective emergency response in order to ensure protection of life, property and the environment.

VOGA has a Source Control Contingency Plan [WNB-3000-PD-0007] and an associated preliminary Relief Well Basis of Design in place for all well construction activities. This provides a guideline to the required response and event hierarchy to a well control event, either contained or uncontained and the processes that shall be followed in the event of a well control incident during well construction and/or intervention operations in the Wandoo Field. The acceptability of the VOGA Source Control Contingency Plan has been demonstrated in the Wandoo Well Operations Management Plan [VOG-1000-YG-0006] which has been accepted by NOPSEMA.

The VOGA Source Control Contingency Plan identifies that if a loss of well control cannot be controlled via secondary well control procedures (e.g. closing a BOP), well fluids may continue to be released until a relief well is drilled or the well is capped at the surface and the flow intersected.

Plans for drilling a relief well will begin in parallel to progressing other well intervention options aimed to stop the flow of hydrocarbon or to permanently secure the primary well. Subsea well capping is not a viable option for stemming the flow of a well blow out at Wandoo, due to blowouts occurring at the sea surface.

In the event of an uncontrolled surface blowout, unless the well kills itself via bridging off or reservoir depletion, the well is killed by means of dynamic kill (i.e. relief well) or some form of surface intervention. If well integrity is intact and access to the wellhead is possible, a surface capping operation may be attempted in parallel while a relief well is drilled. The relief well kill technique may also be combined with plugging materials for highly prolific blowouts. This technique was used in Argentina in 1993, where a high rate gas blowout was killed by simultaneously pumping through the drill pipe (snubbed into the blowout well), and the relief well annulus. These options would be explored at the time of the spill based on the type of blow-out and the ability for personnel to safely attempt surface intervention techniques.

VOGA has contracted Wild Well Control Inc. to support the management of any well control incident occurring in VOGA's operations and to provide technical assistance and specialised firefighting equipment and personnel. VOGA also has service agreements in place with specialists for the purposes of dynamic well kill modelling and engineering.

A relief well will intersect the uncontrolled zones from the primary well and specialised plugging fluids will be pumped into the well to overcome the reservoir pressure. Well kill modelling will be conducted to confirm the fluid rates, pump rates and volumes that will be required to maintain integrity of the primary bore.

In the event a relief well is required, VOGA will mobilise an appropriate MODU from local or international sources that has the required specifications to drill a relief well and regain control over the well that is blowing out.

The process associated with planning and drilling of a relief well if required is estimated to take at least 60 days, which is longer than the duration of flow from the well. This is based on time estimates for the following tasks:

- Event reported and begin mobilisation of rig for relief well drilling – 1 day.
- New rig suspends operations at current location whilst preparing for relief well and rig mobilisation –22 days.
- Spud and drill relief well to intersect wellbore and bottom kill well to control source – 37 days.

VOGA has reviewed the schedule of source control activities and is unable to reduce timing to a point where we can reduce spill duration to below 43 days, see Section 6.2.7.2.1. The Oil Spill response Capability review ensures that Source Control Contingency Plan and resources are reviewed and managed to enable the lowest reasonably practical response duration.

The VOGA Source Control Contingency Plan is reviewed for adequacy at least every five years in line with statutory Wandoo Well Operations Management Plan revisions, as well as each time the Wandoo Well Operations Management Plan is revised for any other reason. The plan is reviewed prior to each drilling campaign to ensure any relevant well specific considerations and technical studies for a relief well kill are addressed to ensure its applicability.

The VOGA Source Control Contingency Plan would also be reviewed prior to implementation as part of any source control contingency execution.

6.2.6.2 *Spill Response*

The response strategies to reduce the environmental impact from this hazard scenario are outlined within Section 2.5 and are implemented through the Wandoo Field OSCP [WAN-2000-RD-0001]. These response strategies are consistent with those outlined in the National Plan and have been determined through VOGA's spill preparedness planning process, described in Section 6.3.5.1.

The planning process results provide an effective mitigation of the environmental impacts of this hazard scenario by identifying suitable spill response strategies which:

- Are appropriate for the hazard profile described and assessed in Sections 6.5.1;
- Consider the benefits of each strategy as outlined in Section 6.5.2; and
- Consider the risks and impacts of each strategy as outlined in Section 6.5.3.

The Oil Pollution Plan (OPP) 2 for this category of spill is based on potential impacts to a number of sensitive shorelines.

These priorities will be verified in a response with real time trajectory data and analysis of seasonal vulnerabilities through the SIMA process. For planning purposes they present as the protection priorities for the initial OPP and first series of IAPs.

On this basis, the response strategies proposed for this hazard include:

- Monitor and evaluation;
- Chemical dispersion;
- Containment and recovery;
- Mechanical dispersion;
- Protection and deflection; and
- Shoreline clean-up.

The impact profile of the spill hazard and subsequent response strategy is reflected in an objective for the response strategy. These outcomes align with the VOGA Critical Procedure Performance Standard for Element 8 – Oil Spill Response [WAN-WNAB-CP-ER-02 and WAN-WNAB-CP-ER-03] key requirements. The resources required to achieve the objective were defined and based on:

- Operational limitations, e.g. metocean conditions, equipment functional capacity/coverage, safety of response personnel;
- Constraints of equipment effectiveness;
- Scale of hazardous event including:
- when and where the resource would be required, based on the results of consequence modelling (e.g. time to impact, thresholds and probability);
- duration of resource use.
- Ancillary resources required to support primary response option;
- Skill-sets required for specific roles (e.g. shoreline survey and assessment, offshore boom and skimmer operation, aerial observation);
- Logistical considerations including:
- location and size of stockpiles available to VOGA;
- mobilisation times;
- logistical requirements for safe deployment of materials and equipment;
- the review allowed for the stockpile locations and availability to be verified for the Australian Marine Oil Spill Centre (AMOSC), Australian Maritime Safety Authority (AMSA) and Oil Spill Response Ltd (OSRL) stockpiles;

- Existing service provider contracts to be reviewed and resources available updated; and
- ALARP review to assess options to further improve delivery of the response strategy objective.

An assessment of the benefits of the oil spill response strategies that are considered feasible for application in response to a spill of this nature is provided in Table 6-5. The response strategies not considered feasible are outlined in Table 6-6.

The impacts of the oil spill response strategies are assessed in Section 6.5. The impacts outlined in this section were considered in the strategy selection process.

Table 6-5: Feasibility and benefits of response strategies for a Category E spill

Response strategy	Feasible	Benefits
Monitor and evaluate	Yes	Monitoring and evaluation provides up-to-date information on the behaviour and likely trajectory of the spill. This will be used to select the most appropriate response strategy and to evaluate its effectiveness.
Chemical dispersion	Yes	Chemical dispersion assists with the natural dispersion process encouraging the slick to mix and suspend within the water column where it can be more easily biodegraded. Laboratory results show that chemical dispersant is effective on weathered and unweathered samples of Wandoo Crude and that dispersant can achieve an efficacy of up to 100% if used in the first three days of weathered oil (ChemCentre 2015). OSTM for this scenario was undertaken with and without the application of dispersant for the worst-case model runs. The OSTM examined the potential benefit of applying surface dispersant as a mitigation measure (referred to as the mitigated case). The benefit of reducing the volume of surface oil against the potential impacts of increasing the volume of subsurface oil and the introduction of dispersants into the environment was assessed based on the OSTM results. Based on an analysis of the OSTM results provided in (Appendix 2), it was concluded that: • For area of surface oil: the maximum distances from the release location to the moderate (10–25 g/m^2) and high (> 25 g/m^2) exposure thresholds was 902 km west and 369 km west-southwest, respectively, for the unmitigated case and 685 km north (summer) and 358 km west-southwest (transitional), respectively, for the mitigated case; • For length of shoreline contact: for the unmitigated case, the greatest length of shoreline contact at, or above, the low threshold (10 g/m^2) during the summer, transitional and winter seasons was 898 km, 227 km and 233 km, respectively, compared to 691 km, 160 km, 190 km for the mitigated case, or a reduction of 30%, 42% and 22%, respectively; and • For volume of oil on shore: the greatest volume of oil on shore from a single spill trajectory was predicted to reduce from 5,606 m^3, to 2,737 m^3 when the mitigation option was considered. This represented a reduction of 45%. The probability of dispersants reducing the net environmental impacts of the spill will be assessed if shoreline contact is predicted. Regardless of season, a dispersant test spray run will be carried out to verify its effectiveness prior to moving to full dispersant application operations.

Response strategy	Feasible	Benefits
Containment and recovery	Yes	Containment and recovery can be used to recover oil to prevent it impacting on environmental, social and cultural sensitivities. The effectiveness of containment and recovery depends on the thickness of the oil and weather and sea-state conditions. Containment and recovery may be effective on Wandoo Crude as it is a persistent crude oil with a high specific gravity and viscosity. OSTM results show that there a probability of sensitive marine resources being impacted by oil at a thickness greater than $10g/m^2$, hence containment and recovery will be considered for this scenario. Depending on metocean conditions, containment and recovery is expected to have a removal efficiency of 10% to 15% for a large spill (ITOPF, 2013).
Mechanical dispersion	Possible	Mechanical dispersion assists with the natural dispersion process, encouraging the slick to mix and suspend within the water column where the smaller droplet size enhances the natural biodegradation process. Mechanical dispersion may also be used to assist the chemical dispersion process when sea conditions are calm. Mechanical dispersion is used when surface oil presents a greater risk to the marine environment than entrained oil.
Protection and deflection	Yes	Protection and deflection (use of booms) can be used to protect sensitive receptors by creating physical barriers on the water surface. Corralling is generally effective on persistent oils such as Wandoo Crude. The effectiveness of protection and deflection depends on the thickness of the oil and metocean conditions. Protection and deflection is likely to be used in cases where shoreline contact by visible floating oil is predicted. Protection booms will be deployed if monitoring identifies that visible oil is approaching sensitive receptors and if the assessment shows that the use of booms will result in a net environmental benefit (as assessed through the spill impact mitigation assessment (SIMA).
Shoreline clean-up	Yes	The OSTM predicts that stranding on shorelines will occur with this magnitude of spill. Consequently shoreline clean-up is likely to be used as one of the response strategies. Shoreline clean-up is an intrusive response that requires careful site specific planning in order to reduce secondary impacts such as beach erosion and the spreading oil beyond shorelines. Flushing may be considered if the oil enters high priority/slow recovery habitats such as mangroves. Natural dispersion will occur as the oil is remobilised from rock shelves and hard substrates, while any residual oil will biodegrade. However, shoreline clean-up techniques will only be applied if the assessment shows that they will result in net environmental benefit (as assessed through the SIMA).
Oiled wildlife response	Possible	This is applicable for marine fauna that come into contact with the spill and become oiled. Oiled wildlife response can minimise environmental impacts by: • reducing the oiling of wildlife by preventing animals entering the impacted environment; and • if practical, the initiation of pre-emptive capture and removal of animals at risk. If animals are oiled prompt initialisation of oiled wildlife response provides a means for rehabilitation and release or humane euthanasia to minimise suffering.

The response strategies will be implemented in accordance with the Wandoo Field OSCP [WAN-2000-RD-0001].

Table 6-6: Response strategies not considered feasible for a Category E spill

Response strategy	Feasible	Considerations
In-situ burning	No	VOGA does not consider in-situ burning as a suitable response option because the flash point of Wandoo Crude (144°C) and the thermodynamic properties of Wandoo crude being unable to sustain sea surface fire.

6.2.7 ALARP demonstration

6.2.7.1 *Loss of Well Control*

The risk associated with a release of hydrocarbon from wells is inherent to the drilling of a petroleum well, however these risks can be managed through the implementation of effective control measures and associated performance monitoring. The ALARP assessment has concluded that the risks are being managed to ALARP because:

- there are sufficient layers of protection in place for the current risk level; and
- additional controls and alternative arrangements were not considered to be practical due to the associated increase to other risks.

Options for additional or alternative prevention measures that could be considered are:

- Higher density drilling and completions fluids could be used to provide greater overbalance on reservoir pressure during operations. However, the fluids currently used already provide significant overbalance. Additionally, increasing the level of overbalance would increase the risk of losses to the formation during operations;
- Higher rated BOP and wellhead components could be used to provide additional redundancy against failure. The maximum surface pressure that could be experienced during a loss of well control at Wandoo is approximately 30% of the currently used, lowest rated, wellhead or BOP component. The industry norm is to specify equipment that is rated to no less than 80% of the maximum anticipated surface pressure. VOGA already significantly exceeds this norm; and
- The number of barriers available during operations could be increased. VOGA standards require two barriers to be in place at all times during operations. Increasing the number of barriers would add significantly to the operational cost.

Consequently, no alternative or additional practicable prevention measures were identified during the risk review process.

6.2.7.2 *Source control*

To assess whether the relief well option results in the risks and impacts being managed to ALARP, the plan was subject to an evaluation to determine if more could be done sooner and identify what the environmental benefit and associated cost would be.

VOGA has reviewed the schedule of source control activities and is unable to reduce timing to a point where we can reduce spill duration to below 43 days. This is based on the following assumptions:

- that the relief well drilling operation itself could not be undertaken any faster, at least 37 days;
- the critical path stage for the relief well plan was identified be the mobilisation including regulatory approvals of the rig, at least 22 days.

VOGA is a signatory of the Australian Industry Mutual Assistance Agreement. The purpose of the MoU is to provide the general principles by which an Assisting Operator may in its entire discretion offer to transfer a drilling unit and/or associated well services to the location of an emergency. To reduce this time, a dedicated rig, suitable for drilling a relief well would need to be available on standby.

If such a rig with necessary approvals was available and located in Dampier it could reduce the mobilisation time from 22 days to 5 days, however the total duration and volume of spill is unlikely to change (37+1+5 = 43 days). The insignificant reduction in oil is based on blowout release data the well would naturally stop flowing within 43 days.

Based on the estimated standby rig costs (at least ~AUD$200k-250k day rate), this would result in an additional 25% overhead for the drilling campaign which would make any campaign uneconomical for no or minimal reduction in environmental impact. .

The ALARP review of the relief well response strategy to meet the environmental objective is provided in Table 6-7.

Table 6-7: Relief Well ALARP review

Tactic to achieve the objective	Applicability	Resource requirements
Establish initial Technical Support Teams within 96 hours and full teams within 7 days.	The Corporate Command Operations Chief, in conjunction with the Incident Commander and WWCI, will authorize the assembly of the following dedicated technical teams to undertake the well kill and relief well planning and execution activities outlined in the SSCP: - Well Control Response Team - Subsurface Team - Relief Well Planning Team	**6 x Technical Support Teams Personnel (Initial – 96 hours)** **15 x Technical Support Teams Personnel (Full – 7 days)** VOGA has 2 subsurface team members during operations, and a consultant based (in Perth office) offshore drilling team (8-10 ppl) available during well construction and intervention programs that would be utilised for a relief well; Current contract with Wild Well Control that can provide an initial 2 personnel for the Relief Well Planning Team, and 6 people within one week; VOGA also has the option, with its international offices, to call on additional internal technical

Tactic to achieve the objective	Applicability	Resource requirements
		support. In addition, VOGA's Perth office has contracts in place with major Service Companies during well construction and intervention programs for specialised personnel to assist in blowout response.
Relief Well Planning tasks completed prior to spud (within 22 days).	The following key planning tasks are required prior to relief well drilling operations: - Identify well kill options - Determine site survey requirements - Review Relief Well Strategy and Basis of Design - Well Kill and Flow Modelling - Well Programs - Internal HSE and Risk assessments/documentation	**Technical Support Teams Personnel** (same as above) plus: **2 x Modelling Personnel within 96 hours** **4 x Modelling Personnel within 7 days.** **2 x VOGA HSE Personnel** Contract with Add Energy to mobilise personnel for dynamic well kill and flow modelling.
Undertake Site Survey prior to spud (within 22 days)	Dependant on the type of MODU to be utilised, different levels of site survey may be required. • Drilling Contractors require site survey data to establish the sea-bed conditions and stability and shallow gas risk. • The site survey must be designed to identify any sea-bed or near sea-bed obstructions or anomalies (such as pipelines, wellheads, wrecks, oil/gas seeps, surface faults, shallow gas etc)	**1 x Site Survey Vessel + Crew** Survey contractor (i.e. Fugro or Neptune) would be able to be engaged within the timeframe required.
Regulatory Approvals completed prior to spud (within 22 days)	Following approval documents required to be reviewed and accepted by NOPSEMA prior to relief well drilling: - Well Construction Environment Plan - Wandoo Facility Safety Case - MODU Safety Case (by MODU contractor) - WOMP (new one required).	**2 x VOGA HSE Personnel (Safety Case and Environment Plan)** **2 of the Technical Support Teams Personnel (WOMP)**
Drill rig, equipment and logistics onsite and drilling within 22 days Relief Well completed within an additional 37 days once on site.	In the event of a surface blowout necessitating rig and/or platform abandonment, the drilling of a relief well is most likely required in order to dynamically kill the blow out well.	**1 x MODU** Based on a rig being available in Australian waters –could be mobilised to location within a range of 10 to 20 days. **2 x Vessels (Workboats) –** use of vessels contracted for drilling program

Tactic to achieve the objective	Applicability	Resource requirements
		Equipment MSAs in place with wide range of oil field equipment and service providers as part of drilling program requirements – this includes for Casing and Wellhead (this includes Cameron, Weatherford, Halliburton, Schlumberger, Drillquip).

Improvements considered	Assessment of option	Adopted/not adopted
Standby MODU for VOGA Drilling	A standby rig is not reasonable given the costs of standby arrangements (effectively doubling the costs of the drilling program) making drilling an unviable activity.	Not adopted
Standby MODU shared across APPEA MOU Titleholders	This option is not considered feasible for a number of Titleholders due to the remote distances in Australia as well as a substantial range of well depths, types, complexities, geologies and geophysical properties across a range of Titleholders	Not adopted
Pre Drilling Top Holes	This option is not considered feasible due to the uncertainties related to the location and trajectory of the intervention well, which may vary according to the actual conditions at the time the loss of containment event occurs. Additionally, there is only expected to be a minor reduction in timing for this option and it represents additional environmental impacts and costs.	Not Adopted
Use of relief well injection spool	The surface wellheads utilised already include side outlets to enable the connection of more surface pumping resources. These additional resources can deliver greater kill fluid rates to the relief well. As all Wandoo wells covered by this EP can be killed with a single relief well using mud pumping resources available on standard MODUs, the use of the relief well injection spool would not be required.	Not applicable
Maintaining relief well drilling supplies	There is not predicted to be any reduction in relief well timing or spill duration from VOGA maintaining stocks of drilling supplies (mud, casing, cement, etc.) Contingency stocks for the drilling program would be available in addition to	Not adopted

Improvements considered	Assessment of option	Adopted/not adopted
	supplies from vendors and NWS supplies of other operators. It would be feasible to source some relief well drilling supplies such as casing but the actual composition of the cement and mud required will need to be specific to the well. Due to the long lead times associated with procuring well construction equipment through manufacturing, it is necessary to design the relief well utilising sufficiently generic equipment such that equipment could either be purchased from vendor's "limited off the shelf" inventory or procured from other operators within the region utilising similar equipment. VOGA have MSAs in place with most major local oilfield service and equipment providers. The preliminary design work has been carried out on conceptual well trajectories to allow confirmation of basic relief well plans to enable detailed directional work to commence. The preliminary casing design has been conducted to confirm the ability to construct the well utilising readily available "generic" casing grades and sizes while adhering to VOGA's well construction standards for well integrity.	
Review key supplier details in the SSCP, and move to the Oil Spill Contracts List	Improvement to ensure that the resources identified are current and their details available in appropriate emergency documentation.	Adopted
Investigate the inclusion of relief well activities within Wandoo Facility EP and Safety Case to enable more rapid regulatory approvals.	Improvement to standby documentation to potentially reduce the time for regulatory approvals. Relief well activities are covered in the Well Construction Environment Plan and a MODU Safety case Revision template will be developed prior to spudding the well.	Adopted
Development of a source control specific IAP for the first 96 hours of a response.	Improvement to standby documentation.	Adopted

6.2.7.3 *Spill Response*

The ALARP assessment of the response strategies are described in the sections to follow. For each strategy the tactics, applicability and required resources (linked to the OPPs within the Wandoo Facility OSCP) have been identified. Alternate tactics and arrangement have also been assessed to ensure that the impacts have been mitigated to ALARP.

The ALARP review for each strategy is documented and continually managed under VOGA Oil Spill Response Capability Review [VOG-7000-RH-0009].

Monitor and evaluate

Monitoring and evaluation of a spill will be initiated in the event of any spill to the marine environment from the time of spill detection. The tactics and resources employed will be commensurate with the size and type of the spill to ensure the objectives of the resource strategy is being achieved and supporting the Incident Action Plan (IAP) decision-making process.

The ALARP review of the proposed response strategy to meet the environmental objective 'to ensure the most effective response strategies are being applied and environmental impacts of the spill and response strategies are measured' is provided in Table 6-8.

Table 6-8: Monitor and evaluate ALARP review

Tactic to achieve the objective	Applicability	Resource requirements
Monitoring to be activated from time of spill detection to inform implementation of response strategies.	Observations will inform emergency response planning by providing key information from onsite command to ICT.	N/A
Platform observations commence immediately following the detection of a spill.	Platform visual observations will inform emergency response planning by providing key information from onsite command to ICT.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements*
Visual observations from chartered vessel to be mobilised immediately following the detection of a spill.	Vessel visual observations will inform emergency response planning by providing key information from onsite command to ICT.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements*
Aerial observations to be initiated within 2 hours of spill being reported (daylight only).	Aerial visual observations will inform emergency response planning by providing key information from onsite command to ICT.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements*
Satellite imagery to be initiated within 2 hours of a spill being reported.	High fidelity photographs using different spectrums to identify the trajectory of the oil and ground truth the OSTM.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans

Tactic to achieve the objective	Applicability	Resource requirements
		Table 3-4 Monitor and evaluate resource requirements
Preliminary OSTM to be requested within 3 hours of a spill been reported. OSTM to continue as required until the termination criteria met.	Activating the OSTM within this timeframe will ensure that additional data is available to help inform the spill response.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements*
Satellite tracking buoys to be deployed within 30 minutes of a spill being reported. Tracking buoys data will be monitored and interrogated at least once every 24 hours.	Satellite tracking buoys available in Wandoo field which will help to inform initial trajectory. Deploying the tracking buoys will provide additional data to inform the spill response.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements*
Operational monitoring available to inform IAP process prior to implementation of strategies that have an environmental impact (e.g. dispersant application).	A range of surveillance and data collection methods are specified in the OPPs to gather environmental data and inform the 24 hour IAP cycle.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements*
Environmental data to support decision making (IAP) and spill impact assessment is available prior to impact.	Baseline data collection is described in the Operational and Scientific Monitoring Plan [WAN-2000-RD-0001.03]. Operational and scientific monitoring plans provide for the minimum resources required for implementation. Resources can be scaled up according to situational need.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements* Operational and Scientific Monitoring Plan [WAN-2000-RD-0001.03]
Shoreline Clean-up Assessment Technique (SCAT) teams will complete surveys before clean-up teams complete assignments so that priority locations are identified and suitable techniques are used.	Resources have been planned for tasks to prevent contact of oil to the protection priorities identified in the Wandoo Field OSCP [WAN-2000-RD-0001]	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-4 Monitor and evaluate resource requirements*.

Improvements considered	Assessment of option	Adopted / Not adopted
Earlier initiation of monitoring activities.	Pre-spill modelling and impact assessment is sufficient to inform initial response planning and resource requirements. OPPs inform the proposed response strategy and equipment items, the information from initial monitoring data helps confirm implementation of response strategies and location of response. This is sufficient time as it would take at least at least six hours to implement the other oil spill response strategies onsite.	Not adopted.
Ongoing real time collection of data prior to any spill event.	Ongoing collection of real time environmental data would provide immediate inputs into decision making however this would require the use of aerial resources, satellite resources, ground surveys and marine surveys. The existing contracts in place for aerial surveillance, satellite imagery, trajectory modelling, marine and shoreline surveys can be activated in a timeframe that provides short, medium, and long-term access to data. An ongoing surveillance program would be at considerable cost to the project. Depending on the measured parameters this could involve ongoing costs in the order of hundreds of thousands each year.	Not adopted.
Surveillance activities conducted during night-time hours. E.g. Forward looking infra-red (FLIR) systems can detect oil on water at night.	AMSA Search and Rescue (SAR) aircraft are fitted with side looking airborne radar (SLAR), FLIR, ultraviolet and infra-red marine pollution scanning sensors tuned to detect and map surface oil spills and transmit information back to shore whilst in flight. AMSA SAR aircraft are only available for oil spill response if not tasked for SAR activities. FLIR or SLAR systems are required to be installed on specific aircraft or vessels, not readily available to VOGA. The costs of sourcing such vessels/ aircraft is approximately $20,000 per day. This has not been adopted in the initial strategy given that there may be the availability of the AMSA SAR aircraft and that daylight observations will enable sufficient response planning. While this would not preclude their use in a spill, VOGA has identified that for the initial response the current arrangements are sufficient to meet the objective, and as such the system is not being planned for.	Not adopted.

Improvements considered	Assessment of option	Adopted / Not adopted
UAVs with video or FLIR can detect oil on water or shorelines in remote hard to access areas.	UAVs may provide surveillance in remote areas and could potential increase the area monitored. However, these were not adopted as it was identified that aerial surveillance proposed in the response would can undertake this task sufficiently.	Not adopted.
Access additional baseline data.	Access to baseline data to inform scientific monitoring programs is required. IGEM (Industry-Government Environmental Meta-database) is a collaboration between the Oil and Gas Industry and Government-funded organisations. Its primary goal is to enable the sharing of marine-based studies between government, industry and other stakeholders in a meta-database format. It provides members the ability to enter, view and filter metadata and export results to a report. Currently IGEM covers the marine environment between the Abrolhos Islands and the Timor Sea, out to the Australia's EEZ (Exclusive Economic Zone).	Adopted
Provision of additional response personnel.	Expanding mutual aid to include operational and scientific monitoring personnel.	Adopted - VOGA is working with industry partners to review options.
Conclusion	Achieving the environmental objective provides sufficient ability to ascertain extent of spill and assess effectiveness of response strategies.	

Dispersant application

For some of the spill categories, the oil spill response at sea may require the application of dispersant as a key response strategy.

To assess the efficacy of dispersants, VOGA has undertaken efficacy testing as well as OSTM to assess whether dispersant application provides any potential reduction in impacts from an oil spill. The effectiveness of chemical dispersant application is outlined in the Wandoo Field OSCP [WAN-2000-RD-0001] and the impacts of application of chemical dispersant versus the impacts of non-application of dispersant are assessed in Section 6.5.3.3.

Chemical dispersant will only be applied when the IAP decision-making process has determined that its application will have a net environmental benefit. Once the decision to apply chemical dispersant has been supported by the SIMA process, VOGA will mount an ongoing aerial and marine operation to apply chemical dispersant within the dispersant “go zone” (as defined in Table 6-9) to allow maximum time for dispersal, thereby reducing the likelihood of shoreline impacts.

The primary zone of application of chemical dispersant is an area of low biodiversity and in relatively deep water. Given the environmental sensitivities within the Hydrocarbon Area, the use of dispersants as an offshore response strategy will potentially minimise impacts on the ecosystems and reduce the need for extensive shoreline clean-up and remediation. A slightly negative impact is likely on the local offshore fisheries of the region, but its significance will largely depend on the extent and duration of a spill.

The ALARP review of the proposed response strategy to meet the response objective to 'Increase the rate of biodegradation to reduce the environmental impact from surface oil and oil stranding on shoreline sensitivities' is provided in Table 6-9.

Table 6-9: Chemical dispersant ALARP review

Tactic to achieve the objective	Applicability	Resource requirements
Dispersant application (aerial and marine) is available to be deployed when Wandoo Crude is most amenable to dispersant for the most effective results.	Analysis has demonstrated that by using the most effective activation timeframes for dispersant stocks, VOGA can obtain dispersant stocks for our needs and arrangements are logistically achievable. Laboratory tests demonstrate that most dispersants are suitable to use within the first 4-5 days of Wandoo Crude being released. As the oil degrades, dispersant effectiveness is reduced.	Section 0
Aerial dispersant will be available to be applied within 36 hours.	Aerial application of dispersant has been identified as the most effective means to reduce the volume of oil to shorelines and minimise the impacts of a spill.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-6 Chemical dispersant minimum requirements aerial operations*
Establish an aerial operating base within 24 hours.	Required to support refuelling and dispersant loading facilities.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-6 Chemical dispersant minimum requirements aerial operations*
Marine dispersant will be available to be applied within 36 hours.	Marine dispersant will apply dispersant to the leading edge of the oil within the dispersant application zone, whilst aerial assets and additional dispersant is mobilised.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-8 Chemical dispersant minimum requirements marine operations*
Establish a marine operating base within 24 hours.	Required to accommodate vessel and vessel crews at a location close to the response site.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-8 Chemical dispersant minimum requirements marine operations*

Tactic to achieve the objective	Applicability	Resource requirements
Use of the most effective chemical dispersant to treat Wandoo Crude.	Laboratory work regarding the window of opportunity and efficacy of dispersants available on weathered Wandoo Crude was undertaken along with detailed testing of the efficacy of dispersants for Wandoo Crude to identify best performing dispersant. ChemCentre conducted study into Wandoo Crude in the Mackay Chamber and found all dispersants in the resource list to be effective on Wandoo Crude. Dispersion modelling conducted to assess the potential change in shoreline contact associated with dispersant use.	Section 0.
Sufficient dispersant stocks available to meet first response demands.	Based on the OSTM and laboratory analysis, the most effective place for dispersant application is where is the surface oil plume is largest and less weathered. This is represented by the dispersant application zone. An assessment was made to confirm that oil within this zone can be dispersed within the operating window of the aircraft (daylight hours and the time to complete a return sortie). 30 m^3 per day of dispersant can be applied for first 2 days then up to 77 m^3 per day from day 3. This is sufficient to cover the expected surface area oil coverage within the dispersant application zone. An additional amount will be required to support marine operations.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-8 Chemical dispersant minimum requirements marine operations*

Improvements considered	Assessment of option	Adopted / Not adopted
Supply chain and consumption analysis to ensure dispersant stockpile availability for the duration of a worst-case spill.	Vermilion conducted a full supply chain and consumption analysis to assess whether there were shortfalls in supply. Review identified membership to OSRL GDS Stockpile was required and changes in supply chain were required to ensure sufficient supply was available at Dampier. This analysis is undertaken annually as part of the OSR Capability Review.	Adopted
Reduce time to application of dispersant.	For aerial dispersant activities a sensitivity analysis was conducted assessing the difference between applying dispersant after 24 hours or after 48 hours (APASA Report Q0087, 2012).	Not adopted.

Improvements considered	Assessment of option	Adopted / Not adopted
	The analysis indicated that if dispersant was applied within 24 hours instead of 48 hours, no significant reductions in the maximum volume of oil on water, oil ashore or change to the minimum time to impact would be realised. Reducing the time for application of dispersant would require either having equipment including FWADC to be located closer to the Wandoo Field, or available on standby. The FWADC are contracted via MOU's and given the requirements under the MOU need to remain at their point of origin, these specific aircraft could not be moved to Karratha and placed on standby. Consequently, additional aircraft would need to be contracted and the spray system adjusted to spray dispersant at the desired droplet size. In lieu of contracting additional aircraft, additional vessels could be used to implement a larger surface dispersant load in between application of dispersant by aircraft. However to achieve more surface dispersant application prior to 36 hours, vessels would either need to be contracted or vessels of opportunity utilised that are retrofitted with dispersant spray systems and portable tanks. Having a FWADC would introduce an ongoing cost to the operations of $30,000/day, or millions of dollars annually (either on hire or purchased craft which would require upkeep). This is not considered to be commensurate to the benefits gained by reducing the timeframe for application by 24 hours. A dedicated vessel with dispersant setup is required to guarantee application to 12-18 hours. Vermilion does not have control over fleet used for Wandoo supply activities so we are unable install equipment on a supply vessel. The costs involved in establishing a standalone vessel suitable for marine dispersant application would be $20,000/day. The outcomes of the analysis showed that there would be minimal impact from improving the dispersant application capability, especially when the costs associated with maintaining a dispersant stockpile and aircraft in Karratha are taken into consideration.	

Improvements considered	Assessment of option	Adopted / Not adopted
Additional application rates (e.g. more aircraft, vessels, associated equipment).	Review of potential oil surface area that could be dispersed was conducted and it was identified sufficient dispersant could be applied to reduce impact of surface oil. The resources have been identified to meet the minimum application rates. If there are spare capacity resources these will be allocated to best mitigate environmental impact from surface oil. Any oil between the application zone and the no-go zone dispersant application will be assessed on what gives us the biggest impact reduction. Additional FWADC would cost approximately $30,000/day. While this would not preclude the use in a spill, VOGA has identified that for the initial response the current arrangements are sufficient to meet the objective, and as such the additional aircraft is not being planned for.	Not adopted.
Subsea dispersant application.	Subsea dispersant application – not considered as not applicable for the Wandoo facility given the surface wells.	Not adopted.
Increase storage of dispersant in Dampier.	Analysis of the supply chain determined that increasing stockpile in Dampier is not a benefit as current arrangements enable for aerial dispersant to be applied within 48 hours. Dispersant can deteriorate over time and effectiveness diminish. For ongoing maintenance it is more advantageous for industry to store dispersant in larger stockpiles and cooler areas.	Not adopted.
Karratha Airport Joint Standard Operating Procedure (JSOP); and AMSA-AMOSC FWADC JSOP.	Review of dispersant logistics identified that operations plan for dispersant loading and aircraft movement at Karratha Airport was required to ensure activity could be conducted as per plan. AMSA-AMOSC FWADC JSOP details operational details for application of dispersant using the FWADC. A JSOP has been drafted ready for use when required.	Adopted
Conclusion	The response objective can be achieved as planned resources provide sufficient ability to apply dispersant and prevent released oil impacting shorelines/sensitive receptors and reduce the impact of oil spills. Reviewed improvements to timeframe, application rate and logistics. Identified and implemented two enhancements which supports meeting the objective of this strategy.	

Mechanical dispersion

The impacts associated with this response strategy have been assessed within the scope of the day-to-day operational support activities or are considered no greater than the impact of the spill itself.

The ALARP review of the proposed response strategy to meet the response objective 'Assist natural dispersion of oil into the water column to reduce environmental impact from surface oil' is provided in Table 6-10.

Table 6-10: Mechanical dispersion ALARP review

Tactic to achieve the objective	Applicability	Resource requirements
Mechanical dispersion is a secondary strategy that will be used opportunistically based on IAP outcomes.	May assist in the physical dispersion of oil into the water column, increasing the speed with which weathering and biodegradation occurs. The Planning Chief will recommend this strategy be implemented based on information collected through monitoring and evaluation.	This will be done on an opportunistic basis when marine resources are available tasked with complementary activities.
Improvements considered	**Assessment of option**	**Adopted / Not adopted**
Dedicated vessels.	Mechanical dispersion is not a planned activity but will be opportunistic as directed by the Planning Chief. A specific level of provision of resources for this activity has not been provided because the vessels used to undertake mechanical dispersion will be tasked for other activities such as transfer of personnel and equipment or monitor and evaluation. This will be done on an opportunistic basis when marine resources are available tasked with complementary activities.	Not adopted.
Conclusion	The objective can be achieved because planned resources provide sufficient ability to physically disperse ad hoc areas of floating oil.	

Containment and recovery

Priority of the implementation of tasks to support this strategy will be focused on containing and recovering oil that has not been successfully chemically dispersed, and to remove as much oil as feasible from the marine environment to prevent it from potentially impacting the shorelines of the Dampier Archipelago and the Barrow, Montebello, Great Sandy and Lowendal islands as well as the mainland of the WA coastline.

The ALARP review of the proposed response strategy to meet the objective to 'reduce overall volume of surface oil to minimise impacts to environmental sensitivities. is provided in Table 6-10.

Table 6-10: Containment and recovery ALARP review

Tactic to achieve the objective	Applicability	Resource requirements
Containment and recovery to be implemented within 72 hours if the data collected through monitoring and evaluation suggests: • the slick is moving toward a sensitive receptor and unable or unsuitable to be dispersed; • sea state and weather conditions allow effective boom and skimmer deployment; • the weathered oil is able to be recovered with skimmers; and • a safe operating environment for responders.	Booms and skimmers identified in equipment stockpiles are able to be deployed to priority locations within the timeframe required. Identified ro-boom and skimmers are available locally through AMOSC, AMSA and Australian Marine Service Pty Ltd (via stand-by contract). Protection priorities have been identified in pre-spill modelling.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-10 Containment and recovery minimum resource requirements*
Equipment available for containment and recovery will be suitable for the hydrocarbon type, and access to equipment will be maintained.	Laboratory data indicates that 52% of the Wandoo Crude is likely to be persistent hydrocarbons, meaning that there will be visible surface oil to target with containment and recovery activities. The ro-boom that is identified in the Wandoo Field OSCP is suitable for offshore containment as described in the National Plan OHS Manual. The AMSA contingency planning guidelines were used to inform boom encounter rate calculations and the minimum thickness of oil considered viable to contain and recover was 10 g/m^2. Offshore boom is characterised by a higher freeboard and longer skirt than nearshore boom types allowing for deployment in conditions with greater wave movement than sheltered nearshore environments (Fingas 2013). The active weir and brush skimmer recovery systems (i.e. GT185 skimmer or Desmi 250) that is identified in the Wandoo Field OSCP is suitable for offshore containment as described in the National Plan OHS Manual. VOGA used the assumption that only a 50% recovery rate would be achieved (20 tonne per hour skimming). This was to allow for the potential waves, wind and oil viscosity.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-10 Containment and recovery minimum resource requirements*

Tactic to achieve the objective	Applicability	Resource requirements
Waste storage and transport plan will be developed within 72 hours of the spill event.	Given that there is sufficient time before the waste is being generated, a plan will be in place prior to the waste needing to be unloaded from this response strategy.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-10 Containment and recovery minimum resource requirements*
Temporary waste storage equipment and arrangements will be maintained.	Maintain access to waste transport equipment, personnel, transport and disposal facilities (liquid and bulk).	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-10 Containment and recovery minimum resource requirements*

Improvements considered	Assessment of option	Adopted / Not adopted
Implement a greater containment and recovery response (i.e. increase the number of teams).	Each additional team comprising additional vessels, equipment and personnel could potentially recover an additional 80 m^3 of floating oil per day. However, containment and recovery operations cannot operate simultaneously in the same area where targeted aerial dispersant application is being undertaken. Utilising additional containment and recovery teams at sea may start to impede dispersant application which is considered to provide a more effective response technique (in achieving the objectives, planning to implement additional containment and recovery teams may start to reduce the effectiveness of the response and thus is not expected to provide significant benefit).	Not adopted.
Deploy containment and recovery resources sooner	Currently capability is based upon response implementation within 72 hours of spill incident. Access to offshore vessels is the critical component associated with a containment and recovery response as other equipment is able to be mobilised to Dampier within a day. The ability to implement a response sooner than 72 hours would require immediate access to vessels. To ensure that a single vessel is available would require the vessel to be contracted at a cost in the order of $20,000/day. On the basis that a single team is on standby (two vessels) costs are upwards of $40,000, and on the assumption that a single team would realistically recovery 80 m^3 of oil per	Not adopted.

Improvements considered	Assessment of option	Adopted / Not adopted
	day. Given the small volume of hydrocarbons recovered and subsequent incidental environmental benefit, the costs are considered significant for the environmental benefit gained.	
NOFI current buster to complement boom and skimmer operations.	NOFI current buster contains and recovers oil in one system thus providing efficiencies in containment and recovery operations and a subsequent environmental benefit.	Adopted
Additional stockpile in Dampier through AMS contract.	Access to additional equipment for containment and recovery activities.	Adopted
Reduce manufacturing time of boom.	Purchase of boom was assessed as not reasonably practicable due to cost and impact reduction. For prolonged events VOGA investigated how much boom is stored in manufacturers warehouses, time required to manufacture booms and what it would take to reduce manufacturing times. Boom manufacturers stock minimum supplies of boom and manufacture it on demand. Manufacturers were also not interested in buying and storing material that would reduce manufacturing time.	Not adopted.
Conclusion	The influence this strategy has on the overall impact reduction of oil is minimal when compared to chemical dispersant. Depending on metocean conditions, containment and recovery is expected to have a removal rate of 10% to 15% (ITOPF, 2013). This is a localised strategy and resources will be allocated based on IAP priorities. With the addition of resources above, planned containment and recovery resources are sufficient to achieve the response objective. The benefit of additional containment and recovery resources to increase oil recovery is outweighed by the operational window, reliability of the system, potential impact reduction and investment required.	

Protection and deflection

Protection and deflection is subject to amenable weather and sea conditions as well as equipment operational limits. As for containment and recovery, the priority of the implementation of tasks to support this strategy will be focused on deflecting oil that has not been successfully chemically dispersed and nearing shorelines.

The ALARP review of the proposed response strategy to meet the response objective to 'minimise environmental impacts to priority near-shore environmental sensitivities by reducing oil contact' is provided in Table 6-11.

Table 6-11: Protection and deflection ALARP review

Tactic to achieve the objective	Applicability	Resource requirement
Protection and deflection equipment and resources required to be deployed to protection priorities within 48 hours of Category D, E and F spill event.	Land sea boom identified in equipment stockpiles are able to be deployed to staging area within a day for further deployment to priority locations within the timeframe required. Protection priorities have been identified in pre-spill modelling.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-14 Protection and deflection minimum resource requirements*
Equipment available for protection and deflection will be suitable for the hydrocarbon type, and access to equipment will be maintained.	Booms have been specifically selected for the NWS environmental conditions. Limitations of booming systems in regard to tides and currents is understood. The selection of nearshore boom systems and vessels is appropriate for nearshore and shallow area work.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-14 Protection and deflection minimum resource requirements*
Improvements considered	**Assessment of option**	**Adopted / Not adopted**
Reduce deployment time of protection and deflection resources through various means including: • pre-positioning equipment at protection priorities; or • storing on vessels.	Unlike other strategies, this response requires small to medium sized vessels which are more readily available, and thus implementation of this strategy is limited by mobilisation times of protection and deflection equipment. The risk of shoreline contact within 72 hours is highly unlikely and exact locations of shoreline contact not known until real time modelling is available. There is little environmental benefit in reducing deployment times as existing equipment can be deployed within three days.	Not adopted.
Implement a greater initial protection and deflection response.	Oil doesn't contact all shorelines instantaneously but reaches various locations over a period of time dependant on oceanic currents and wind directions. As such, implementing a greater initial response is not appropriate, however resources are ramped up over a longer period of time as they are required. Mobilising additional resources too early, may result in excess resources being on-location that are not required. Consequently, this has the potential to cause additional environmental impacts if larger than required storage areas and increased personnel presence result in further sensitising coastal habitats without providing significant benefit.	Not adopted.

Improvements considered	Assessment of option	Adopted / Not adopted
Tactical plans for identified protection priorities.	Tactical plans can assist response teams identify appropriate protection shoreline response. The development of tactical plans for priority areas were identified as a priority action to better inform the implementation of response strategies and determine local resource requirements and supply chain mobilisation and staging considerations.	Adopted
Conclusion	The influence this strategy has on the overall impact of a large-scale oil spill is minimal. It is a localised strategy and resources will be allocated based on priorities. Tactical plans will assist in the implementation of IAP activities. Not all protection priorities will be contacted at the same time, planned resources provide sufficient ability to prevent floating oil contacting shorelines and reducing the impact of oil spills.	

Shoreline clean-up

The purpose of shoreline clean-up is to remove stranded hydrocarbons from shorelines without causing greater environmental damage impact than leaving the hydrocarbons in-situ. Shoreline clean-up operations are likely to be activated if the information collected through monitoring and evaluation suggests:

- Shorelines are predicted to be impacted by oil at a thickness greater than 100 g/m^2; and
- A safe operating environment for responders.

The ALARP review of the proposed response strategy to meet the response objective 'to remove stranded hydrocarbons from shorelines without causing greater environmental impact than leaving the hydrocarbons in-situ' is provided in Table 6-12.

Shoreline clean-up will implement a three-stage methodology:

- Bulk removal of oil from the shore to prevent remobilisation;
- Removal of stranded oil and oiled shoreline material; and
- Final clean-up of light contamination and removal of stains, if required.

The focus for shoreline response will be initially on areas of heavy oiling where manual collection is possible and there is a moderate to high potential for remobilisation of the oil. Sandy shorelines are generally the most accessible and amenable to manual and mechanical clean-up activities than mangroves, mudflats and salt flats. However, with extensive repeated shoreline clean-up operations, there is a risk these activities can cause their own impacts. That is, each shoreline clean-up operation may cause additional negative ground disturbance.

As a part of response planning, Vermilion has undertaken assurance around the provisioning required to implement large scale shoreline clean up. As such Vermilion has detailed a base case inventory of the human resources and major oil spill response equipment needed to implement a shoreline clean-up response based on a worse-case deterministic modelling run for a theoretical oil spill. Based on the modelling output, the length of each major shoreline type that might be contacted and the volume of oil ashore was estimated and volume. Personnel resources needed to clean-up the oiled shoreline was then determined.

Table 6-12: Shoreline clean-up ALARP review

Tactic to achieve the objective	Applicability	Resource requirements
Equipment for shoreline clean-up tasks that are suitable for environment and hydrocarbon type are available.	Resources have been planned for tasks to prevent contact of oil to the protection priorities identified in the Wandoo Field OSCP [WAN-2000-RD-0001]. Resources include: • Logistics – crew being accommodated, safe and in contact with other parts of the response. • Vessels – capable of carrying crew and spill equipment to remote islands. • Equipment – cleaning equipment, decontamination set, mechanical equipment, etc. • Booming systems – a system that can effectively direct or prevent the movement of oil.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-16 Shoreline cleanup minimum resource requirements*
Shoreline clean-up resources can be deployed to protection priorities within 72 hours.	Maintaining access to shoreline clean-up resources including equipment and personnel will enable deployment to protection priorities within a timeframe.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-16 Shoreline cleanup minimum resource requirements*
Manning of shoreline clean-up teams	VOGA has analysed OSTM data to inform shoreline clean-up personnel requirements as described in the Wandoo Field OSCP. Shoreline clean-up teams will scale up from 3 teams (one leader and ten workers) in the first three days to up to 100 teams by day 20. For planning purposes, VOGA utilises the IPIECA (2015) Shoreline cleanup guidelines which suggest that one person can remove 1 m^3 of oil per day from a shoreline.	Wandoo Field OSCP Document 1, Part 2 Response Strategies *Table 7-11 Shoreline clean-up potential waste and personnel requirements* Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-16 Shoreline cleanup minimum resource requirements*
Shoreline teams will be informed of how to minimise damage to flora and avoid encounters with fauna.	Trainers will provide guidance to shoreline teams to minimise impacts to the environment while undertaking assessment and clean-up activities.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-16 Shoreline cleanup minimum resource requirements*
SCAT teams will complete surveys before clean-up teams complete assignments so that priority locations are worked on	SCAT teams will assess shorelines for oiling and sensitivity prior to operations commencing.	Refer to Table 6-8

Tactic to achieve the objective	Applicability	Resource requirements
and suitable techniques are used.	Available and suitable shoreline clean-up resources are deployed if there are sufficient quantities of oil to be collected, areas predicted to be impacted have a long recovery time, and impact reduction is not outweighed by impact of activity.	
Shoreline clean-up will implement a three-stage methodology: • Emergency phase – collection of oil floating close to the shore and pooled bulk oil removal. • Project phase – removal of stranded oil and oiled shoreline material that cannot be cleaned in-situ. • Polishing phase – final clean-up of light oil contamination and removal of oil stains, where the SIMA demonstrates this is necessary.	Actual clean-up tasks for each of the three stages will be selected from the most appropriate activities, based on an assessment of suitability for the clean-up task for the oil character and shoreline type, and will be dependent on the data collected by the SCAT teams. In undertaking this three-step process, VOGA contractors, employees and support agencies will work to effectively and efficiently clean shorelines where possible.	Wandoo Field OSCP Document 1, Part 2, Response Strategies *Table 7-8 Shoreline clean-up methods* Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-16 Shoreline cleanup minimum resource requirements*
Waste storage and transport plan will be developed within 72 hours of the spill event.	Solid contaminated waste estimated volumes based on a bulking factor of 10, as per IPIECA (2015)	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-16 Shoreline cleanup minimum resource requirements*
Temporary waste storage equipment and arrangements will be maintained.	Maintain access to waste transport equipment, personnel, transport and disposal facilities (liquid and bulk).	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 3-16 Shoreline cleanup minimum resource requirements*

Improvements considered	Assessment of option	Adopted / Not Adopted
Reduce the time for shoreline response.	Allocating shoreline clean-up resources relies on understanding the trajectory of the oil and timeframe for expected contact. It is not practical to pre-position teams ready for rapid deployment to reduce the timeframe for shoreline response because the stochastic OSTM used in planning indicates a number of potential shoreline contact locations. Resources (people and equipment) can be activated and deployed on initiation of OPP2 in readiness for the real time OSTM outputs.	Not adopted.

Improvements considered	Assessment of option	Adopted / Not Adopted
	Earliest contact on shorelines is predicted to be Day 3, this is sufficient time to mobilise people and equipment.	
Increase manning of shoreline clean-up teams	VOGA has planned for shoreline clean up teams of 10 (IPIECA, 2015). An assessment of what further work is required can then be made and a decision to increase or decrease personnel made.	Not adopted.
Increase in the number of vessels used to support shoreline response.	Vessels will be used to transport people and equipment; and assist in nearshore protection and deflection if required. The minimum resources specified are sufficient to transport the shoreline clean-up teams to locations identified in planning OSTM. These can be ramped up if required after the initial response activities using VOGA's marine contract lists.	Not adopted.
Increase in the number of equipment sets used to support shoreline response.	The equipment sets identified in planning are intended to be used for manual removal of oil from shorelines. Not all oil on shorelines will be able to be manually removed with this equipment. One set of manual clean-up tools per team is sufficient as a minimum requirement (8 teams = 80 sets). Real time modelling and assessment will determine if extra resources are required. If this is the case, then the clean-up tools required are readily available from hardware outlets and can be transported to site within a day.	Not adopted.
Preposition containers of equipment.	Equipment stockpiles in Exmouth and Dampier are sufficient to deploy equipment in a timely manner. Equipment can be transported from Perth in a timely manner. VOGA owns shoreline clean-up equipment to mount an initial shoreline response.	Not adopted.
Survey shorelines and describe characteristics pre-spill.	Shoreline surveys are costly and resource intensive. Surveys have been conducted by other operators, coastal compartment mapping available – no benefit in VOGA undertaking more field work but rather compiling existing information regarding protection priorities.	Not adopted - VOGA has joined the IGEM collaboration.
Tactical plans for identified protection priorities.	Tactical plans can assist response teams identify appropriate protection shoreline response. The development of tactical plans for priority areas were identified as a priority action to better inform the	Adopted.

Improvements considered	Assessment of option	Adopted / Not Adopted
	implementation of response strategies and determine local resource requirements and supply chain mobilisation and staging considerations.	
Conclusion	Not all protection priorities will be contacted at the same time, planned resources provide sufficient ability to remove stranded oil on shorelines where appropriate and reducing the impact of oil spills to ALARP.	

Oiled wildlife response

Capability for an oiled wildlife response has been prepared at an Oiled Wildlife Level 6 response as per the Pilbara Oiled Wildlife Response Plan (POWRP).

Analysis of OSTM data for a category E spill was undertaken in conjunction with information on environmental sensitivities to identify the initial protection priorities for wildlife. The output from this analysis is an understanding of the scale of the operating area and timeframe for both the initial response and the scaling up oiled wildlife capabilities.

The focus for VOGA pre-planning of response activities regarding first strike response and initial resource mobilisation is the Pilbara coast and associated offshore islands between Robe River Mouth and Dampier Archipelago. This area is the most likely to be impacted first, contains several sensitive locations and aligns with the Pilbara Oiled Wildlife Response Plan (POWRP) Operational Sectors 7 to 12. Dampier is the site most likely to require for an oiled wildlife facility.

For indicative planning for Day 9 and beyond, OSTM analysis indicates that several sensitive locations from Robe River Mouth down to North West Cape and from Dampier up to Eighty Mile Beach may be impacted to varying levels and require wildlife response between Days 9 and 20. Between Days 20 and 30, from Eighty Mile Beach up to Broome is potentially impacted.

This could require staging sites in various locations in addition to holding centres and/or oiled wildlife facilities (small, medium or large) to be set up in Exmouth, Onslow, Port Hedland or Broome in these timeframes. Sites are pre-identified in the POWRP and the most appropriate locations will be determined in a response with real time trajectory data and analysis of seasonal vulnerabilities through the SIMA process and in consultation with DoT. The ALARP review of the proposed response strategy to meet the response objective 'to minimise and mitigate the number of wildlife oiled following a spill' is provided in Table 6-13.

Table 6-13: Oiled wildlife ALARP review

Tactic to achieve the objective	Applicability	Resource requirement
Resources for oiled wildlife response activities have been planned for a Level 6 Oiled Wildlife Response.	Resources have been planned for a Level 6 Oiled Wildlife Response due to the quantity and location of wildlife potentially contacted by oil. AMOSC and DPaW activate the Western Australian Oiled Wildlife Response Plan (WAOWRP) and POWRP resources and provide specialist oiled wildlife response support.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 4-6 Oiled wildlife response minimum resources*

Tactic to achieve the objective	Applicability	Resource requirement
First strike response kits are activated within 24 hours.	Support mobilisation of first strike response kits to priority shoreline staging areas.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 4-6 Oiled wildlife response minimum resources*
Two oiled wildlife response containers are mobilised to an oiled wildlife response facility location in Dampier within 24 hours.	Dampier to be set up first to service POWRP Operational Sectors 7 to 12. The response strategies in the initial incident action plan for OWR are to complete Stages 1, 2 and 3 of OWR as described in the WAOWRP: • Stage 1 – wildlife first strike response. • Stage 2 – mobilisations of wildlife resources. • Stage 3 – wildlife reconnaissance.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 4-6 Oiled wildlife response minimum resources*
An Oiled Wildlife Advisor and Wildlife Division Coordinator are activated and assigned to the ICT once WAOWRP is activated.	Activate and mobilise an Oiled Wildlife Advisor and Wildlife Division Coordinator to Dampier. Source unskilled personnel (oiled wildlife response skill level 1) mobilise to Dampier and conduct induction process and basic training developed by DPaW. Access to DPaW volunteer database to also be undertaken via the DPaW Duty Officer.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 4-6 Oiled wildlife response minimum resources*
Information contained in POWRP and SIMA is ground truthed.	Reconnaissance across priority shorelines Resources are required to identify and record location of oiled wildlife as well as determining the presence of wildlife in areas predicted to be impacted by oil. Real time wildlife reconnaissance is necessary to ground truth information contained in the POWRP due to seasonal and inter-annual variation in abundance and distribution of wildlife. Tactics may include: • Aerial reconnaissance; • Marine reconnaissance; and • Shoreline reconnaissance.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 4-6 Oiled wildlife response minimum resources*
IAP wildlife sub-plan developed within 48 hours.	Future oiled wildlife response activities arrangements developed based on the spill scenario and will be guided by the WAOWRP. The aim of the OWR sub-plan will be to: • Reducing the oiling of wildlife by preventing animals from entering the impacted environment; • If animals are oiled, maximise the number of oiled wildlife treated and/or rehabilitated; and	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 4-6 Oiled wildlife response minimum resources*

Tactic to achieve the objective	Applicability	Resource requirement
	• Remove dead and dying wildlife from affected area to minimise secondary exposure.	
Wildlife rescue and staging are developed within 72 hours.	Begin establishing staging site as a logistic base for search and capture teams. Staging areas to be set up in most appropriate POWRP Operational Sectors base don the spill trajectory.	Wandoo Field OSCP Document 2, Part 5 Oil Pollution Plans *Table 4-6 Oiled wildlife response minimum resources*

Improvements considered	Assessment of option	Adopted / Not Adopted
Pre-positioning of oiled wildlife response resources.	Oiled wildlife response equipment containers for first strike activities are positioned in Exmouth.	Not adopted.
Additional resources (equipment and personnel).	VOGA has undertaken an oiled wildlife assessment to estimate the approximate numbers of wildlife requiring care over time and region. This was assumed without the application of dispersant and so represents a conservative estimate. To meet the increased resource requirement, VOGA invested in oiled wildlife response equipment in 2013. WAOWRP and POWRP planned resources assessed as sufficient for the worst case spill risk.	Adopted – an oiled wildlife response Level 6 have been adopted for OPP2.
Prepare induction training for oiled wildlife response labour hire personnel.	Prepared induction training allows for personnel to be deployed when required.	Adopted
Conclusion	VOGAs oiled wildlife response capability was undertaken based on the number of wildlife requiring care identified in an oiled wildlife risk assessment. Resources identified in the WAOWRP, POWRP and the Wandoo Field OSCP [WAN-2000-RD-001] were assessed as sufficient to mount an initial oiled wildlife response.	

Capability determination and management

The VOGA Oil Spill Response Capability Review [VOG-7000-RH-0009] documents the processes where VOGA continually manages oil spill response arrangement resources and ICT systems. The Wandoo Field OSCP [WAN-2000-RD-0001] outlines the frequency and trigger for reviews which ensures that VOGA manages oil spill response requirements on an ongoing basis.

6.2.7.4 *Conclusion*

The ALARP assessment has concluded that the risks are being managed to ALARP because:

- As part of VOGA's risk management processes, the primary failure modes associated with other industry loss of control events are considered during the engineering, design, planning and preparation for well construction activities;

- VOGA has a rigorous barrier verification process, including interfaces between Well Construction and Production during the well handover phase. This process requires the MODU Contractor and the VOGA Drilling Supervisor to sign off at any point where barrier systems change, to confirm that the VOGA barrier standards have been met;
- There are sufficient layers of protection in place for the current risk level;
- In the unlikely event of spill from the wells, response strategies which match the hazard profile are defined in the Wandoo Field OSCP [WAN-2000-RD-0001] and will be implemented to reduce the impact of the spill to the environment. The resources to implement the response has been determined and evaluated to ensure that the response strategies mitigate the spill and can be achieved;
    - As the alternative arrangements are either not considered practical, increase associated safety, do not reduce environmental impact and are not sustainable from a cost or environmental impact point of view.
- Once all the control measures outlined above are implemented, the residual risk associated with a total loss of well control event during well construction or intervention operations at Wandoo is assessed as a medium risk, and therefore considered tolerable/acceptable on demonstration of ALARP.

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6.3 Liquid hydrocarbon release from the platform, export equipment or pipeline(s)

6.3.1 Hazard report

Table 6-14: Hazard report – Liquid hydrocarbon release from the platform, export equipment or pipeline(s)

HAZARD:	Liquid hydrocarbon release from the platform, export equipment or pipeline(s) - 300 m^3 from export pipeline and/or 0.5 m^3 of oil per conductor. (Uncontrolled release of diesel from AHTS vessel or MODU collision from a collision is addressed in EP-WC-R03, Section 6.4).				
EP risk number:	EP-WC-R02				
Potential impacts:	Temporary decrease in marine water quality. Increased toxicity of, and bioaccumulation in, marine organisms from the ingestion of hydrocarbons. Injury or death of exposed marine fauna (e.g. oiling of seabirds). Habitat impacts where the spill reaches sensitive marine areas such as coral reefs or the shoreline.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Collision between an AHTS vessel and the platform. **Context**: Vessel is assumed to be AHTS-type vessels supporting a MODU well construction campaign.	Platform location published in Notice to Mariners and Marine Charts.	Administrative	No uncontrolled release of hydrocarbons to the environment from platform or export equipment due to vessel collision.	Wandoo facilities are marked on AUS 42 (Australian Hydrographic Service [AHS]) any changes to Wandoo facilities shall be amended onto Notices to Mariners.	Wandoo facilities are on chart.
	Navigational lights on all AHTS vessels and MODU.	Engineering		AHTS vessels and MODU navigation lighting shall comply with SOLAS and the *Navigation Act 2012*.	Pre-hire inspection confirms lighting complies with SOLAS and the *Navigation Act 2012*.
	Vessel contract specifies Dynamic Positioning (DP) capable AHTS vessels.	Administrative		AHTS vessels shall be DP capable.	Specification noted in contract.
	AHTS vessels contracted by VOGA have competent masters.	Administrative		AHTS vessel masters must meet requirements of their company's Competency Management System (CMS).	Review of contractors CMS.
	AHTS vessels obtain permission to enter restricted zone.	Administrative		AHTS vessels are required to establish radio communications with the platform and request permission to enter the restricted zone.	Noted in radio log and/or Wandoo Marine Operations Checklist.
	AHTS vessels perform DP trials as required by their Safety Management System.	Engineering		AHTS vessels are required to conduct DP trials prior to entry into the restricted zone.	DP trials noted in ships log and/or Wandoo Marine Operations Checklist.
	AHTS vessels able to communicate with platform.	Administrative		AHTS vessel communications systems fully functional.	Confirmed in Wandoo Marine Operations Checklist.
	AHTS vessels contracted by VOGA have systems to assist with tracking and identifying vessels in the general area.	Administrative		AHTS vessels shall be fitted with radar and Automatic Identification System (AIS).	Pre-hire inspection confirms presence of working equipment.
Collision between MODU and the platform. **Context**: During a rig move operation, the MODU must be positioned in close proximity with the platform in order to work on platform wells.	Rig move plan will be prepared in general accordance with Drilling Contractor's Marine Operations Manual.	Engineering Engineering	No uncontrolled release of hydrocarbons to the environment from platform or export equipment due to MODU collision.	Rig move plan shall be signed off ready for use.	Rig move plan agreed and signed by VOGA and MODU Contractor.
		Administrative		Communications systems shall be checked prior to final move onto location.	Noted in radio or MODU logs.
		Engineering		Tow vessels must be inspected by Tow Master before the rig move commences.	Tow vessel inspection report.
	Detailed SIMOPs Plan (including wells shut in and external conductors bled down during move onto location).	Engineering		Wells shall be shut in and external conductors bled down, in-field pipelines shut in and depressurised during MODU move onto location.	Signed pre-move checklist from Platform to MODU confirming that pre-move checks have been completed.

<table>
<tr><th colspan="6">MITIGATION:</th></tr>
<tr><th colspan="2">Existing control measures</th><th>Control hierarchy</th><th>Performance outcome</th><th>Performance standard</th><th>Measurement criteria</th></tr>
<tr><td colspan="2">Permission to approach platform.</td><td>Administration</td><td>To limit the volume of hydrocarbons released to the environment by isolating the well inventory.</td><td>Platform status must comply with requirements of the Project SIMOPS Plan and Rig Move Plan prior to a MODU obtaining permission to approach platform during rig move.</td><td>Signed pre-move checklist from Platform to MODU confirming pre-move checks were completed.</td></tr>
<tr><td colspan="2">Wandoo Emergency Response Plan [VOG-2000-RD-0017]/Wandoo Field OSCP [WAN-2000-RD-0001].</td><td>Administrative</td><td>To mitigate the impact of hydrocarbons released to the marine environment.</td><td>Oil spill response strategies shall be implemented in accordance with the Wandoo Field OSCP [WAN-2000-RD-0001].</td><td>IAP records</td></tr>
<tr><th colspan="6">INITIAL RISK WITH EXISTING CONTROLS:</th></tr>
<tr><th colspan="2">Consequence</th><th colspan="2">Likelihood (of consequence)</th><th colspan="2">Initial risk</th></tr>
<tr><td colspan="2">Major (4)</td><td colspan="2">Unlikely (B)</td><td colspan="2">Medium</td></tr>
<tr><th colspan="6">ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:</th></tr>
<tr><td colspan="6">Following the adoption of standard industry good practice controls, a medium risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.</td></tr>
<tr><th>Additional control measures</th><th>Prevention/ mitigation</th><th>Control hierarchy</th><th>Performance outcome</th><th>Performance standard</th><th>Measurement criteria</th></tr>
<tr><td>None identified.</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="6">RESIDUAL RISK AFTER ADDITIONAL CONTROLS:</th></tr>
<tr><th colspan="2">Consequence</th><th colspan="2">Likelihood (of consequence)</th><th colspan="2"></th></tr>
<tr><td colspan="2">Major (4)</td><td colspan="2">Unlikely (B)</td><td colspan="2">RRIII (Medium)</td></tr>
</table>

<table>
<tr><th colspan="6">ACCEPTABLE LEVEL OF RISK DEMONSTRATED:</th></tr>
<tr><th>Principles of ESD not compromised</th><th>External Context – objects or claims considered</th><th>Internal Context – VOGA HSE / procedures met</th><th>Other Requirements met</th><th>RR < Extreme (I)</th><th>EPO(s) manage risk to acceptable level(s)</th></tr>
<tr><td>Relevant principles of ESD not compromised given proposed controls</td><td>N/A – no external objections or claims received</td><td>Yes – Risk managed in accordance with VOGA HSE policy , SIMOPs Plan and Rig Move Plan. Potential spills to be managed in accordance with Wandoo Emergency Response Plan [VOG-2000-RD-0017]/Wandoo Field OSCP [WAN-2000-RD-0001].</td><td>Yes – MODU operations to be consistent with MODU Safety Case. AHTS vessels and MODU navigation lighting comply with SOLAS and the Navigation Act 2012. Notice to Mariners issues as required.</td><td>Yes – RR = RRIII (Medium)</td><td>Yes – EPOs specify no uncontrolled release of hydrocarbons. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.</td></tr>
</table>

6.3.2 Description of hazard

Whilst the activities that could result in a loss of liquid hydrocarbon from the export equipment in the Wandoo Field are primarily associated with the operation of the Wandoo Facility, there is the potential for collision between the MODU or AHTS vessels and a platform resulting in a loss of hydrocarbons (Wandoo Crude) from the platform or export systems.

During a rig move, the AHTS vessel or MODU may collide with a platform. Such a collision could result in the loss of hydrocarbons from the export pipelines or flowlines. A spill could result in localised oiling of the sea surface and localised/temporary impacts on marine fauna and changes to water quality/ecosystem.

The risks and impacts associated with the loss of hydrocarbons (diesel) from the collision of an AHTS vessel or MODU, is addressed in Section 6.4 (Diesel spill to sea).

6.3.3 Impact assessment

6.3.3.1 *Sensitive receptors*

Marine habitats, plankton, fish (pelagic), marine mammals, marine reptiles and seabirds.

6.3.3.2 *Impacts description*

Automated Data Inquiry for Oil Spills (ADIOS®) software developed by the National Oceanic and Atmospheric Administration (NOAA) was used to predict weathering of an instantaneous release of 300 m^3 of Wandoo crude in the marine environment. After 120 hours, ADIOS predicted 84% of Wandoo crude to remain on the sea surface at water temperatures of 23^{o}C, current speed of 1 knot and a wind speed of 5 m/s. To calculate the extent of surface hydrocarbon exposures from this type of spill event, the influence of wind velocity on the surface slick as wind often determines the direction and speed with which a slick moves, with oil drift velocity about 3% of wind velocity (Lee 1980). The extent was then calculated using a velocity of 0.15 m/s (based upon 3% of 5 m/s). Based on these parameters, surface hydrocarbons have the potential to travel 65 km within 120 hours. The closest sensitive habitats to the Operational Area are located in the Dampier Archipelago and Montebello Islands, 40km and 70km from the Operational Area respectively. As a result, there is potential of hydrocarbon exposure to surface, entrained and shoreline receptors as a result of a liquid hydrocarbon release from export equipment and pipelines.

Detailed description of the potential effects of hydrocarbons on the surrounding marine environment in the event of liquid hydrocarbon release from wells (25,555 m^3 of Wandoo crude over 43 days) is provided in Section 6.2. The impacts associated with an instantaneous release of 300 m^3 of Wandoo crude would be significantly less.

6.3.4 Control measures

6.3.4.1 *Prevention measures*

The Wandoo platform locations are on existing charts issued by the AHS and have been for many years. The charts define a restricted zone extending 500 m around the platform and submarine pipelines. In addition both MODU and AHTS vessels will have navigational lighting to ensure they are visible to not only other vessels transiting the area, but also the facility.

Permission must be granted by the Wandoo Control Room Operator prior to any vessel entering the restricted zone around a platform. VOGA contract vessels which have DP capability are to act as AHTS vessels. DP provides excellent station holding capability for the vessels. DP trials are conducted regularly by the vessels and noted in the ships logs.

By exception, if a vessel is to be used in close support near a platform that is not DP capable, then it must able to be fitted with a three or four-point mooring system.

Vessels without a VOGA contract will not be permitted to enter the restricted zone around the platform.

VOGA conduct AHTS vessel on-hire inspections to satisfy the Company that vessel operations are being managed satisfactorily.

Prior to the MODU rig move commencing a detailed rig move plan is prepared incorporating:

- weather criteria for the move;
- pre-tow vessel inspection requirements;
- communications protocols;
- conditions precedent for entering platform restricted zone;
- rig positioning requirements; and
- rig preload requirements.

The MODU Rig Move Plan is signed off by both VOGA and the MODU Contractor.

The tow vessels are inspected by the MODU Tow Master prior to the rig move.

MODU moves to position rig alongside a platform are subject to a SIMOPS Plan. The SIMOPS Plan includes a number of requirements that must be met prior to the MODU being granted permission to make its final approach to the platform. Important conditions to be met include:

- Platform wells are to be shut-in and nominated wells depressurised;
- Pipelines are to be shut-in and depressurised;
- Weather conditions must be suitable for positioning the MODU adjacent to the platform;
- High accuracy navigation system must be functioning correctly; and
- Communications are checked.

VOGA contracts MODUs with substantial cantilever extension capability. This enables the MODU to be positioned with the hull nominally 12.0 m away from the column on WNA and 9.0 m away from the column on WNB, thus reducing the risk of a collision.

6.3.4.2 *Mitigation measures*

In the event of a collision, the platform design is to use the columns to largely shield pipelines from an impact. This largely mitigates the likely consequence of a collision.

An assessment of the benefits of the oil spill response strategies that are considered feasible to respond to this spill are provided in Table 6-15. The response strategies not considered feasible are outlined in Table 6-16. The impacts of the oil spill response strategies are assessed in Section 6.5.

Table 6-15: Feasibility and benefits of response strategies for Category A spills

Response strategy	Feasible	Benefits
Source control	Yes	Isolation of ruptured section of flowline, flow stopped or redirected, thus minimising the potential spill volume. Subsea inspection and repair to follow. Preventative inspections and maintenance carried out periodically. This is an important mitigation measure once a spill has occurred, to reduce the volume of oil reaching the marine environment.
Monitor and evaluate	Yes	Monitoring and evaluation provides up-to-date information on the behaviour and likely trajectory of the spill. This will be used to select the most appropriate response strategy and to evaluate its effectiveness.
Chemical dispersion	Yes	Chemical dispersion assists with the natural dispersion process, encouraging the slick to mix and suspend within the water column where it can be more easily biodegraded. This is likely to be used to reduce the impact of surface oil on environmental sensitivities. Laboratory results show that chemical dispersant is effective on weathered and unweathered samples of Wandoo Crude and dispersant can achieve an efficacy of up to 65% within 8 hours of application (Intertek, 2012). Regardless of season, a dispersant test spray run will be undertaken prior to moving to full dispersant application operations to verify its effectiveness. Real-time operational information and spill location will also be used to determine the net environmental benefit of dispersant application.
Containment and recovery	Possible	Containment and recovery can be used to recover oil to prevent it impacting on environmental, social and cultural sensitivities. Containment and recovery may be effective on Wandoo Crude as it is a persistent crude oil with a high specific gravity and viscosity. Depending on metocean conditions, containment and recovery is expected to have a removal rate of 10% to 15% (ITOPF, 2013). Containment and recovery will be used if metocean conditions are suitable and if oil if of suitable thickness.
Mechanical dispersion	Possible	Mechanical dispersion assists with the natural dispersion process, breaking down the oil into smaller droplet sizes, encouraging the slick to mix and suspend within the water column where it can be more easily biodegraded. It may also be used to assist chemical dispersion when sea conditions are calm. Mechanical dispersion is used when surface oil presents a greater risk to the marine environment than entrained oil.

Response strategy	Feasible	Benefits
Oiled wildlife response	Possible	This is applicable for marine fauna that come close to the spill or become oiled. Oiled wildlife response can minimise environmental impacts by: • reducing the oiling of wildlife by preventing animals entering the impacted environment; and • if practical, the initiation of pre-emptive capture and removal of animals at risk. If animals are oiled prompt initialisation of oiled wildlife response provides a means for rehabilitation and release or humane euthanasia to minimise suffering.

The response strategies will be implemented in accordance with the Wandoo Field OSCP [WAN-2000-RD-0001].

Table 6-16: Response strategies not considered feasible for Category A spills

Oil spill response strategy	Feasible	Considerations
Protection and deflection	No	Protection and deflection can be used to protect sensitive receptors through the use of booms to create physical barriers on the water surface. Corralling is generally effective on persistent oils such as Wandoo Crude. The effectiveness of protection and deflection depends on the thickness of the oil and weather and sea-state conditions. It is unlikely that protection and deflection will be used in this case as shoreline contact is not predicted.
Shoreline clean-up	No	Shoreline clean-up is unlikely to be used as shoreline contact is not predicted.
In-situ burning	No	In-situ burning is not considered feasible as Wandoo Crude has not been proven to be amenable to this type of response. Also the required equipment, technology and training are not conducted in Australia for operators planning to use this technique. No in-situ burning accelerants are currently listed on the National Plan Register for OSCA Register.

6.3.5 ALARP demonstration

VOGA contracts AHTS vessels with DP capability to support the Wandoo well construction campaigns. VOGA conducts third party on-hire surveys to confirm that the vessels are compliant with their Class certification, that the ship's logs include notations about DP trials and that the masters are certified to Master Class 1. This demonstrates VOGA's commitment to contracting high quality AHTS vessels with qualified crew.

VOGA have a gazetted restricted zone extending 500m around the platforms and pipelines in the Wandoo Field. This restricted zone has been noted on marine charts of the area for many years. The Wandoo platforms are equipped with navigation lights and a fog horn system in compliance with IALA regulations and SOLAS conventions and present a substantial radar reflection. Noting the platform locations on marine charts and operating navigation aids demonstrates VOGA's commitment to ensuring that vessels are aware of the presence of the platforms.

Prior to vessels entering the 500 m restricted zone around the platforms they are required to seek permission from the Wandoo Control Room Operator. Permission is granted to vessels contracted to VOGA and is subject to metocean conditions. This process demonstrates that VOGA manages the approach of vessels to the platform to an ALARP level.

When a MODU is required to position adjacent to a VOGA platform it is a closely managed operation. A site specific rig move plan and the project specific SIMOPS Plan and the MODU Safety Case Revision detail requirements for the rig move including, amongst other criterion, metocean limitations, communications protocols, production status and positioning tolerances.

Shutting-in at risk wells and depressurising pipelines prior to a rig move mitigates the potential consequence if a collision were to occur.

Shutting down wells and depressurising the pipelines for all vessel approaches is an option, but will only reduce operational risk very slightly, however it will have a significant impact on production. This action was rejected as the vessels attending the MODU during rig support operations are largely shielded from contact with critical platform infrastructure by the MODU legs.

The combination of vessel selection, rig move procedures and positioning tolerances reduce the risk of a collision between MODU support vessels and/or the MODU with a platform to ALARP. The additional controls of shutting in production and depressurising pipelines during a rig move mitigate the consequences of a collision to ALARP.

6.3.5.1 *Spill response*

VOGA has a spill preparedness planning process that identifies suitable spill response strategies which:

- Are consistent with the hazard profile;
- VOGA's response strategies and procedures to reduce the volume of hydrocarbons spilt and the potential environmental impact are outlined in the OSCP. These response strategies are consistent with those outlined in the National Plan;
- Considers the benefits of each strategy as outlined in Section 5.3.4.2;
- Considers the risks and impacts of each strategy as outlined in Section 5.5.4; and
- The spill response planning process is described in Section 6.12.3 and results in a spill response that will best mitigate the environmental impacts of this hazard scenario.

ALARP demonstration for response strategies are detailed in Section 6.2.7 above.

6.4 Diesel spill to sea

6.4.1 Hazard report

Table 6-17: Hazard report – Diesel spill to sea

HAZARD:	Diesel spill to sea (loss of diesel of up to 700 m^3).				
EP risk number:	EP-WC-R03				
Potential impacts:	Temporary decline in marine water quality. Injury or death of exposed marine fauna. Potential impacts where the spill reaches sensitive marine areas such as coral reefs or sandy/rocky shorelines.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Loss of diesel from MODU/AHTS vessel caused by collision with another vessel or the Facility.	Notification of intent to move MODU to or from Field is notified in advance to AMSA.	Administrative	No vessel collisions resulting in the release of diesel to the environment.	AMSA shall be advised of planned rig moves at least two weeks prior to scheduled move date.	Copy of Notice to Mariners, noting location of MODU.
	Navigational lights on all AHTS vessels and MODU.	Engineering		AHTS vessels and MODU navigation lighting shall comply with SOLAS and the *Navigation Act 2012*.	Pre-hire inspection confirms lighting complies with SOLAS and the *Navigation Act 2012*.
	Vessel contract specifies DP-capable AHTS vessels	Administrative		AHTS vessels shall be DP capable.	Specification noted in contract.
	AHTS vessels obtain permission to enter restricted zone.	Administrative		AHTS vessels are required to establish radio communications with the platform and request permission to enter the restricted zone.	Noted in radio log and/or Wandoo Marine Operations Checklist.
	AHTS vessels perform DP trials as required by their Preventative Maintenance System (PMS).	Engineering		AHTS vessels are required to conduct DP trials prior to entry into the restricted zone.	DP trials noted in ships log and/or Wandoo Marine Operations Checklist.
	SIMOPS Plan defines controls to be implemented when multiple vessels are in field.	Administrative		SIMOPS Plan shall define controls to be implemented when multiple vessels are in field.	SIMOPS Plan implemented. Audit records to confirm compliance.
	AHTS vessels contracted by VOGA have certified masters.	Administrative		VOGA shall validate that AHTS vessels masters meet requirements of their company's CMS.	Review of contractors CMS.
	AHTS vessels contracted by VOGA have systems to assist with tracking and identifying vessels in the general area.	Administrative		VOGA shall validate that AHTS vessels are fitted with radar and AIS.	Pre-hire inspection confirms presence of working equipment.
Diesel spill caused by equipment failure during bunkering.	Breakaway coupling on refuelling hose to prevent spill due to vessel loss of position.	Engineering	No diesel spills to the marine environment from bunkering.	Breakaway coupling are required to be installed on refuelling hoses.	Pre-hire inspection confirms presence of equipment.
	Bunkering undertaken in accordance with the MODU bunkering procedure.	Administrative		VOGA shall validate that MODU bunkering is conducted under a Permit to Work.	Permit to Work.
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
MODU and AHTS vessels must have a SOPEP / SMPEP (equivalent to class) procedures to manage small spills on their facilities.		Administrative	All small spills are responded to in accordance with SOPEP/ SMPEP (equivalent to class).	SOPEP / SMPEP (equivalent to class) procedures shall be available during well construction activities.	VOGA inspection or audit confirms SOPEP / SMPEP (equivalent to class) procedures are available on the MODU and AHTS vessels during well construction activities.
Wandoo Emergency Response Plan [VOG-2000-RD-0017]/Wandoo Field OSCP [WAN-2000-RD-0001].		Administrative	To mitigate the impact of hydrocarbons released to the marine environment.	Oil spill response strategies shall be implemented in accordance with the Wandoo Field OSCP [WAN-2000-RD-0001].	IAP records.
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence		**Likelihood (of consequence)**		**Initial risk**	
Major (4)		Unlikely (B)		Medium	

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a medium risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					
Additional control measures	**Prevention/mitigation**	**Control hierarchy**	**Performance objective**	**Performance standard**	**Measurement criteria**
None identified.	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:		
Consequence	**Likelihood (of consequence)**	**Residual risk**
Major (4)	Unlikely (B)	RRIII (Medium)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA HSE policy / procedures met**	**Other Requirements met**	**RR < Extreme (I)**	**EPO(s) manage risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Risk managed in accordance with VOGA HSE policy. Potential spills to be managed in accordance with Wandoo Emergency Response Plan [VOG-2000-RD-0017]/Wandoo Field OSCP [WAN-2000-RD-0001].	Yes – MODU operations to be consistent with MODU bunkering procedure. Notice to Mariners issues via AMSA in a timely manner. Potential spills to be managed in accordance with SOPEP/ SMPEP (equivalent to class).	Yes – RR = RRIII (Medium)	Yes – EPOs specify no diesel spills to marine environment. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.4.2 Description of hazard

Loss of diesel fuel could potentially occur from the following scenarios:

- Collision of the MODU or AHTS vessels with another vessel or platform; or
- Hose or coupling failure during fuel transfer from AHTS vessel to MODU or platform.

Vessel-to-vessel collisions depend on a variety of factors such as metocean conditions and visibility, but can be avoided by maintaining appropriate communications, deck watch and vessel speeds. The maximum credible spill scenario due to a vessel collision is the loss of the largest fuel tank (AMSA, 2013). The anticipated total volume of diesel that may be stored, within multiple internal tanks, by the MODU and AHTS vessel are 824m^3 and 2,325m^3 respectively. The maximum volume of the single largest fuel tank (based upon 100% capacity) aboard an AHTS is generally <300m3 and less for a MODU. A volume of 300m^3 was therefore considered as the maximum volume of diesel that could be spilled.

For conservatism in the assessment of impact, the maximum spill extent of 150km in the NERA Reference Case was used, which is based on a diesel spill volume of up to of 700m^3

An unplanned release of diesel fuel could result from the failure of a hose or coupling during fuel transfer from AHTS vessels to MODU or platform, the maximum spill volume from an event of this type is in the order of 10 m^3. This is based on a maximum flow rate of 110 m^3/hr from the hose and assumes that the refuelling process would be shut down within five minutes of notification of equipment failure. This is the conservative time taken to identify the spill and shut down the refuelling operation. This scenario was not identified as a worst-case spill scenario.

6.4.3 Impact assessment

6.4.3.1 *Sensitive receptors*

Potential impacts to sensitive receptors in the unlikely event of vessel to vessel collision resulting in a fuel tank rupture are described in the National Energy Resources Australia (NERA) Consequence Analysis of an Accidental Release of Diesel Reference Case (NERA, 2018). This Reference Case is considered relevant to the risk described for this activity given that:

• Water depths within the Operational Area are greater than 10 m (i.e. 50 m).

• Accidental release volume is <700 m^3 (i.e. 300 m^3).

• Fuel type is marine diesel (i.e. consistent with hydrocarbon characteristics within the Reference Case).

• Other variables, including air temperature, release duration and consequence thresholds are consistent within those used in the Reference Case's impact analysis.

The modelling results for the Reference Case demonstrated that there was no surface impact above thresholds beyond 150 km from the source of the spill. The models also showed that entrained concentrations above thresholds generally travelled with the prevailing currents which tend to oscillate and run longitudinally to coastlines. Entrained hydrocarbons > 500 ppb (threshold) are expected at the release point and can extend beyond 150 km from the release site.

However, while sub-surface entrained and dissolved hydrocarbons may travel beyond 150 km from the immediate discharge location, most of the models showed the greatest concentration of hydrocarbons remained within the top few metres of the water column and closer to the release site.

Given that the greatest concentrations of hydrocarbons remain in the top few metres, shoals and reefs, and demersal fauna located in waters below 10 m water depth are unlikely to be affected by entrained and dissolved hydrocarbons.

Based on the limited offshore area exposed by moderate levels of hydrocarbons, the sensitive receptors are limited to plankton and transient fish (pelagic), marine mammals, marine reptiles and seabirds.

6.4.3.2 *Impact description*

Marine fauna

The extent of surface water hydrocarbon exposure has the potential to cause injury and mortality through toxicity poisoning to an intersecting individual marine receptor (such as seabirds, marine turtles or marine mammals):

- Seabirds dive in ocean waters to feed or rest at the surface. In the event that seabirds are exposed to hydrocarbons, these behaviours will oil feathers breaking down thermal insulation and buoyancy properties of seabird plumage which prevents them from feeding or flying (Crawford *et al.,* 2000). Seabird preening of oiled feathers will result in oil ingestion and resultant gut damage (Crawford *et al.,* 2000). Oiling of seabird feathers may result in mortal injury through starvation, cold and poisoning. Breeding BIA for the Wedge-tailed Shearwater is present within 150km of the release site, however, it is noted that the BIA intersected is the buffer zone around a breeding island (i.e. not the breeding location itself). A study tracking movements of wedge-tailed shearwaters indicate that birds forage on average 85 km away and up to a maximum of approx. 185 km from their nesting site, over short trips of 1-3 day duration (Cecere et al 2013).
- Marine turtles have the potential to ingest oil by surface breathing within the slick or consuming contaminated prey species. Ingestion of oil may result in mortal injury from damaged digestive function (Milton and Lutz 2003). Flatback turtle internesting BIA is present within 150km of the release site however no known aggregation areas are present / nor have the potential to be exposed to hydrocarbons from this event.
- Surfacing marine mammals such as blue whales and humpback whales migrating through surface hydrocarbon exposures are susceptible to fume inhalation and oil absorption through the skin (Helm *et al.,* 2015). Physical contact by individual whales of MDO is unlikely to lead to any long-term impacts (Fraker, 2013). Given the mobility and wide geographical distribution of whales on the NWS, only a small proportion of the population would be expected to surface in an area exposed to surface hydrocarbons, resulting in short-term and localised consequences, with no long-term population viability effects (Helm *et al.,* 2015). Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. While this reduces

the potential for physiological impacts from contact with hydrocarbons, active avoidance of an area may disrupt behaviours such as migration.

The extent of in-water hydrocarbon exposure has the potential to cause chronic impacts to planktonic organisms, pelagic fish and marine mammals that might move within the plume.

- Plankton are drifting organisms which includes eggs and larvae of fish and other animals. Plankton species are sensitive to toxic effects of oil at low concentrations and large numbers of planktonic organisms may be affected (ITOPF, 2011). Plankton are numerous and widespread but do act as the basis for the marine food web. However, any impact is expected to be localised and temporary, meaning that an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Once background water quality conditions have re-established, the plankton community may take weeks to months to recover (ITOPF, 2011). The potential impacts to plankton are expected to be short-term, localised, and not affecting local ecosystem functioning.
- Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2011). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. A proportion of the foraging population of whale sharks could be affected, which could result in temporary and localised consequences.
- Cetacean exposure to in-water hydrocarbons can occur via ingestion or physical coating (Geraci and St Aubin, 1988). The potential for environmental impacts would be limited to a relatively short period following the release and would need to coincide with a migration or aggregation event to result in exposure of a large number of individuals. However, such exposure is not anticipated to result in long-term population viability effects. A proportion of the migrating population of whales could be affected for a single migration event, which could result in temporary and localised consequences.
- Tainting of seafood can occur rapidly with even very low concentrations of hydrocarbons in the water. Tainting is where fish/shellfish absorb hydrocarbon from the water and its flesh has an oil odour or flavour when eaten. Tainted fish will be unacceptable to the market and may need to be dumped. If left in clean water for a few weeks the tainting will gradually disappear (NERA 2018:1003).

Given that the potential for hydrocarbon exposure within 150km of the release site is relatively short-term (up to 144 hours), receptors may be exposed resulting in potential localised consequences. It is unlikely that many marine receptors will be exposed and therefore no receptor populations will be affected.

In the event a vessel collision would result in the release of diesel, marine fauna casualties may result however would only occur at a localised level (given the limited duration and transient nature of receptors within the area) and would be unlikely to impact local populations. This event is expected to result in localised, short-term impacts to transient marine receptors.

The potential impacts of spill response activities are discussed in Section 6.5.

6.4.4 Control measures

6.4.4.1 *Prevention measures*

AHTS vessels contracted by VOGA are manned by qualified crews and led by a master with a Master Class 1 certificate of competency. Whilst at sea, the AHTS vessels maintain a bridge watch and monitor the emergency frequency VHF Channel 16. In addition both MODU and AHTS vessels will have navigational lighting to ensure they are visible to other vessels transiting the area.

AHTS vessels contracted by VOGA are fitted with radar and AIS that track and identify vessels in the general area. The AIS calculates collision risk and alerts the bridge officers. AIS is required on all vessels of 300 tonne displacement or greater.

The WNA or WNB platforms have been marked on charts issued by the AHS since installation in the mid-1990s. The charts define a 500m restricted zone around the Wandoo platforms and their associated seabed and surface infrastructure.

Permission must be granted by the Wandoo Control Room Operator prior to any vessel entering the restricted zone around a platform. VOGA contract AHTS vessels which have DP capability; DP provides excellent station holding capability for the vessels. DP trials are conducted regularly by the vessels and are noted in the ship's logs.

By exception, if a vessel without DP capability is to be used in close support near a platform it must able to be fitted with a three or four-point mooring system.

Vessels without a VOGA contract will not be permitted to enter the restricted zone around the platform.

VOGA conducts on-hire surveys for vessels without an operational history with the Company. In addition, audits of the ship's logs are carried out to satisfy the Company that vessel operations are being managed satisfactorily.

The most likely spill scenario is for a spill to occur during diesel transfer. Controls to reduce this risk include:

- Diesel transfers to the MODU are conducted under the MODU Permit to Work procedure;
- Use of DP vessels greatly reduces the risk of an AHTS vessel moving off location during diesel transfer;
- Diesel transfer hoses are equipped with dry breakaway couplings that seal and prevent diesel loss from the transfer hose; and
- Hose used for diesel transfer is certified and pressure tested in accordance with the MODU preventative maintenance system.

A watcher on the MODU, equipped with a radio, is tasked with watching the diesel transfer process to alert the AHTS vessel officer of the watch if anything untoward is observed, so that the pumps can be shut down and spillage avoided or reduced.

Refuelling frequency to the MODU is minimised by balancing the fuel load on the MODU with forecast operations and forecast weather conditions. In practice, this is an ongoing risk management exercise for the MODU crew, in which it may be preferable to refuel before it would otherwise be necessary in order to synchronise with optimal weather conditions, thus reducing risk.

In the event of a spill, the vessel's SOPEP will be used to manage a minor diesel spill and, if a larger spill occurs, the VOGA OSCP will be activated.

6.4.4.2 *Mitigation measures*

An assessment of the benefits of the feasible diesel spill response for this type of spill, are provided in Table 5-12. The response strategies not considered feasible are outlined in Table 5-13. The impacts of the oil spill response strategies are assessed in Section 5.5.

Table 6-18: Feasibility and benefits of response strategies for Category B spills

Oil spill response strategy	Feasible	Benefits
Source control	Yes	Source control activities include shutting off pumps and transferring fuel to another fuel tank. All strategies would be effective in minimising the amount of diesel lost to the environment and would reduce the area of potential exposure.
Monitor and evaluate	Yes	Monitoring and evaluation provides up-to-date information on the behaviour and likely trajectory of the spill. This will be used to select the most appropriate response strategy and to evaluate its effectiveness.
Mechanical dispersion	Possible	Mechanical dispersion assists with the natural dispersion process, encouraging the slick to mix, create a smaller droplet size and suspend within the water column where it can be more easily biodegraded. It may also be used to assist chemical dispersion when sea conditions are calm. Mechanical dispersion is used when surface oil presents a greater risk to the marine environment than entrained oil.
Oiled wildlife response	Possible	This is applicable for marine fauna that come close to the spill or become oiled. Oiled wildlife response can minimise environmental impacts by: • reducing the oiling of wildlife by preventing animals entering the impacted environment; and • if practical, the initiation of pre-emptive capture and removal of animals at risk. If animals are oiled prompt initialisation of oiled wildlife response provides a means for rehabilitation and release or humane euthanasia to minimise suffering.

The response strategies will be implemented in accordance with the Wandoo Field OSCP [WAN-2000-RD-0001].

Table 6-19: Response strategies not considered feasible for Category B spills

Oil spill response strategy	Feasible	Considerations
Containment and recovery	No	The effectiveness of containment and recovery depends on the thickness of the hydrocarbon and metocean conditions. As diesel is a volatile non-persistent hydrocarbon, it is easily spread by wind and wave action. The ability to contain and recover spreading diesel on the ocean is extremely limited, hence this response strategy is not considered effective in reducing the net environmental impacts of the spill.
Chemical dispersion	No	Diesel is not considered to be a persistent hydrocarbon; it has a high natural dispersion and evaporation rate. Chemical dispersant application is not recommended as a beneficial option for a diesel spill, as it has a low probability of increasing the dispersion rate of the spill while, in the process, more chemicals are introduced into the marine environment.
Protection and deflection	No	Protection and deflection can be used to protect sensitive receptors through the use of booms to create physical barriers on the water surface. The effectiveness of protection and deflection depends on the thickness of the hydrocarbon and the metocean conditions. The ability to corral diesel is extremely limited as diesel is a volatile, non-persistent hydrocarbon that is easily spread by wind and wave action. Modelling results also predict that a diesel spill of this magnitude has a low probability of shoreline contact (Section 3.2.1). Hence it is unlikely that protection and deflection will be used in this case.
Shoreline clean-up	No	Shoreline clean-up is unlikely to be used, because shoreline contact is not predicted.
In-situ burning	No	In-situ burning is not considered feasible, as diesel has not been proven to be amenable to in-situ burning. Also the required equipment, technology and training are not available in Australia for operators planning to use this technique. No in-situ burning accelerants are currently listed on the National Plan Register for OSCA.

6.4.5 ALARP demonstration

VOGA has evaluated the risk of a diesel spill from an AHTS vessel or MODU and determined that there are two scenarios in which a spill is credible:

- Vessel collision resulting in a rupture of one or more vessel or MODU fuel tanks. The risk of a vessel collision is managed through a combination of vessel and equipment selection, confirmation of the master's qualifications and procedural controls. The resultant risk is very low.
- Vessel or MODU collision with a Wandoo platform. The risk of a collision with Wandoo platform is managed through the use of compliant navigation lights and a requirement for the vessels to obtain specific permission from the Wandoo Control Room Operator prior to entering the 500m restricted zone around the platforms. Conditions applied to the permission to enter the restricted zone reduce the risk of a collision to a very low level.

Diesel fuel transfers between an AHTS vessel and the MODU introduce a greater risk of a diesel spill although the magnitude of the spill is low. This risk is managed through a combination of equipment selection and maintenance and testing, in conjunction with procedures to monitor the operation closely.

One control not mandated by VOGA during its operations is restricting refuelling operations to daylight hours. This was considered and, where possible, it is the preferred choice, however the MODU and AHTS vessels have excellent lighting and conducting the transfer in good weather conditions reduces the risk of a spill event more than the mitigation offered through refuelling during daylight. In the area around the Wandoo platforms, the calmest weather is often a few hours just prior to dawn. VOGA has determined that limiting fuel transfers to daylight introduces a greater risk than ensuring that transfers take place in optimal weather conditions and thus does not mandate this control.

The ALARP assessment has concluded that the risks associated with collision of the MODU or AHTS vessel with another vessel, or hose failure during fuel transfer, are managed to ALARP as:

- There are sufficient layers of protection in place for the current risk level;
- In the unlikely event of an AHTS vessel collision, response strategies which match the hazard profile are defined in the OSCP and will be implemented to reduce the impact of the spill to the environment. The resources required to implement the response strategies have been assessed to ensure that those available are appropriate for the level of risk associated with the operations and that the required response objectives can be achieved;
- Actions taken in the event of a spill occurring during diesel transfer from the AHTS vessel to the MODU will restrict the size of the spill; and
- Additional controls and alternative arrangements were not considered to be beneficial due to the potential to increase overall risk if implemented.

Spill response capability demonstration for the implementation of feasible response strategies is detailed in Section 6.2.5.

6.5 Environmental impacts of oil spill response

6.5.1 Hazard report

Table 6-20: Hazard report – Environmental impact from oil spill response

HAZARD:	Environmental impact from oil spill response activities
EP risk number:	EP-WC-R04
Potential impacts:	Increased entrained fraction of hydrocarbons in the water column after adding dispersants. Toxicity effects on marine fauna from dispersant. Disturbance to benthic habitat, adjacent vegetation and other environmentally sensitive areas. Scouring of sediments. Waste generation, disposal and management.

PREVENTION:					
Activity/cause	**Existing control measures**	**Control type**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Key component as outlined WAN-WNAB-CP-ER-03-01 - *Response strategy - Monitor and evaluate.*	Ensure the most effective response strategies are being applied and environmental impact of the spill and response strategies are measured.	Administrative	To mitigate the environmental impacts as a result of oil spill response activities.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-01 - Response strategy - Monitor and evaluate (Appendix 4)	Assurance activities, as per WAN-WNAB-CP-ER-03-01 - Response strategy - Monitor and evaluate.
Key component as WAN-WNAB-CP-ER-03-02 - *Response Strategy - Chemical dispersant application.*	Application of chemical dispersant in accordance with the dispersant application zones.	Administrative	Minimise environmental impacts associated with dispersant application.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-02 - Response Strategy - Chemical dispersant application (Appendix 4).	Assurance activities, as per WAN-WNAB-CP-ER-03-02 - Response Strategy - Chemical dispersant application.
Key component as outlined WAN-WNAB-CP-ER-03-03 - *Response strategy - Mechanical dispersant application.*	Application of mechanical dispersant activities in accordance with application zones.	Administrative	Minimise environmental impacts associated with mechanical dispersant activities.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-03 - Response strategy - Mechanical dispersant application (Appendix 4).	Assurance activities, as per WAN-WNAB-CP-ER-03-03 - Response strategy - Mechanical dispersant application.
Key component as outlined in WAN-WNAB-CP-ER-03-04 - *Response strategy - Containment and recovery.*	Deployment of equipment will be undertaken by trained incident response personnel.	Administrative	Minimise environmental impacts associated with improperly deployed equipment.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-04 - Response strategy - Containment and recovery (Appendix 4).	Assurance activities, as per WAN-WNAB-CP-ER-03-04 - Response strategy - Containment and recovery.
Key component as outlined in WAN-WNAB-CP-ER-03-05 - *Response strategy - Protection and deflection.*	Deployment of equipment will be undertaken by trained incident response personnel.	Administrative	Minimise environmental impacts associated with improperly deployed equipment.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-05 - Response strategy - Protection and deflection (Appendix 4).	Assurance activities, as per WAN-WNAB-CP-ER-03-05 - Response strategy - Protection and deflection.
	Booms shall only be installed after consultation and approval from the Department of Transport.	Administrative	Minimise impact to fauna from oil spill response activities.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-05 - Response strategy - Protection and deflection (Appendix 4).	Assurance activities, as per WAN-WNAB-CP-ER-03-05 - Response strategy - Protection and deflection.
Key component as outlined WAN-WNAB-CP-ER-03-06 - *Response strategy - Shoreline clean-up.*	Shoreline assessments will be used to select appropriate shoreline clean-up techniques.	Administrative	Minimise impact to key shoreline habitats associated with shoreline clean-up activities.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-06 - Response strategy - Shoreline clean-up (Appendix 4).	Assurance activities, as per WAN-WNAB-CP-ER-03-06 - Response strategy - Shoreline clean-up.
Key component as outlined in WAN-WNAB-CP-ER-03-07 - *Response strategy - Oiled wildlife response.*	Induction and training for onshore and offshore teams.	Administrative	Minimise potential impacts on fauna caused by oiled wildlife response activities.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-03-07 - Response strategy - Oiled wildlife response (Appendix 4).	Assurance activities, as per WAN-WNAB-CP-ER-03-07 - Response strategy - Oiled wildlife response.

PREVENTION:					
Activity/cause	**Existing control measures**	**Control type**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Key component as outlined in WAN-WNAB-CP-ER-01-04 - *Arrangements are accessible.*	Current oil spill response arrangements are accessible to all personnel in the event of an oil spill.	Administrative	To mitigate the environmental impacts as a result of oil spill response.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-01-04 - Arrangements are accessible.	Assurance activities, as per WAN-WNAB-CP-ER-01-04 - Arrangements are accessible.
Key component as outlined in WAN-WNAB-CP-ER-01-05 - *Arrangements are understood.*	Oil spill response personnel understand and competently perform their response roles.	Administrative	To mitigate the environmental impacts as a result of oil spill response.	Performance criteria shall apply, as per WAN-WNAB-CP-ER-01-05 - Arrangements are understood.	Assurance activities, as per WAN-WNAB-CP-ER-01-05 - Arrangements are understood.

MITIGATION:				
Existing control measures	**Control type**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Environmental monitoring of impact of the spill and response strategies.	Administrative	To assess environmental impacts associated with oil spill response activities which are outlined in the Wandoo Field OSCP [WAN-2000-RD-0001].	The Wandoo Field OSCP [WAN-2000-RD-0001] shall be implemented inclusive of an environmental monitoring plan which considers: - environmental impact associated with the spill and response strategies; - environmental sensitivities to be monitored; - monitoring methods and type; - sources of baseline data; - resources required and mobilisation times; and - termination criteria.	Results from environmental monitoring plan are available for IAP.

INITIAL RISK WITH EXISTING CONTROLS:		
Consequence	**Likelihood (of consequence)**	**Initial risk**
Moderate (3)	Unlikely (B)	Medium

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:

Following the adoption of standard industry good practice controls, a medium risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.

Additional control measures	Prevention/mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
N/A	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:		
Consequence	**Likelihood (of consequence)**	**Residual risk**
Moderate (3)	Unlikely (B)	RRIII (Medium)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**RR < Extreme (I)**	**EPO(s) manage risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Risk managed in accordance with VOGA HSE policy. Potential spills to be managed in accordance with Wandoo Emergency Response Plan [VOG-2000-RD-0017]/Wandoo Field OSCP [WAN-2000-RD-0001].	Yes – Wandoo Field OSCP [WAN-2000-RD-0001] consistent with NatPlan.	Yes – RR = RRIII (Medium)	Yes – EPOs specify mitigation or minimisation of potential environmental impacts via the application of specific performance criteria. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.5.2 Overview

While spill response activities are intended to reduce the potential environmental consequences of a hydrocarbon spill, response activities could potentially exacerbate or cause further environmental harm. Decisions regarding spill response activities need to consider both the potential environmental impacts associated with taking no action and the potential environmental impacts associated with a response activity or combination of spill response activities. Poorly planned and coordinated response activities can result in a lack of, or inadequate information and poor decisions being made during incident response.

Response activities can result in:

- spreading of hydrocarbons further beyond the zone of contamination (e.g. secondary contamination due to hull contamination of response vessels);
- inadequate surveillance leading to poor information and unforeseen impacts; or
- inappropriate response strategy implemented and additional sensitive receptors impacted (e.g. use of dispersants when containment and recovery would have been of greater benefit).

This section assesses the available spill response strategies to determine which strategies will be implemented in response to a diesel or crude oil spill.

The assessment of each response strategy was based on a SIMA approach which considered the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response. This Strategic SIMA takes into account the hydrocarbon type, threshold levels and sensitivity of the area potentially affected by the spill, and the potential outcomes (positive and negative) of the proposed response strategy. This assessment is summarised in Section 6.2.6.1.2 of this EP and a Strategic SIMA is presented in the OSCP (Appendix C). The SIMA has been undertaken based on predicted information to determine the level of spill response required. In the actual event of a spill, the SIMA is revisited regularly as more information becomes available on actual conditions, spill trajectory path and locations of sensitive receptors. This review process allows response strategies to be adjusted to provide optimal results.

6.5.3 Risk assessment of oil spill response strategies

The acceptability of the potential environmental impacts and risks associated with the following oil spill response strategies have been evaluated in accordance with VOGA's management systems and sub-regulations 13(5) and 13(6) of the OPGGS(E)R:

- source control;
- monitor and evaluate;
- chemical dispersion;
- containment and recovery;
- mechanical dispersion;
- protection and deflection;

- shoreline clean-up; and
- oiled wildlife response.

6.5.3.1 *Source control*

Description of hazard

Source control activities are effective in minimising the amount of hydrocarbons lost to the environment and reducing the area of potential exposure.

Potential source control activities include:

- surface well intervention;
- drilling a relief well;
- emergency shutdown; and
- isolation of equipment.

Impact assessment

Source control activities such as emergency shut down and isolation of equipment will reduce the volume of oil released to the marine environment. Consequently these response strategies will not create additional impacts on the marine environment over and above the spill itself.

Surface intervention may be required to reduce the amount of oil released to the marine environment if there is a total loss of well control. During the surface intervention operations, AHTS vessel support would be required to deliver related equipment to the MODU and to remove any unnecessary equipment to facilitate the operations. Hence the impacts associated with surface intervention activities are the same as those associated with vessel operation as outlined in Sections 6.6 (noise), 6.7 (atmospheric emissions), 6.8 (artificial light), 1.1 (cooling water), 5.10 (deck drainage and bilge water discharge), 6.15 (physical presence of AHTS vessel) and 6.11 (waste management) respectively.

Drilling a relief well may be required if there is a total loss of well control. The response process to be followed in the event of a loss of well control incident is outlined in the Wandoo Field Source Control Contingency Plan [WNB-3000-PD-0007].

If a relief well was required, it would be drilled using a semi-submersible or jack-up MODU within the Operational Area. The impacts associated with proposed well construction activities outlined in this EP are the same as those associated with drilling a relief well in the Wandoo Operational Area. The impacts associated with drilling a relief well are summarised in Table 6-21.

Table 6-21: Summary of impacts of drilling a relief well

Hazard	Impact description
Noise	Impacts from noise from the MODU and AHTS vessels within the operational area have been detailed in Section 5.6.
Atmospheric emissions	Impacts from atmospheric emissions from the MODU and AHTS vessels within the operational area have been detailed in Section 5.7.

Hazard	Impact description
Artificial light	Impacts from light from the MODU and AHTS vessels within the operational area have been detailed in Section 5.8.
Discharge of cooling reject water	Impacts from discharge of cooling water from the MODU and AHTS vessels have been detailed in Section 5.9.
Deck drainage and bilge water discharge	Impacts from discharge of deck drainage and bilge water from the MODU and AHTS vessels are outlined in Section 5.10.
Non-hazardous and hazardous waste	The impacts of generation of MODU and AHTS vessel wastes within the operational area have been detailed in Section 5.11.
Discharge of drill cuttings, cement and well construction fluids	Impacts from discharge of drill cuttings, cement and well construction fluids are outlined in Section 5.12.
Discharge of sewage, grey water and putrescible waste	Impacts from the MODU and AHTS vessels within the operational area interacting with other users have been detailed in Section 5.13.
Physical presence	Impacts from the MODU and AHTS vessels within the operational area interacting with other users have been detailed in Section 5.15.
Seabed disturbance	Impacts of installing temporary moorings associated with placement of the MODU are outlined in Section 5.16.
Introduction of invasive marine species	Potential impacts from invasive marine species from the MODU and AHTS vessels within the operational area have been detailed in Section 5.17.
Spills	Impacts from potential spills from the MODU and AHTS vessels have been outlined in Section 5.4.

6.5.3.2 *Monitor and evaluate*

Description of hazard

As discussed above several methods can be used to monitor and evaluate, including:

- surveillance from field infrastructure, MODU and vessels;
- aerial surveillance;
- satellite tracking buoys; and
- OSTM.

Many monitoring and evaluation methods will not create any additional impacts on the environment. However, surveillance of spill size and tracking its movement using vessels and aircraft will have an impact.

Impact assessment

There are a number of generic impacts that will arise (or could potentially arise) from vessel and aircraft operation. The nature of these additional routine impacts (e.g. discharges, emissions, vessel movements) and unplanned impacts (e.g. diesel spills) are as described within the following EP sections:

- Diesel spill to sea (Section 6.4);
- Noise (Section 6.6);

- Atmospheric emissions (Section 6.7);
- Artificial light (Section 6.8);
- Deck drainage and bilge water discharge (Section 6.10);
- Discharge of sewage, grey water and putrescible waste from vessels (Section 6.13);
- Non-hazardous and hazardous wastes (Section 6.11);
- Physical presence (Section 6.15);
- Ancillary hydrocarbon or chemical spills/discharges (Section 6.16); and
- Introduction of invasive marine species (Section 6.17).

6.5.3.3 *Chemical dispersion*

Description of hazard

Chemical dispersion involves the application of chemical dispersant.

VOGA has identified three potential dispersant application zones: the ‘go’ zone, the ‘intermediate’ zone, and the ‘no go’ zone. These are described in the Wando Field OSCP [WAN-2000-RD-0001] and presented in Figure 6-1.

For planning purposes, the dispersant application zones were utilised in OSTM as a basis for spill response impact assessment within this EP (see Section 5.5). As the OSTM was unable to prioritise dispersant locations within the intermediate zone, VOGA has limited the modelling of dispersant application to the dispersant ‘go’ zone. This results in a more conservative assessment of the benefit of this strategy.

Dispersant Efficacy testing

Dispersant efficacy testing was undertaken by ChemCentre (2015) to determine the efficacy profile of dispersants. Test were conducted on fresh and weathered Wandoo Crude for their dispersibility with five different dispersants, including:

- Ardrox;
- Corexit 9500A;
- Dasic Slickgone EW;
- Dasic Slickgone NS; and
- Finasol OSR 52.

Weathering of Wandoo crude was tested under both summer and winter weather conditions. As summer exhibited greater weathering, crude weathered in these conditions were used for the dispersant efficacy laboratory tests.

Results from this study informed of the efficacy of a larger range of dispersants and if prolonged chemical dispersant application is viable on the Wandoo crude.

All the dispersants tested were effective at dispersing a large percentage of the oil on the water up to three days after the spill (Table 6-22). For each dispersant, ‘10A’ represents the percentage of the weathered oil that has dispersed through the water column after ten minutes of agitation and considered to be an effective measure of dispersibility.

Table 6-22: Dispersant trial against the Wandoo crude, ChemCentre (2015)

Dispersant	Ardrox	Corexit 9500A	Finasol OSR 52	Slickgone EW	Slickgone NS
Oil	**10A**	**10A**	**10A**	**10A**	**10A**
Fresh	86%	100%	100%	100%	100%
1 day weathered	72%	79%	78%	100%	100%
2 day weathered	82%	84%	63%	100%	100%
3 day weathered	89%	100%	100%	100%	100%
4 day weathered	49%	66%	78%	100%	93%
5 day weathered	25%	54%	98%	39%	5%
10 day weathered	13%	35%	31%	23%	-

Note: AMSA accepts a dispersant on to the Oil Spill Control Register if it has a dispersant efficacy of 70%. VOGA modelled a conservative oil spill dispersant efficacy of 50%.

The dispersant trials gave particularly good results for all dispersants if used in the first three days. Of note was the increase in efficacy observed in most samples on a 3 day weathered sample over a 2 day weathered sample. While some variability in results might be expected, three of the dispersants had increased efficacy after three days, while the remaining two (Slickgone NS and Slickgone EW) were already giving 100% dispersant efficacy. While this result might suggest that spill responders dealing with a 2 day old slick might choose to wait a day to improve their response, this is not recommended due to the difficulty in ensuring that lab trials match the exact weathering conditions of a real spill.

Impact assessment

The application of chemical dispersant is highly effective in assisting the natural process of biodegradation and minimising the risk of oil impacts to vulnerable coastal receptors on the Dampier Archipelago and the Barrow, Montebello, Great Sandy and Lowendal islands, as well as the mainland of the WA coastline.

For some species/habitats, the use of chemical dispersants can effectively reduce the severity of hydrocarbon impact. Dispersing oil into the water column reduces the quantity of oil on the surface, subsequently reducing the amount of oil that can strand and smother any resource which it comes into contact with, i.e. mangrove pneumatophores (rhizomes that grow upwards vertically out of the mud – used for respiration and salt balance) and species such as turtles, migratory birds, seabirds and shorebirds. However, species present within the water column such as whales, dugongs, dolphins and sharks, and biological processes such as coral spawning, could be negatively affected by the increased concentration of dispersed oil and associated chemicals in the water column.

The use of dispersant has the potential to change both the rate and location of organism exposure to the oil. As dispersant causes the transfer of oil from the water surface into the water column, it introduces the need to assess this relative to the risk of exposure from oil remaining at the surface with the risk of exposure to the oil-dispersant mixture in the water column. Potential impacts from the use of chemical dispersants include:

- Increased toxicity to marine habitats and fauna due, to the addition of dispersant chemicals to the marine environment; and
- Increased toxicity to marine habitats and fauna due to dispersed oil in the water column in the form of entrained oil and dissolved oil.

The decision to use chemical dispersants, as with all response strategies, is governed by the outcomes of a SIMA. In this case, a SIMA will consider the benefit of reducing the volume of floating oil against the potential impacts of increasing the volume of subsurface oil and the introduction of the chemical dispersant itself.

The use of chemical dispersant has potential environmental impacts which are associated with its inherent toxicity. Dispersants currently in use however are much less toxic than early-generation dispersants, with acute toxicity values (measured in standard 96h LC50 tests) typically in the range of 190 to 500 mg/L (Fingas, 2008). In comparison, toxicity of the Water Accommodated Fraction (WAF) for samples of Wandoo Crude was in a similar range of values as typical dispersants (140 to 400 mg/L) (Ecotox, 2012). The result for the acute prawn toxicity test was in the order of 1,500 mg/L for Wandoo Crude based on an IC10 value (Ecotox, 2012).

This was supported in recent studies of a range of dispersants, completed for the USEPA during the Macondo spill response. These studies showed that dispersants alone have only low toxicity, while dispersant-oil mixtures generally have similar toxicity to crude oil alone (Hemmer *et al.,* 2011) http://www.epa.gov/bpspill/dispersants-qanda.html#q011

The potential impacts of chemical dispersant on key environmental sensitivities are outlined in Table 6-23, Table 6-24 and Table 6-25.

Some recent studies have indicated that Corexit 9500A oil mixtures may have significantly higher toxicity in the laboratory than either the dispersant or oil alone (Rico-Martínez *et al.,* 2013; Radniecki *et al*., 2013; Zhang *et al*., 2013). However, it is suggested that this is simply due to an increase in organism exposure to oil within the water column following dispersant treatment, rather than an actual increase in toxicity (Coelho *et al*., 2013; Radniecki *et al*., 2013).

Embryonic and larval stages appear to be more sensitive than adults to both dispersants and dispersed oil (Clark *et al.,* 2001), with LC50s for both oyster and fish larvae reported to be as low as 3 mg/L for dispersant alone. However, some studies report higher larval toxicity values (i.e. lower sensitivity) for dispersant that are closer to the adult values (Coutou *et al.,* 2001).

Any dispersant used would be selected from the AMSA OSCA Register prior to use. Criteria for inclusion on the OSCA Register includes a ban on toxic components including benzene, carbon tetrachloride or other chlorinated hydrocarbons, phenols, cresols, caustic alkali, or free mineral acid.

The main source of toxicity from the application of dispersant to oil is likely to come from oil dispersed in the water column in the form of entrained oil or dissolved oil (i.e. the water accommodated fraction which can then potentially contact marine flora and fauna and benthic habitats).

A review of oil spill dispersants by Fingas (2008) confirmed that dispersant toxicity is consistently less than the toxicity of dispersed oil. Dispersant acute toxicity values are typically in the range of 190 to 500 mg/l (NAS, 2005). In comparison, toxicity of the WAF for samples of Wandoo Crude was in a similar range of values (140 to 400 mg/l) (Ecotox, 2012). About half of these found that the cause for this was the increased PAHs, typically about 5 to 10 times, in the water column. PAHs are of particular environmental concern since they are carcinogenic and mutagenic to marine organisms and can persist in the environment for long periods (as opposed to more volatile aromatic hydrocarbons such as BTEX). There is a low risk of toxicity to marine organisms from direct contact or ingestion of entrained Wandoo Crude, due to the low proportion of aromatic hydrocarbons present (APASA, 2013).

The elevated levels of hydrocarbons and subsequent impacts due to dispersant application are limited to the upper layers of the water column (Lee *et al.,* 2013; European Maritime Safety Agency, 2010; APASA, 2013). During testing for the Montara spill, APASA (2010) found that effects associated with dispersed oil were mostly contained within the top metre of the water column, with the concentration quickly reducing with time, depth and distance from the application site. APASA (2013) further concluded that the concentration of hydrocarbons within the water column, due to dispersed oil, was low relative to the amount that was already in the water column from the release. Lee *et al.* (2013) also found that dispersed oil is rapidly entrained within the top 1m of the water column and within 24 hours the dispersed oil is likely to mix within the top 10m of the water column and be rapidly diluted.

The impacts of dispersants, oil dispersed in the water column and oil on key environmental sensitivities is based on OSTM (refer Section 3.2.1 and Appendix 2) and are compared inTables 6-23 to 6-25.

Figure 6-1: Chemical dispersant application zones

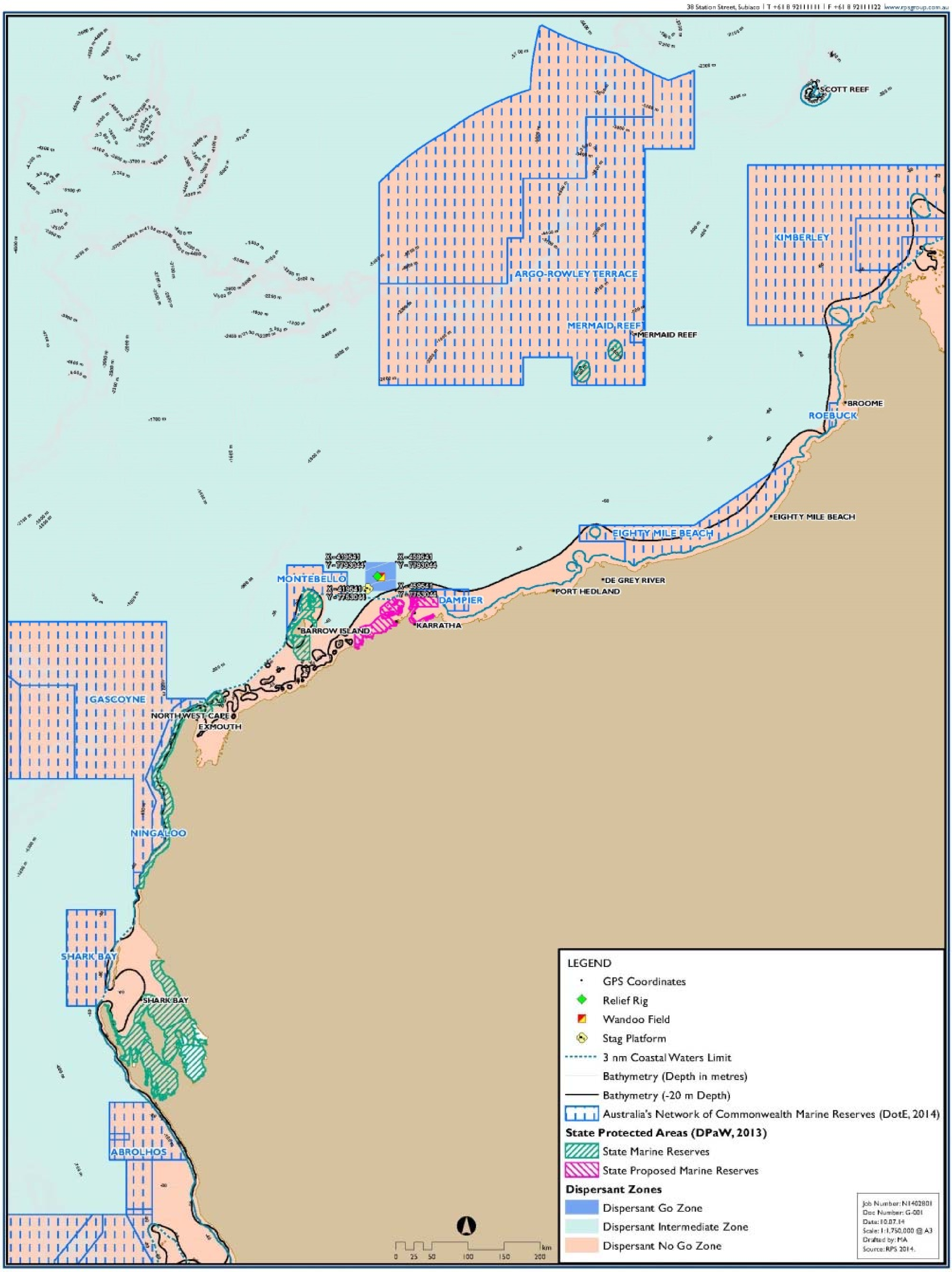


Table 6-23: Potential impacts of the application of dispersant on fauna

Ecological sensitivity	Key features	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
Marine mammals	Fifteen marine mammals which are listed as Threatened or Migratory under the EPBC Act, including 13 cetaceans, one dugong and one pinniped, may potentially occur in the EMBA. Within the Hydrocarbon Area, 11 marine mammals which are listed as Threatened or Migratory under the EPBC Act, all of which are cetaceans; Antarctic Minke Whale; Sei Whale; Bryde's Whale; Blue Whale; Fin Whale; Pygmy Right Whale; Southern Right Whale; Humpback Whale; Killer Whale; Sperm Whale and Spotted Bottlenose Dolphin (Table 4-9). Migrating humpback whales may occur within the Hydrocarbon Area during migration from July to October. The recognised peak in the humpback whale northern migration is mid-late July to August and the southern migration peak is late August to September (Jenner *et al.,* 2001). The migration BIA for the humpback whale is located within the Hydrocarbon Area. Pygmy blue whale have a feeding area in the Perth Canyon, whales feed between January and May. Whales then migrate north through the EMBA and past Exmouth within the Hydrocarbon Area between April to August; with southern migration typically occurs from October to late-December (DEWHA 2008c). Evidence suggesting that feeding likely occurs along the shelf in water depths from 500 to 1,000 m (Jenner and Jenner, 2008; McCauley *et al.,* 2004). A Distribution BIA for the pygmy blue whale is located within the Hydrocarbon Area. Dugongs are often found in shallow waters where seagrass beds flourish. Dugongs are migratory and are known to occur around the islands of the NWS, Shark Bay, Exmouth Gulf and the Dampier Archipelago where seagrass beds occur (Gales *et al.,* 2004). As such Dugongs may occur within the EMBA and Hydrocarbon Area. Several areas within the EMBA and Hydrocarbon Area have been recognised as critical habitats for marine mammals. These include the humpback whale calving grounds in the southern Kimberley region (Camden Sound) (DEH, 2005a), the humpback whale resting areas in Shark Bay and Exmouth Gulf, the dugong feeding grounds in Shark Bay, Exmouth Gulf and coastal waters near Broome, the Australian snubfin dolphin and Indo-Pacific humpback dolphin foraging and calving area in Roebuck Bay and the Australian sea lion breeding and foraging area in the Houtman Abrolhos Islands and Jurien Bay (Section 4.3.4.5).	The impacts of the dispersants themselves can be considered similar to that of entrained oil, given that the toxicity values for the dispersant, and the WAF of Wandoo Crude are both at around 140 to 500mg/L. These are discussed in Section 6.5. An additional potential impact of dispersants is the removal of natural water repellent oils from marine mammal fur (sea lion), making them less buoyant and susceptible to hypothermia (Kucklick *et al.,* 1997). However this is unlikely to occur given that dispersant application is not proposed in known sea lion habitat, and concentrations of dispersant will reduce outside of the application area.	Generally the use of dispersant will increase the amount of oil that physically mixes into the water column thus reducing the potential for a surface slick to come into contact with marine mammals that surface to breathe. Spill modelling results for the loss of well control scenario predicts that the use of dispersant will reduce the proportion of oil on the sea surface during all seasons. Spill modelling results also predict that the use of dispersants will increase the potential zones of low entrained hydrocarbon and dissolved aromatic exposure. Zones of moderate entrained hydrocarbon exposure are also predicted with the use of dispersants. Dispersed oil is unlikely to affect marine mammals due to the low toxicity of dispersed oils, low period of exposure that could occur and the low dosage of oil that may be received.	The impact assessment outlined in Section 6.5 predicts that major impacts to marine mammals are likely in the event of a loss of well control without the use of dispersants.	The application of dispersant reduces the oil level on the surface in most cases thus reducing the level of exposure to the oil of surface dwelling organisms such as marine mammals. Dispersant should be applied in open water where surface of trajectory modelling indicates high priority protection areas are at risk from oiling. During a spill response, real-time data is required to confirm whether dispersant will have a net benefit based on the conditions, spill location and application area.

Ecological sensitivity	Key features	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
Marine reptiles	**Turtles** Five species of turtle listed as Protected under the EPBC Act may potentially occur within the Operational Area and Hydrocarbon Area, and six species of turtle listed under the EPBC Act may occur in the EMBA (Table 4-13). The green turtle nesting area nearest to the Operational Area is located on the west coast of Barrow Island (approximately 100 km from the Operational Area). The major hawksbill rookeries are the Dampier Archipelago (40km from the Operational Area), Montebello Islands (approximately 90 km from the Operational Area) and Lowendal Islands (approximately 80 km from Operational Area), which occur within the Hydrocarbon Area Flatback turtles have major nesting sites occurring within the Hydrocarbon Area shoreline at Barrow Island (approximately 100 km from Operational Area), Mundabullangana Station (approximately 160 km from Operational Area), Eighty Mile Beach (approximately 300 km from Operational Area), Roebuck Bay (approximately 600 km from the Operational Area) the Lacepede Islands (approximately 690 km from the Operational Area), Dampier Archipelago (approximately 40 km from Operational Area), the Montebello Islands (approximately 90 km from the Operational Area), Port Hedland (approximately 220 km from the Operational Area), and the Lowendal Islands (approximately 80 km from Operational Area). Shallow water habitats are key nesting and inter-nesting sites in the Dampier Archipelago, Ningaloo Reef and offshore islands, e.g. Barrow Island, Montebello Islands occur within the Hydrocarbon Area. Critical nesting periods between November and March. BIAs for Loggerhead Turtle, Green Turtle, Hawksbill Turtle and Flatback Turtle occur within the Hydrocarbon Area. **Snakes** Two species of sea snake listed as Protected may occur in the EMBA. The Short-nosed Seasnake also may occur within the Operational Area. However, prefers the reef flats or shallow waters along outer reef edges in water depths to 10m and generally stay within 50 m of the reef. While the leaf-scaled seasnake occurs on the reefs of the Sahul Shelf in Western Australia, particularly on Ashmore and Hibernia Reefs within EMBA. **Crocodile** The saltwater crocodile listed as Protected under the EPBC Act may also occur in the Hydrocarbon Area (Section 4.3.4.6).	Sea turtles may be exposed to dispersants either internally (eating or swallowing oil, or inhaling of volatile oil related compounds) or externally (swimming in oil or dispersants, or oil or dispersants on skin and body) (NOAA, 2012). Direct contact of skin with petroleum compounds or dispersants may cause skin irritation, chemical burns, and infections. Inhalation of dispersants may irritate or injure the respiratory tract which may lead to inflammation or pneumonia. Ingestion of petroleum compounds or dispersants may cause injury to the gastrointestinal tract, which may affect the animals' ability to absorb or digest foods. Absorption of petroleum compounds or dispersants may damage liver, kidney, and brain function as well as causing anaemia and immune suppression. As chemically dispersed oil moves away from the spray zone, the dissolution of dispersant results in lower potential toxicity to species exposed to the dispersed oil. There are no specific studies on sea snakes reported in the scientific literature, but impacts are likely to be similar to those described for turtles as they are often seen at the sea surface.	The use of dispersants increases the amount of oil that physically mixes into the water column thus reducing the potential for a surface slick to come into contact with marine reptiles such as turtles that surface to breathe. The use of dispersants may also reduce the volume of oil that ends up on shorelines and the probability of oil reaching shorelines, thus reducing the impact to hatchling and turtles using nesting beaches. Spill modelling results for the loss of well control scenario predict that the use of dispersant will reduce the proportion of oil on the sea surface during all seasons and reduce the average volume of oil to shorelines in the majority of cases. Spill modelling results also predict that the use of dispersants will increase the potential zones of low entrained hydrocarbon and dissolved aromatic exposure. Zone of moderate entrained hydrocarbon exposure are also predicted with the use of dispersants. Dispersed oil is unlikely to affect marine reptiles due to its low toxicity, the low periods of exposure that could occur and the low dosage of oil that may be received.	The impact assessment outlined in Section 6.5 predicts that major impacts to marine reptiles are likely in the event of a loss of well control without the use of dispersants.	The application of dispersant reduces the oil level on the surface thus reducing the level of exposure to the oil of marine reptiles that return to the sea surface to breathe. The greatest impacts are posed to shoreline nesting sites. The application of dispersant will also reduce the volume and likelihood of oil reaching key habitat locations, reducing potential exposure to nesting turtles. Chemical dispersants should only be applied in open water where surface oil trajectory modelling indicates high priority protection areas are at risk from oiling if the spilt oil remains on the water surface.

Ecological sensitivity	Key features	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
Fish and sharks	Four species of shark, three sawfish and two rays listed as Threatened or Migratory under the EPBC Act potentially occur in the Operational Area. Seven shark, four sawfish and two ray species which are listed as Threatened or Migratory under the EPBC Act may potentially occur in the EMBA. Mako sharks have a widespread distribution and are unlikely to occur in large numbers. Whale sharks could potentially occur within the Operational Area and EMBA between March and June. Eighty Mile Beach, Roebuck Bay and Camden Sound are important areas for sawfish species and the northern river shark (Section 4.3.4.4). Fish are present in the Operational Area, but it is not a known area for aggregations of fish.	No specific studies reported in the scientific literature, but impacts are likely to be similar to those described for fish as they are predominantly pelagic species. As chemically dispersed oil moves away from the spray zone, the dissolution of dispersant results in lower potential toxicity to species exposed to the dispersed oil.	Dispersant application results in an increase in oil becoming entrained in the water column this significantly increased the potential for exposure of sharks throughout the water column (Gulf Coast Research Laboratory, 2013). A study conducted by Fuller *et al.,* (2004) using two fish species, *Cyprinodon variegatus* and *Menidia beryllina*, one shrimp species, *Americamysis bahia* (formerly *Mysidopsis bahia*), and the luminescent bacteria *Vibrio fisherithese*, indicated that the toxicity of chemically dispersed oil preparations was equal or less toxic than that of the oil alone. The potential for impact is highest at the point of application, where the concentration of dissolved hydrocarbons and/or dispersant chemicals is greatest. Exposure to dispersed oil is concentrated in the top portion of the water column and decreases fairly rapidly over time in areas with depths over 9m and good circulation (NRC, 1989; SEA, 1995). Spill modelling results for the loss of well control also predicts that the use of dispersants will increase the potential zones of low and moderate concentration of entrained hydrocarbons. Entrained oil is unlikely to affect species that exist in the water column due to its low toxicity, the low periods of exposure that could occur and the low dosage of oil that may be received. Spill modelling results also predict that the use of dispersants increases potential zones of low dissolved aromatic exposure. Exposure to dissolved aromatic hydrocarbons may result in delayed predatory/avoidance response times and disorientation. Given the low concentration and small extent of dissolved aromatic hydrocarbons predicted impacts to fish and sharks are likely to be minor.	The impact assessment outlined in Section 5.2.3.2 predicts that minor impacts to fish and sharks are likely in the event of a loss of well control without the use of dispersants	Chemical dispersants should only be applied in open water where surface oil trajectory modelling indicates high priority protection areas are at risk from oiling if the spilt oil remains on the water surface. The whale shark aggregation period from March to June will be considered in the SIMA.

Ecological sensitivity	Key features	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
Seabirds	12 birds potentially occur in the Operational Area, of which five threatened and 11 migratory species may occur. 56 birds potentially occur in the Hydrocarbon Area, of which17 Threatened species and 33 Migratory species of birds (Table 4-4). 126 birds potentially occur in the EMBA, of which 46 Threatened species and 71 Migratory species of birds may potentially occur within the wider EMBA (DoE, 2014c). Migratory species occur at the Ramsar sites at Eighty Mile Beach and Roebuck Bay, but also at the Rowley Shoals and other undisturbed offshore islands within the Hydrocarbon Area. The timing of migration varies between species, however birds typically begin to arrive in August to September and depart around March to April (Rogers *et al.,* 2011). Important seabird breeding sites within the region include the Montebello/Barrow islands group, Rowley Shoals, Eighty Mile Beach and Roebuck Bay. All of these areas are within the EMBA and Hydrocarbon Area (Section 4.3.4.3).	Dispersants may remove the natural water repellent oils from bird feathers (Boyd *et al.,* 2001) making them less buoyant and more vulnerable to hypothermia. Higher metabolic rates were also found in birds exposed to dispersant, presumably due to the increased energy suspended to maintain a normal body temperature (Lambert *et al.,* 1982).	The use of dispersants increases the amount of oil that physically mixes into the water column, thus reducing the potential for a surface slick to come into contact with seabirds that frequent the air water interface. Peakall *et al.,* (1987) concluded that, from the toxicological perspective, the effects of oil and chemically dispersed oil on seabirds were similar, based on sub-lethal responses at the biochemical and physiological level. Similarly, studies on the effects of oil on the hatching success of bird eggs (summarised in NRC, 1989) also indicated that toxicities of oil and dispersed oil were similar. Spill modelling results for the loss of well control scenario indicates that the use of dispersants will reduce the proportion of oil on the sea surface during all seasons.	The impact assessment outlined in Section 6.5 predicts that minor impacts to seabirds are likely in the event of a loss of well control without the use of dispersants	Application of dispersant or dispersed oil in the water column presents much lesser risk to seabirds and waders than leaving an oil spill untreated, as it reduces their exposure to hydrocarbons (French-McCay, 2004). Dispersant should be applied in open water where trajectory modelling indicates high priority protection areas are at risk from oiling.

Table 6-24: Potential impacts of the application of dispersant on habitat sensitivities

Habitat sensitivity	Key habitat types	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
Hard corals	None present in Operational Area. The closest significant coral reefs to the Operational Area being the Glomar Shoals (approximately 37 km northeast) and Ningaloo Reef (approximately 250 km away) (Section 4.3.2.2). Significant coral reefs within the in-water and shoreline Hydrocarbon Area include Ningaloo Marine Park, the Montebello/Barrow/Lowendal islands, Muiron Island, the Dampier Archipelago, Glomar Shoals, Rankin Bank, Mermaid Reef and the Rowley Shoal.	Recent studies of coral larvae clearly demonstrate impacts of dispersants and dispersed oil on corals and, because of their life history and habitat characteristics, these species may be especially susceptible (NAP, 2005). Settlement of *P.astreoides* larvae, in particular, significantly decreases after exposure to all concentrations of dispersant [25 ppm, 50 ppm, 100 ppm], with no settlement occurring at the highest concentrations. Constant exposure to Corexit® 9500 also caused dramatic declines in larval survivorship, resulting in complete larval mortality (100%) after exposure to both medium and high concentrations [50 ppm, 100 ppm] (Goodbody Grinley *et al.,* 2013). It is unlikely that corals will be impacted by chemical dispersant as the concentration of dispersant reduces rapidly outside the application zone.	The application of dispersant will, typically, increase oil exposure for water column and bottom dwelling organisms such as hard coral (Boyd *et al.,* 2001). Spill modelling results for the loss of well control scenario indicates that the use of dispersant dramatically increases the extent of entrained hydrocarbons in the water column during all seasons. Moderate zones (100 ppb) of entrained hydrocarbons are predicted around the Montebello Islands and Exmouth, which may impact corals. There are no significant coral reefs in the predicted low dissolved aromatic hydrocarbon exposure zone. However, coral sensitivity to dispersed oil depends on the concentration and the length of exposure. Very high dispersed oil concentrations and long exposures can kill coral, whereas lower doses and short-term exposure show few, if any, impacts, many of which are reversible (Shingenaka *et al.,* 2010).	The impact assessment outlined in Section 6.5 predicts that major impacts to hard corals are likely in the event of a loss of well control without the use of dispersants	Dispersant-use decisions to treat oil already over a reef should take into account the type of oil and location of the reef. No dispersant will be sprayed in areas with water depth of less than 20 m depth. Dispersant use should be considered to treat oil over reefs in water depths greater than 20 m if the alternative is to allow the oil to impact other sensitive habitats on shore. Dispersion is not recommended to treat oil already in reef habitats having low-water exchange rates (e.g. lagoons and atolls) if mechanical clean-up methods are possible.

Habitat sensitivity	Key habitat types	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
Coral spawning	Spawning events have been observed throughout the Dampier Archipelago in March and April (Stoddart and Gilmour, 2005) and along the Ningaloo Coast during March (Simpson, 1993) within Hydrocarbon Area.	Dispersants resulted in significant inhibition to Acropora sperm and eggs (Negri and Heyward, 2000).	Chemically dispersed oil exposures resulted in a dramatic increase in acute toxicity to both coral species larvae. In addition, the authors reported that dispersants and dispersed oil treatments caused larval morphological deformations, loss of normal swimming behaviour, and rapid tissue degeneration (Epstein *et al.,* 2000).	Chronic oil pollution damages the reproductive system of scleractinian corals (Rinkevich and Loya, 1977). Gametes of most spawning species tend to rise to the surface just after spawning, where they are more likely to encounter oil and thus more likely to suffer damage (Harrison *et al.,* 1984).	Major spawning events occur after full moons in March/April, minor spawning events occur after full moon in February and May. The coral spawning period will be considered in the SIMA.
Macro-algae	Macro-algal habitat is most likely associated with coastal reefs and other hard substrates. It is widespread throughout the EMBA and Hydrocarbon Area and there are no specifically identified areas of significant environmental value (Section 3.3.4).	Virtually all macro-algae, in particular rhodophyte species are more susceptible to dispersants than to oil (Edgar and Barrett, 1995).	Complete or partial mortality of kelps is possible at exposure concentrations (>10ppm) of TPH as chemically dispersed oil (Ross, 2002). Spill modelling results for the loss of well control scenario indicate that the use of dispersants will increase the potential zones of low (10ppb) and moderate (100ppb) entrained hydrocarbons. Entrained oil at these thresholds is unlikely to cause mortality to sea kelp. Spill modelling results also predict a low potential zone of dissolved aromatic exposure. Given the low concentration and small extent of dissolved aromatic hydrocarbons predicted impacts to macro-algae are likely to be minor.	The impact assessment outlined in Section 6.5 predicts that serious impacts to macro-algae are likely in the event of a loss of well control without the use of dispersants.	When the addition of a chemical dispersant is deemed necessary to protect other resources in the area, the macro-algae may still recover depending on the dispersant used.
Seagrass	None present in Operational Area. Extensive seagrass meadows are known to occur within the EMBA at Shark Bay, Exmouth Gulf and Roebuck Bay and are reported to provide important feeding habitat for dugongs and green turtles (Sheppard *et al.,* 2010; Bjorndal, 1985) (Section 4.3.2.3). Within the Hydrocarbon Area Ningaloo Reef, Dampier Archipelago and Montebello and Barrow islands exist.	Most dispersant alone treatments caused photosynthetic stress to the seagrass, and in some cases this was greater than the dispersed oil and the oil alone treatments (Wilson and Ralph, 2008). Ralph and Burchett (1998) found that laboratory-cultured *Halophila ovalis* was reasonably tolerant of petrochemical exposure and there was little difference between exposure to oil, oil and dispersant and dispersant alone.	Seagrasses have been shown to absorb more aliphatic and aromatic oil fractions when the oil is dispersed, therefore increasing the toxicity (den Hartog, 1984). Non-dispersed oil, in general, leads to less photosynthetic stress to *Zostera capricorni* and *Halophila ovalis* compared with the addition of a chemical dispersant (Wilson and Ralph, 2008). Low entrained hydrocarbon exposure zones are predicted at Shark Bay. There are no extensive areas of seagrass in the predicted low dissolved aromatic hydrocarbon exposure zone.	The impact assessment outlined in Section 6.5 predicts that serious impacts to seagrass are likely in the event of a loss of well control without the use of dispersants.	When the addition of a chemical dispersant is deemed necessary to protect other resources in the area, the seagrass may still recover depending on the dispersant used.

Habitat sensitivity	Key habitat types	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
Mangroves	Mangroves are not present within the Operational Area. The nearest areas of mangrove habitat occur at the Dampier Archipelago (over 30 km from Operational Area) (Section 3.3.5). Other significant areas of mangrove habitat occurring within the Hydrocarbon Area include the Montebello Islands, Ningaloo Coastline and scattered areas along the coast between Onslow and just north of Port Hedland (Section 4.3.2.4).	Dispersant causes significant and short term leaf damage to treated *Avicennia* when sprayed on leaves and pneumatophores (Wardrup, 1987).	Dispersed oil is readily flushed by tidal movement and the resident time of oil and consequent exposure time of flora and fauna is much shorter compared to oil with no dispersant (Schuler and Bacer, 2006). Laboratory and field studies have shown that the use of dispersant significantly reduces the death of mangrove trees (Duke *et al.,* 1998 a,b; Duke and Burns, 1999). Spill modelling results for the loss of well control scenario predict that the use of dispersant will reduce the proportion of oil on the sea surface during all seasons and reduce the average volume of oil to shorelines in the majority of cases. Spill modelling results also predict that the use of dispersants will increase the potential zones of low and moderate concentration of entrained hydrocarbons. Dispersed oil was significantly less toxic to mangrove trees than oil only treatments (Burns *et al.,* 1999).	The impact assessment outlined in Section 6.5 predicts that major impacts to mangroves are likely in the event of a loss of well control without the use of dispersants.	Any action taken to prevent or reduce stranding of oil in mangrove forests is likely to have a positive effect in reducing damages to mangroves. Chemical dispersion of oil in deep water, away from near-shore environments, is likely to allow dilution of dispersed oil such that exposure of sensitive subtidal environments to toxic concentrations is not likely to occur.
Intertidal beaches/ mudflats/rocky shorelines/intertidal reef platforms	No intertidal reefs, beaches/mudflats occur within the Operational Area, which is approximately 40km from the nearest landfall. Three intertidal beach/mudflat areas of international conservation significance occur within the Hydrocarbon Area (Bandicoot Bay, Eighty Mile Beach and Roebuck Bay). Bandicoot Bay is a Conservation Reserve within the Montebello/Barrow Islands Marine Management Area and Eighty Mile Beach and Roebuck Bay are listed under the Ramsar Convention and are afforded specific protection under the EBPC Act (Section 4.3.3.3).	Lethal and sub-lethal effects of most dispersants occur at 0.1 to 100ppm for marine invertebrates including those that inhabit intertidal reefs, beaches and mudflats (Volkman *et al.,* 1994).	Potential impacts on invertebrates and macro-algal species associated with reef are possible from exposure to entrained hydrocarbons. However, these impacts are considered less significant when compared to the resultant effects from direct exposure to oil. Spill modelling results for the loss of well control scenario show that the use of dispersant reduces the volume of oil to Bandicoot Bay and the shoreline from Port Hedland to Broome during both summer and winter conditions.	The impact assessment outlined in Section 6.5 predicts that minor impacts to Intertidal beaches/mudflats/ rocky shorelines/intertidal reef platforms are likely in the event of a loss of well control without the use of dispersants.	Dispersing oil before it impacts intertidal habitats is the preferred strategy in most cases. In cases where the oil was dispersed prior to contacting these habitats, the net ecological effect was much less severe compared to when oil was allowed ashore (NRC, 1989). Where the intertidal environment is highly sensitive to oil pollution, the no-action response option has a relatively high probability of resulting in significant adverse environmental impacts, and therefore, the no-action option is not recommended (Ballou *et al.,* 1987).
Protected areas					
World Heritage Areas	The Ningaloo Coast and Shark Bay WHA occur within the EMBA (Section 4.3.6.1) and may be impacted in the event of a loss of well control. The in water Hydrocarbon Area only encompasses Ningaloo Coast WHA, while shore line Hydrocarbon Area overlaps Shark Bay WHA	The impact of dispersant on the values associated with WHAs has been assessed in terms of key ecological and socio-economic sensitivities.	The impact of dispersed oil on the values associated with WHAs has been assessed in terms of key ecological and socioeconomic sensitivities.	The impact of not using dispersant on values associated with WHAs has been discussed in Section 6.5. Impacts ranging from minor to catastrophic are predicted.	Dispersant will be sprayed in accordance with the dispersant application zones outlined.
Australian Marine Parks	There are no Commonwealth Marine Protected Areas within the Operational Area; however they do occur within the EMBA and Hydrocarbon Area (Section 4.3.6.2).	The impact of dispersant on the values associated with Commonwealth Marine Protected Areas has been assessed in terms of key ecological and socio-economic sensitivities.	The impact of dispersed oil on the values associated with Commonwealth Marine Protected Areas has been assessed in terms of key ecological and socioeconomic sensitivities.	The impact of not using dispersant on values associated with Commonwealth Marine Protected Areas has been discussed in Section 6.5. Impacts ranging from minor to catastrophic are predicted.	Dispersant will be sprayed in accordance with the dispersant application zones outlined. Dispersant will not be used in Commonwealth Marine Protected Areas.

Habitat sensitivity	Key habitat types	Impact of dispersant	Impact of oil dispersed in the water column	Impact of oil	Actions/status/response
State Marine Protected Areas	State Marine Reserves do not occur within the Operational Area however they do occur within the EMBA and Hydrocarbon Area (Section 4.3.6.3).	The impact of dispersant on the values associated with State Marine Protected Areas has been assessed in terms of key ecological and socio-economic sensitivities.	The impact of dispersed oil on the values associated with State Marine Protected Areas has been assessed in terms of key ecological and socioeconomic sensitivities.	The impact of not using dispersant on values associated with WHAs has been discussed in Section 6.5 Impacts ranging from minor to catastrophic are predicted.	Dispersant will be sprayed in accordance with the dispersant application zones outlined. Dispersant will not be used in State Marine Protected Areas.
Key ecological features					
Key Ecological Features	No Key Ecological Features occur within the Operational Area; however they do occur within the EMBA and Hydrocarbon Area as outlined in Section 4.3.6.5.	The impact of dispersant on the values associated KEFs have been assessed in terms of key ecological and socio-economic sensitivities.	The impact of dispersed oil on the values associated with KEFs have been assessed in terms of key ecological and socio-economic sensitivities.	The impact of not using dispersant on values associated with KEFs have been discussed in Section 6.5. Impacts ranging from minor to catastrophic are predicted.	Dispersant will be sprayed in accordance with the dispersant application zones outlined above.

Table 6-25: Potential impacts of the application of dispersant on socioeconomic sensitivities, KEFs and protected areas

Sensitivity/feature or area	Key features	Impact of dispersant	Impact of chemically dispersed oil	Impact without use of dispersant	Actions/status/response
Socio-economic sensitivity					
Commonwealth and State Managed Fisheries (and aquaculture)	Several offshore and coastal fisheries occur within the EMBA and Hydrocarbon Area both in shallow water (<20 m depth) and much deeper offshore waters. It is unlikely that fishing activity will occur in the Operational Area due to the restricted zones. No aquaculture activities take place within the Operational Area. There are aquaculture facilities located in near-shore waters of the EMBA, with the closest known facilities to the Operational Area being at the Dampier Archipelago (Section 4.3.5.3).	Dispersants must be used with care so as not to cause tainting of shellfish and captured or cultivated stock. As a general guide, it is not prudent to use dispersant in shallow waters where fishing or aquaculture is important. Application of dispersant will have less effect on demersal and deepwater trawl fisheries as compared to the shallow water coastal fishery.	Closure of a fishery for reasons of contamination or tainting of the exploitable life stages – where oil concentrations are >1 ppm is assumed to cause tainting – will result in closure of fishing zone for one month (Ross, 2002). Dispersant application results in a high percentage of hydrocarbons becoming entrained in the top 10m of the water column which increases the potential to direct exposure to hydrocarbons to pelagic species, sessile aquaculture species and also to planktonic life stages of other fish species. Dispersant increases the volume of entrained hydrocarbon also increasing the potential for tainting.	The impact assessment outlined in Section 6.5 predicts that serious impacts to fisheries and aquaculture are likely in the event of a loss of well control without the use of dispersants.	Dispersant can be applied in open water where trajectory modelling indicates that oil is heading offshore away from coastal areas. The use of dispersants over important fishing grounds or aquaculture areas, except where ecologically important nursery habitats are threatened (mangroves, seagrasses and coral reefs), is not recommended. Dispersant use in areas where eggs and larvae of important commercial species are present is not recommended, except where important nursery habitats are threatened (mangroves, seagrasses and coral reefs).
Commercial Shipping	The Operational Area is approximately 25 km from the northbound shipping fairway from Dampier (Figure 4-22). There are significant commercial shipping activities within the EMBA and Hydrocarbon Area (Section 4.3.5.6).	Negligible.	Negligible.	The impact assessment outlined in Section 6.5 predicts that minor impacts to shipping are likely in the event of a loss of well control without the use of dispersants.	Dispersant can be applied in the vicinity of the shipping fairways.

Sensitivity/feature or area	Key features	Impact of dispersant	Impact of chemically dispersed oil	Impact without use of dispersant	Actions/status/response
Other users	A number of tourist destinations occur within the EMBA and Hydrocarbon Area, including the Ningaloo Coast, Exmouth Gulf and Broome (Section 4.3.5.8). The Operational Area is surrounded by a number of other leaseholders that operate petroleum related activities.	The dispersant application zone may impact on operations and people.	The impacts of dispersed oil on tourism and petroleum related activities are likely to be similar to the impacts of the oil spill. Tourism numbers to the area are likely to reduce during dispersant application. Recreational activities are likely to close temporarily due to risks to human health. Dispersant application has the potential to disrupt petroleum related activities, potentially halting production or exploration with associated economic impact.	The impact assessment outlined in Section 6.5 predicts that serious impacts to other users are likely in the event of a loss of well control without the use of dispersants	Dispersant will be applied in open water within the WA-14L Operational Area and within a nominal 20km radius of the spill location. Application of dispersant in areas outside the designated application area or the SIMA zone will only be done in accordance with the oil spill response plan.

6.5.3.4 *Mechanical dispersion*

Hazard description

Activities associated with mechanical dispersion include regular vessel operations and use of vessels for propeller washing.

Impact assessment

In addition to the generic vessel impacts, the potential use of vessels for propeller-washing to mechanically disperse spilt oil in shallow coastal waters introduces the potential for damage to sensitive seabed habitats such as coral reefs, macro-algae beds and seagrasses. Potential damage could occur from unplanned vessel grounding or propeller-wash (turbulence) in shallow water. These impacts could include scouring of sediments and physically damaging/removing subtidal habitat, together with any supported invertebrate communities. Mechanical dispersion will only be carried out in waters deeper than 20m (WAN-WNAB-CP-ER-03-03 - Response strategy - Mechanical dispersant application); hence impacts to sediments and subtidal habitats are unlikely.

6.5.3.5 *Containment and recovery*

Hazard description

Activities associated with containment and recovery includes:

- vessel and aircraft operations;
- transport and disposal of waste; and
- vessel boom anchoring, retrieval or sorbents.

Impact assessment

The potential impacts associated with vessel and aircraft operations are outlined in the referenced sections listed at the beginning of this section.

A containment and recovery spill response should generally have an increase in net environmental benefit for most species and habitats. However, during a shallow-water response, there is the potential that disturbance to benthic communities could occur due to vessel activities and/or boom anchoring. Potential impacts to marine habitats associated with anchoring are discussed in Section 6.16. Vessel size and/or draft will limit speed, manoeuvrability and access to operate.

Physical disturbance of habitat during deployment and retrieval of sorbents could occur. Poorly deployed or tended sorbent material could also crush or smother sensitive organisms. If sorbents are left in place for too long, there is a risk that the sorbents can break apart and become an ingestion hazard to wildlife.

Waste generated from the containment and recovery process includes oily sorbents. The collection of oil and the transport of oil and oiled equipment to either an offshore processing or an onshore disposal/wash-down site will create the potential for an unplanned release of hazardous wastes as described in non-hazardous and hazardous waste (Section 6.11). Free-floating oil removed during skimming operations can be recycled. Emulsions formed during the process must be treated (broken) before recycling. Oil-contaminated waste from the treatment phase will be treated as waste water.

6.5.3.6 *Protection and deflection*

Description of hazard

Activities associated with protection and deflection, include:

- vessel and aircraft operations;
- transport and disposal of waste;
- shallow water operation-vessel boom anchoring, retrieval or sorbents; and
- use of barriers/berms.

Impact assessment

Protection and deflection will involve the use of vessels near shallow coastal areas where sensitive habitats and aggregations of wildlife may be present. In addition to generic vessel impacts described in the referenced sections listed at beginning of this section the operation of vessels near shallow waters increases the risk of damage to sensitive habitats (hard corals, macro-algae, and seagrasses) from vessel grounding, manoeuvring and anchoring. Potential impacts to marine habitats associated with anchoring are discussed in Section 5.16. Sensitive habitat areas will be avoided during vessel grounding and anchoring.

Poorly placed deflection booms could potentially direct floating oil to shoreline areas where impacts could be more severe (e.g. mangrove areas) and, also, exacerbate the level of impact and recovery time for the ecosystem. Sensitive receptors identified in this EP will be avoided when placing protection and deflection booms.

Sediment barriers used for protection and deflection may become contaminated on the oil side and filter fence materials will have to be disposed of as oily wastes.

6.5.3.7 *Shoreline clean-up*

Description of hazard

Activities associated with shoreline clean-up include:

- vessel and aircraft operations;
- transport and disposal of waste; and
- shallow water and shoreline operations.

Impact assessment

OSTM indicates that there is a high probability of shoreline contact under a range of scenarios, refer to Hydrocarbon Area – Shoreline as shown in Figure 4-1.

Accessing shorelines for clean-up will have associated ecological constraints, especially if accessing uninhabited, sensitive coastal areas. Environmentally intrusive or potentially damaging activities should only be considered if there is a positive net environmental benefit. If significant shoreline oiling occurs, removal of vegetation may be required. Habitat removal will have significant impacts on the function of coastal ecosystems.

Physical clean-up methods can alter the elevation or profile of beaches, which may lead to erosion of beaches following the clean-up process, particularly if heavy machinery is used. Shoreline clean-up techniques are outlined in Section 6.5.3.7. The impact of shoreline clean-up techniques on various habitat types is outlined in Table 6-26.

The use of vessels to transport personnel to shoreline areas also increases the level of generic vessel impacts, as described at the beginning of this section.

Table 6-26: Potential impacts of shoreline clean-up activities on various habitat types

Habitat type	Key features	Undertaking shoreline clean-up	Not undertaking shoreline clean-up	Priority/Action
Mangroves	Mangroves are productive coastal forest systems, providing habitat and shelter for infauna, epifauna, gastropods, crustaceans, fish and other marine species. They occur in relatively flat areas with soft sediment. Mangroves are not present within the Operational Area. The nearest areas of mangrove habitat occur at the Dampier Archipelago (Section 4.3.3.1).	Natural recovery is the preferred clean-up method as mangroves have been shown to be more easily damaged by physical disturbance caused by clean-up than the oil itself. Mechanical removal and high pressure flushing has the potential to cause damage to mangroves and should not be attempted. Trampling associated with manual clean-up also has the potential to cause damage to mangroves. Sorbents may be used, as they eliminate the requirement for foot traffic and mechanical equipment. However, this technique is not recommended for high energy shorelines, as sorbents may be lost during periods of high wave action or tidal movement. It may also generate large volumes of waste. Low pressure flushing with seawater may be used for thick films only. It has the potential to cause removal or mortality of surface organisms and surface and near surface habitat disturbance.	Mangroves are very sensitive to hydrocarbons, even light oiling can result in defoliation and mortality. The recovery rate of mangrove areas depends on the dominant species involved. It is generally estimated that 25 to 40 years may be required for a mangrove community to re-establish itself (O'Sullivan *et al.,* 2001).	**High** As certain methods of shoreline clean-up have the potential to cause damage to mangrove habitats, focus should be on prevention of further hydrocarbon entry by using protection and deflection. If oil ends up in mangrove habitats, leaving residual oil to weather and degrade naturally is usually recommended, as mangroves have been shown to be more easily damaged by the physical disturbance caused by clean-up teams and vehicles, than by the oil itself.
Rocky shorelines/intertidal reef platforms				
Cliffs	Vertical or sloped escarpments which restrict access to the underlying shores.	Manual clean-up of cliffs may be difficult due to: • absence of access; • high sea states; or • dangerous working conditions. Sheltered cliffs associated with platforms may need cleaning. In these cases the following methods may be used: • Low pressure washing with seawater (thick films only); and • Manual removal.	Oil may cause some damage to key species individuals. However, the spill will not cause significant habitat damage.	**Low** Often cliffs do not require cleaning because: • oil has been held off the coast by wave reflection; • self-cleaning is rapid due to exposure to high wave energies.

Habitat type	Key features	Undertaking shoreline clean-up	Not undertaking shoreline clean-up	Priority/Action
Intertidal platforms	Intertidal reef platforms are located in the intertidal zone and consist of flat or gently sloping rock surfaces that provide habitat for many species such as molluscs (snails, oysters, chitons and gastropods). Platforms may be 'broken' with associated crevices, rock pools or boulders or 'unbroken' smooth surfaces with or without rock pools. Platforms may occur in association with other beach types.	Vacuum systems can be used to collect heavy (thick) or pooled deposits of oil where access is possible. Vacuum equipment also has the potential to cause damage to sensitive habitats and should not be used where foot traffic and equipment operation is restricted. Sorbents may be used as they eliminate the requirement for foot traffic and mechanical equipment. However, this technique is not recommended for high energy shorelines, as they may be lost during periods of high wave action. It may also generate large volumes of waste. Low pressure washing with hot or cold seawater may be used, as this is effective to flush floating or loose oil out of tidal pools, depressions, crevices, etc. and remove oil from vegetation. Potential impacts of low pressure washing include removal or mortality of surface organisms and surface and near-surface habitat disruption. Oil can be transported to lower inter tidal or previously clean areas and subtidal organisms may be buried by downslope sediment transport (Owens, 1998).	Oil may cause some damage to key species individuals living in the rocks. However, the spill will not cause significant habitat damage.	**Low** Platforms, which lie in the lower intertidal zone, are generally afforded a low priority, because oil tends not to adhere to the wet surfaces (i.e. wave exposed surface) and is rapidly removed. Platforms in the mid to upper intertidal zone are also generally self-cleaning and therefore oil does not persist.

Habitat type	Key features	Undertaking shoreline clean-up	Not undertaking shoreline clean-up	Priority/Action
Boulder beaches	Consist of large rocks (over 250mm in diameter)	Manual removal may not be suitable as access to rocky shore is difficult and particular attention needs to be given to safety of workers on particular surfaces in addition to hazards of waves and tides (ITOPF, 2011). Low pressure washing with hot or cold seawater may be used, as this is effective in flushing floating or loose oil out of tidal pools, depressions, crevices, etc. and in removing oil from vegetation. Potential impacts include removal or mortality of surface organisms and surface and near-surface habitat disruption. Oil can be transported to lower intertidal or previously clean areas, and subtidal organisms may be buried by downslope sediment transport (Owens, 1998). In areas of high concentrations of wildlife, where significant amounts of oil have stranded, loose sorbent material can be spread over oiled rocks to reduce contamination of fur or feathers (ITOPF, 2011). However, there is a potential that secondary contamination may result from drifting mats of the oil sorbent mixture.	Oil may cause some damage to key species individuals living in the rocks. However, the spill will not cause significant habitat damage.	**Low** Natural recovery is effective on weathered and heavy crude in most situations and causes the least environmental impact.

Habitat type	Key features	Undertaking shoreline clean-up	Not undertaking shoreline clean-up	Priority/Action
Cobble/ pebble beaches	Consists of small areas of cobbles (diameter 6-25 cm) and pebbles (diameter up to 6 cm).	Mechanical or manual clean-up techniques may not be suitable on this type of shoreline, as the movement of both vehicles and personnel have the potential to cause oil to penetrate into the spaces between stones and deep into the beach. Low pressure washing with hot or cold seawater may be used, as this is effective in flushing floating or loose oil out of tide pools, depressions, crevices, etc. and removing oil from vegetation. Potential impacts include removal or mortality of surface organisms and surface and near-surface habitat disruption. Oil can be transported to lower inter tidal or previously clean areas, and subtidal organisms may be buried by downslope sediment transport (Owens, 1998). Surf washing may be suitable on moderate to high energy shorelines where moderately oiled sediments are located in the higher portions of the upper intertidal or supratidal zone. Potential impacts include: • oil and/or sediments could damage healthy biological communities in the lower intertidal zone; • oil that is released is rarely fully contained and could impact adjacent areas; and • sediment loss resulting from alongshore suspension and movement of sediment in the water on fine-grained sediment beaches.	Vulnerable, especially to low viscosity or light oils which will rapidly penetrate the substrate and become buried. May persist for several years in areas of low or moderate energy. The sparse fauna levels that inhibit beaches are generally not sensitive to oil pollution (O'Sullivan *et al.,* 2001).	**Low** Natural recovery is effective on weathered and heavy crude in most situations and causes the least environmental impact.

Habitat type	Key features	Undertaking shoreline clean-up	Not undertaking shoreline clean-up	Priority/Action
Beaches				
Intertidal sand and mudflats	Intertidal flats are comprised of mud or sand, or a mixture of both. Sediments are often water saturated and may be very soft and, unconsolidated and, as such, cannot support vehicle or foot traffic. No intertidal reefs, beaches/mudflats occur within the Operational Area, which is approximately 40km from the nearest landfall. Three intertidal beach/mudflat areas of international conservation significance occur within the region (Bandicoot Bay, Eighty Mile Beach and Roebuck Bay). Bandicoot Bay is a Conservation Reserve within the Montebello/Barrow Islands Marine Management Area and Eighty Mile Beach and Roebuck Bay are listed under the Ramsar Convention and are afforded specific protection under the EBPC Act (Section 4.3.6.4).	Natural recovery is the preferable clean-up method for this type of shoreline, particularly where oil has been washed up on vegetation. On many occasions activities such as mechanical or manual clean-up have resulted in more damage than allowing natural recovery to take place due to trampling and substrate erosion. Where removal of oil is essential to prevent its remobilisation and spreading along the shoreline, low pressure flushing can be used. Potential impacts include removal or mortality of surface organisms and surface and near-surface habitat disruption. Oil can be transported to lower intertidal or previously clean areas, and subtidal organisms may be buried by downslope sediment transport (Owens, 1998).	Owning to their relative shelter and low wave energy, oil is likely to persist for long periods of time in sheltered muddy or sandy intertidal areas. In an eroding area oil is unlikely to accumulate, but in an area where accretion is taking place the oil may become buried under a layer of sediment. Most organisms living in these sediments are highly sensitive to the components of oil. Polychaete worms and other soft-bodied organisms are particularly susceptible to oil contamination. Recovery periods will be determined to a large extent by the degree of penetration and persistence of oil in the sediment. Experimental work has indicated two to four years for recovery (O'Sullivan *et al.,* 2001).	**High-medium** Some mudflats also support diverse biological communities that are allocated a high priority for protection and cleaning.

Habitat type	Key features	Undertaking shoreline clean-up	Not undertaking shoreline clean-up	Priority/Action
Sandy beaches	Sandy beaches are not present in the Operational Area. The nearest sandy beaches occur at the Dampier Archipelago (approximately 40km from the Operational Area) and the Montebello Islands (approximately 90km from the Operational Area). Shallow water habitats at offshore islands, such as the Dampier Archipelago, Barrow and Montebello Islands, provide key inter-nesting sites. Critical nesting periods occur between November and March. Further details on nesting areas and turtle species are provided in Section 4.3.4.6. Sandy beaches are also considered a significant habitat for seabird nesting (Section 4.3.4.3).	Mechanical clean-up may be suitable for sandy beaches, provided the beach can support heavy machinery. This method can result in shoreline erosion if excessive material is removed without replacement. However, for most exposed beaches, the seasonal cycles of erosion and accretion are so large that the amount of material removed during clean-up operations is usually insignificant in comparison and will normally be replaced naturally. Manual clean-up may be used where access is restricted, if oiling is light, or if the beach cannot support heavy vehicles. Surf washing may be suitable on moderate to high energy shorelines where moderately oiled sediments are located in the higher portions of the upper intertidal or supratidal zone. Re-floated oil can be collected using booms and skimmers. Vacuum trucks or systems may be used on pooled oil, or where oil is very thick.	Oil can rapidly penetrate sandy beaches, particularly if the oil is mobile and the sand is dry. Under conditions of strong wave action and light oiling, any oil will be dispersed fairly rapidly. Heavier oils are liable to form an oil-water mixture that is heavier than water and may persist for long periods of time at or below the low water mark. Sand dwelling organisms have the ability to recover quickly, except during large scale pollution (O'Sullivan *et al.,* 2001).	**High** Beaches used by nesting turtles and/or seabirds are given a high priority for protection and clean-up. A high protection priority will also be given to recreational beaches or those of high economic value.

6.5.3.8 *Oiled wildlife response*

Description of hazard

Oiled wildlife response has the potential to cause impacts to marine fauna. Activities associated with oiled wildlife response that can cause impacts to marine fauna include:

- hazing;
- pre-emptive capture;
- search and capture; and
- field stabilisation.

Impact assessment

Hazing involves the use of visual, auditory or sensory deterrents to keep healthy marine fauna away from the oil. This can lead to the separation of groups or adults/juveniles, collisions with marine fauna, inadvertent movement of animals into the oiled area, or scattering of oiled animals.

Pre-emptive capture involves the capture and relocation of marine fauna before they become oiled. Potential impacts include relocation to inappropriate areas that will not support the animal’s requirements (e.g. habitat, food sources).

The goal of search and capture is to collect as many live oiled animals as quickly as possible and in the best possible condition to maximise survival. Marine fauna may be injured during collection and, if their condition is already poor due to oil contact, inexperienced handling can rapidly exacerbate their condition.

Field stabilisation is required prior to further treatment of oiled animals, to ensure they can cope with the cleaning and rehabilitation process that will follow. Effective field stabilisation requires deployment of adequate handlers to appropriate locations in a timely manner.

Although there are potential impacts to marina fauna from oiled wildlife response, these impacts are likely to be less than the potential impacts to marine fauna from oil, as outlined in Section 5.2.3. Following a spill, some slightly oiled fauna may survive, but those that are very heavily oiled will probably die. Prompt initialisation of an oiled wildlife response that quickly and effectively collects wildlife and provides a means for humane euthanasia, or rehabilitation and release, will minimise suffering.

6.5.4 Control measures

All spill response strategies are subject to a SIMA which is described in the Wandoo Field OSCP [WAN-2000-RD-0001] and considers:

- risk, impacts and benefits associated with each strategy and whether it is consistent with the EP;
- environmental sensitivities and their priority (environmental significance, severity of impact and recovery time);
- seasonal and migratory patterns; and

- State (WA) jurisdictional requirements and approvals.

The control measures applicable to each response strategy are outlined in the Wandoo Field OSCP [WAN-2000-RD-0001] and the Performance Standard: ELEMENT 8 – OIL SPILL RESPONSE (WAN-WNAB-CP-ER-02 and WAN-WNAB-CP-ER-03).

6.5.5 ALARP demonstration

6.5.5.1 *Overview*

VOGA's response strategies will allow responders to meet defined response objectives without causing more environmental damage than the oil spill itself. Once the initial response removes the bulk of the oil, additional mitigation measures focussed on removal of residual oil will be evaluated in terms of net environmental benefit.

In relation to a response for a spill of crude, the Incident Action Plan (IAP) within the Wandoo Field OSCP [WAN-2000-RD-0001] includes a SIMA process which is used to identify and prioritise key sensitivities vulnerable to a hydrocarbon impact. The incident action planning process considers the effectiveness of oil spill strategies and net environmental outcomes as part of the IAP decision-making process. The incident action planning process is outlined within the Wandoo Field OSCP [WAN-2000-RD-0001].

The SIMA processes and the SIMA matrix (refer to OSCP) prioritises VOGA's environmental sensitivities and assesses the individual net effect that each response option may have on various species, habitats and socio-economic sensitivities. Its application will ensure that the response strategies implemented will minimise the overall impact on the environment.

6.5.5.2 *Review of impacts*

Dispersant application

For some of the spill categories, the oil spill response at sea may require the application of dispersant. Other alternatives, which include the use of booms and skimmers, have negligible environmental impacts, but typically only recover small volumes of oil. VOGA has conducted OSTM to assess whether dispersant application provides any potential reduction in impacts from an oil spill.

The effectiveness of chemical dispersant application is reviewed in the Wandoo Field OSCP [WAN-2000-RD-0001] and the impacts of application of chemical dispersant versus the impacts of non-application of dispersant are assessed in Table 5-16, Table 5-17 and Table 5-18 of this EP.

Chemical dispersant will only be applied when the IAP decision-making process has determined that its application will have a net environmental benefit. Once the decision to apply chemical dispersant has been supported by the SIMA process, VOGA will mount an ongoing aerial and marine operation to apply chemical dispersant within the primary zone of application (as defined in Figure 5-23) to allow maximum time for dispersal, thereby reducing the likelihood of shoreline impacts.

The primary zone of application of chemical dispersant is an area of low biodiversity and in relatively deep water. Given the environmental sensitivities within the EMBA, the use of dispersants as an offshore response strategy will potentially minimise impacts on the ecosystems and reduce the need for extensive shoreline clean-up and remediation. A slightly negative impact is likely on the local offshore fisheries of the region, but its significance will largely depend on the extent and duration of a spill.

Other response strategies

The impacts associated with the remaining response strategies are already within the scope of the day-to-day operational support activities (such as logistics), or are no greater than the impact of the spill itself.

In consideration of all these factors, risk management of the proposed oil spill response activities is considered to be ALARP because:

- the incident action planning process is documented and allows for the selection of oil spill response strategies that achieve a net environmental benefit;
- the incident action planning process is continually reviewed to ensure that the outcomes from the response strategies are providing a net environmental benefit;
- the effectiveness of the oil spill response strategies are monitored and the results are considered in the review and adjustment phases of the incident action planning process;
- the response strategies are consistent with those outlined in the National Marine OSCP (AMSA, 2011b);
- the response strategies are internationally accepted and were proven successful in recent industry-based spill events.

6.6 Noise

6.6.1 Hazard report

Table 6-27: Hazard report – Noise

HAZARD:	Noise				
EP risk number:	EP-WC-R05				
Potential impacts:	Injury to hearing or other organs of marine fauna. Masking or interfering with biologically important sounds. Disturbance leading to behavioural changes or displacement of fauna.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Operation of mechanical systems on the MODU and the AHTS vessels not maintained causing excessive noise generation.	MODU and AHTS vessel engines and power generation equipment maintained to optimise smooth running.	Engineering	Equipment on MODU and AHTS vessels maintained.	All MODU and AHTS vessel engines and power generation equipment shall be serviced in accordance with the relevant Contractor's preventative maintenance system (PMS) to limit excessive noise generation.	VOGA inspection or audit confirms application of contractor's PMS. Contractor's servicing and maintenance records are up to date.
AHTS vessel operation generating noise close to noise sensitive cetaceans.	Vessels operating in the Operational Area must adhere to Part 8 of EPBC Regulation 2000 to minimise exposure of marine fauna to noise impacts.	Administrative	AHTS vessels comply with Part 8 of EPBC Regulation 2000.	Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.05 and 8.06) Interacting with cetaceans to minimise potential for vessel strike	Records demonstrate no breaches of EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans.
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.		N/A	N/A	N/A	N/A
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Initial risk**	
Incidental (1)	Unlikely (B)			Low	
ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					
Additional control measures	**Prevention/ mitigation**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.	N/A	N/A	N/A	N/A	N/A
RESIDUAL RISK AFTER ADDITIONAL CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Residual risk**	
Incidental (1)	Unlikely (B)			RRIV (Low)	
ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**RR < Extreme (I)**	**EPO(s) manage impacts to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy.	Yes – AHTS vessels comply with Part 8 of EPBC Regulation 2000.	Yes – RRIV (Low)	Yes – EPOs specify compliance with regulatory guidance. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.6.2 Description of hazard

During VOGA well construction campaigns, the MODU is supported by AHTS vessels and helicopters. All these items of equipment generate noise that is different to the background noise in the ocean.

The change in noise type and magnitude may mask or interfere with biologically important sounds, damage the hearing of, and otherwise disturb, marine fauna.

The MODU generates noise through the operation of power generation equipment and the operation of machinery used in the well construction and support processes. As the MODU will be jack-up, noise related to dynamic positioning will not occur.

The AHTS vessels generate noise from their power generation equipment and from the screws and thrusters when operating.

The helicopters generate noise from their turbine engines and the action of the rotors generating lift from the air.

6.6.3 Impact assessment

6.6.3.1 *Sensitive receptors*

Ambient noise, plankton, fish and sharks, marine mammals, marine reptiles.

6.6.3.2 *Impact description*

Noise sources associated with well construction activities are created by the operation of the MODU and its associated mechanical systems, AHTS vessels and helicopters. Well construction activities will be of a short duration (approximately 30 to 100 days).

Sound levels generated by the well construction campaigns include (Austin and Hanney, 2018; Hannay et al, 2004; Richardson *et al.,* 1995):

- MODU (jack-up) – 169 dB SPL RMS
- AHTS vessels – 182 dB SPL RMS
- Helicopter – 149 dB SPL RMS

MODU and AHTS vessels with similar specifications will be used during each campaign, resulting in similar noise impacts for each campaign.

Natural sea noise sources are dominated by local wind noise, but also include rain and biological noises and the sporadic noise from earthquakes. Baseline noise levels in the Otway Basin, Victoria were measured to oscillate between 94 and 99 dB SPL RMS. In the Otway Basin, fish choruses of approximately 1 kilohertz (kHz) peak frequency were regularly recorded. As the Operational Area is an open ocean environment, it is reasonable to assume that the baseline noise levels will be similar to those in the Otway Basin.

The highest sound level will be generated by AHTS vessels. An acoustic monitoring program commissioned by Santos was conducted during an exploratory drilling program in 2003, which indicated that the drilling operation (i.e. dynamically positioned MODU) was not audible between 8 and 28 km from the MODU (McCauley, 2004), with most sound above 120 dB SPL RMS confined within a 2–4 km radius of the MODU.

Ambient noise is therefore expected to be elevated within 2-4 km of the well construction campaigns.

Plankton

There is a moderate risk of behavioural effects to fish eggs and larvae within tens of metres of the source (Popper *et al.,* 2014). It is possible that zooplankton, including free-swimming larvae, could move either vertically or horizontally within the water column in response to a stimulus such as underwater noise.

These impacts are likely to be limited to a range of a few tens of metres from the source.

Fish and Sharks

Limited research has been conducted on shark responses to noise. Myberg (2001) stated that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1 µPa above broadband ambient SPL) when approaching within 10 m of the sound source.

Due to a lack of observational data on impacts to fish from continuous sources, Popper *et al.,* (2014) proposed qualitative indicators of relative risk of effects indicating that 207 dB SPL Peak has the potential to result in a recoverable injury in fish that have high or medium hearing sensitivity. A conservative threshold level of 130 dB SPL RMS for behavioural changes in fish has been adopted, based on DFO, 2004; McCauley *et al.,* 2003, and the NOAA thresholds (2018).

Additional evidence from exploration conducted on the NWS suggests that, in response to noise generated by well construction activities, behavioural changes for some fish species are temporary and short lived (i.e. nuisance factor). Displacement of pelagic or migratory fish populations is unlikely (McCauley, 1998).

The Operational Area for the Wandoo Well Construction Program is partially within a foraging BIA for the whale shark. The Whale Shark Recovery Plan 2005-2010, which has not been superseded, does not list noise disturbance as a threat. Given the low level of disturbance expected to fish and sharks, impacts to whale shark are not expected to affect foraging behaviours within the BIA.

Marine Mammals

Marine mammals are sensitive to noise in the marine environment. Their use of sound for communication, prey capture, predator avoidance, navigation and their physiological features (i.e. large gas-filled organs) make them vulnerable to both disturbance and physiological damage from underwater noise of sufficient magnitude. However, cetaceans are likely to display behavioural changes in response to noise generated from the MODU and associated activities, rather than experiencing physiological effects.

Using the National Marine Fisheries Service (NMFS) guidance for non-pulsed sound, such as vessel noise and drilling operational noise, a behavioural disturbance limit of 120 dB SLP RMS is adopted (NFMS, 2016). Richardson *et al.,* (1995) and Southall *et al.,* (2007) indicate that behavioural avoidance by baleen whales may onset from 140 to 160 dB SPL RMS or possibly higher. McCauley (1998; 2004) indicates that continuous noise sources from MODU and vessel operations are expected to fall below 120 dB SPL RMS within 4 km of the MODU / vessel. Hearing damage in marine mammals from shipping noise has not been widely reported (OSPAR Commission, 2009).

It is expected that all changes to fauna behaviour and fauna avoidance will occur within 4 km of the Wandoo Well Construction Program.

The Operational Area for the Wandoo Well Construction Program is within a migration BIA for the humpback whale, and a distribution BIA for the pygmy blue whale. Noise disturbance / interference is listed as a threat in the Conservation Management Plan for the Blue Whale, and the Conservation Advice for Humpback Whale, mostly due to the effects of anthropogenic noise on marine mammal vocalisation. It is possible that continuous noise generated by the Wandoo Well Construction Program will mask natural vocalisation undertaken by these species, however impacts will be localised to the Operational Area and limited to the duration of the program, with no long-term impacts expected. Shipping and industrial noise are assessed by the Conservation Management Plan for the Blue Whale as posing a moderate risk to Blue Whale, with an outcome that additional controls may be required.

Marine Reptiles

Electro-physical studies have indicated that the best hearing range for marine turtles is in the range of 100-700 Hz, however no definitive thresholds are known for the sensitivity to underwater sounds or the levels required to cause pathological damage (McCauley, 1994). Using the limited information available, it has been reported that behavioural and masking changes are likely to occur at levels above 120 dB re 1 µPa (SVT Engineering Consultants, 2009), which will be restricted to 3-4 km of the source (McCauley, 1998).

Turtles are probably most vulnerable during the nesting period, when they congregate in shallow water near the breeding beaches and come ashore to lay eggs. They are also vulnerable when the hatchlings make their way across the beaches to the water. Turtles are not expected to exhibit behavioural responses if the noise source is more than 5km of a nesting beach.

The Operational Area for the Wandoo Well Construction Program is within an internesting BIA and critical nesting habitat for the flatback turtle.

The Recovery Plan for Marine Turtles in Australia 2017-2027 lists noise disturbance from acute and chronic sources as a threat. Noise generated by the petroleum activity will be chronic noise (i.e. continuous), which is considered a threat to marine turtles as it may lead to avoidance of important habitats. Critical behaviour such as internesting may occur within the Operational Area, however the Operational Area is over 40 km from the nearest turtle nesting beach, therefore impacts are not expected to result in population or ecosystem level affects. The Well Construction Program will be short-term, with impact temporary and localised.

6.6.4 Control measures

The following control measures are in place for each campaign:

- All MODU and vessel equipment will be serviced in accordance with the relevant contractor's preventative maintenance system to prevent excessive noise generation; and
- Vessels operating in the Operational Area will adhere to Part 8 of EPBC Regulation 2000 to minimise exposure of marine fauna to noise impacts.

6.6.5 ALARP demonstration

Helicopters are the only practical option for personnel transfers to and from a MODU located in the Operational Area. The alternative would be vessel transfers, however, the use of vessels for crew changes is deemed to be a high safety risk, particularly in inclement weather conditions and poor metocean conditions. Any personnel transfer from a vessel to a MODU or vice-versa would have to use hoisted baskets. IMCA Guidance on the Transfer of Personnel to and from Offshore Vessels (IMCA SEL 025, IMCA M202) states: "All basket transfers should be considered a high risk operation at all times and they should be undertaken when transfer is essential and cannot be undertaken by other means. It would not be appropriate to use personnel baskets for routine crew changes in open waters when more appropriate methods of transfer are available."

Elimination of vessel operations is also not feasible due to the scope and duration of well construction campaigns and the limited storage capacity of MODUs. Logistical support by vessels is the only practical option for supporting offshore well construction campaigns.

Jack-up MODUs (such as those used for operations in the Operational Area) have a reduced marine noise profile compared with submersibles or semi-submersibles, due to the hull being jacked up out of the water during well construction operations.

Sounds produced by MODU, AHTS vessels and helicopter operations are not expected to be significantly above those routinely associated with the Wandoo facilities, nor are they expected to have any significant impact on marine fauna that may be present, with the exception of minor avoidance reactions. Normal marine fauna behaviour is expected to return as soon as the MODU leaves the Operational Area.

No alternative or additional practicable control measures were identified that would provide a net environmental benefit. The residual risks associated with the transient and intermittent nature of the noise generated by MODU, AHTS vessels and helicopter activities, when conducting well construction operations, is acceptable and considered ALARP.

6.7 Atmospheric emissions

6.7.1 Hazard report

Table 6-28: Hazard report – Atmospheric emissions

HAZARD:	Atmospheric emissions
EP risk number:	EP-WC-R06
Potential impacts:	A localised and temporary reduction in air quality leading to the displacement or injury of avifauna. Substantial contribution to global greenhouse gases.

PREVENTION:

Activity/cause:	Existing control measures	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
MODU and AHTS vessel operations and other diesel-powered equipment.	The sulphur content of fuel complies with Regulation 14 of MARPOL 73/78 Annex IV and AMSA Marine Order 97.	Substitute	Atmospheric emissions within the Operational Area must be in compliance with MARPOL 73/78 Annex VI and AMSA Marine Order 97.	Marine-grade diesel (sulphur content of less than 0.5% m/m) shall be supplied to MODU and AHTS vessels by VOGA.	VOGA supplies fuel compliant with MARPOL 73/78 Annex VI to MODU and AHTS vessels specified in contract.
	MODU and AHTS Vessels comply with Regulation 14 of MARPOL 73/78 Annex VI and AMSA Marine Order Part 97.	Administrative		MODU and AHTS vessels shall have current International Air Pollution Prevention (IAPP) certificates as required under MARPOL 73/78 Annex VI and AMSA Marine Orders Part 97.	Pre-hire inspection confirms presence of IAPP certificate.
	Contractor PMS in place to maintain power generation systems and ancillary diesel engines.	Administrative	MODU and AHTS vessel engines and power generation equipment maintained in accordance with contractor's PMS.	VOGA inspection or audit shall confirm application of contractor's PMS. Contractor's servicing and maintenance records shall be validated by VOGA to ensure they are up to date.	VOGA inspection or audit confirms application of contractor's PMS. Contractor's servicing and maintenance records are up to date.
Use of refrigerants (in HVAC systems).	Contractor PMS in place to maintain refrigeration systems within the use of ozone depleting substances.	Administrative/Substitute	Refrigerant emissions within the Operational Area are minimised	Refrigeration systems shall be maintained in accordance with contractor's PMS to ensure refrigerant emissions are minimised. Contractor's servicing and maintenance records are shall be validated by VOGA to ensure they are up to date.	VOGA inspection or audit confirms application of contractor's PMS. Contractor's servicing and maintenance records are up to date.

MITIGATION:

Existing control measures	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A

INITIAL RISK WITH EXISTING CONTROLS:

Consequence	Likelihood (of consequence)	Initial risk
Incidental (1) – impacts to avifauna	Possible (C)	Low
Minor (2) – substantial contribution to climate change	Unlikely (B)	Low

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:

Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.

Additional control measures	Prevention/mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:

Consequence	Likelihood (of consequence)	Residual risk
Incidental (1) – impacts to avifauna	Possible (C)	RRIV (Low)
Minor (2) – substantial contribution to climate change	Unlikely (B)	RRIV (Low)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:

Principles of ESD not compromised	External Context – objects or claims considered	Internal Context – VOGA environment policy / procedures met	Other Requirements met	RR < Extreme (I)	EPO(s) manage impacts to acceptable level(s)
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy and Contractor PMS.	Yes – MARPOL 73/78 Annex VI and AMSA Marine Order 97.	Yes – RRIV (Low)	Yes – EPOs specify compliance with regulatory guidance. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.7.2 Description of hazard

There are two sources of atmospheric emissions from VOGA well construction operations. They are emissions from power generation equipment including the MODU, AHTS vessels and helicopters. The other source of emissions is leakage of refrigerants on the MODU and AHTS vessels.

The use of fuel to power MODU, vessel and helicopter engines, and mobile and fixed plant (e.g. cranes, generators, power packs) will result in gaseous emissions of Greenhouse Gas (GHG) from engine exhausts such as; carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); and carbon monoxide (CO), along with non-GHG particulate emissions such as sulphur oxides (SO_X) and nitrous oxides (NO_X). Minimal quantities of sulphur dioxide (SO_2) will be generated because of the use of low sulphur content diesel.

Sections 2.6 and 2.7 describe the frequency of vessel and helicopter operations.

The MODU and AHTS vessels use refrigerants in the Heating, Ventilation and Air Conditioning (HVAC) and freezer/chiller refrigeration plants. Refrigerants are Ozone Depleting Substances (ODS) and have the potential to contribute to ozone depletion if released to the atmosphere.

6.7.3 Impact assessment

6.7.3.1 *Sensitive receptors*

Seabirds and human receptors (other users).

6.7.3.2 *Impacts description*

Release of GHG and non-GHGs

The emission of GHG during the operation of equipment on the MODU, vessels and helicopters can add to the GHG load in the atmosphere which can contribute to global warming potential.

Non-GHGs are also released from the operation of vessels, helicopters and other machinery.

Air emissions from well construction activities are considered unlikely to have a significant impact on air quality at the local and regional scales, as they are expected to be quickly dissipated into the surrounding atmosphere. Atmospheric emissions will not impact avifauna, the health or amenity of the well construction personnel, or the nearest human settlements of Dampier and Karratha (over 70km away) because of the rapid dispersion of emissions.

The Operational Area for the Wandoo Well Construction Program is within a breeding BIA for the wedge-tailed shearwater; these BIAs are based on buffer areas surrounding the offshore islands (e.g. within Dampier Archipelago) that are used for nesting by this species.

The Wildlife Conservation Plan for Migratory Shorebirds does not list a change in air quality as a threat, however climate change is identified as a potential threat to populations. Any change in climate resulting from the Wandoo Well Construction Program is not expected to contribute significantly to long-term climate change and impacts to listed threatened or migratory bird species are therefore not expected.

The release of emissions during well construction activities are not expected to contribute substantial to climate change.

Release of ozone depleting substances

ODS are used in closed refrigeration systems. ODS have the potential to contribute to ozone layer depletion if released to the atmosphere.

It is unlikely that ODS will be accidently released to the atmosphere, as refrigeration systems are serviced on a regular basis to ensure efficient operation which inherently minimises the potential for unplanned release.

In summary, the quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere.

6.7.4 Control measures

The MODU and the AHTS vessels use very low sulphur diesel fuel in accordance with MARPOL 73/78 Annex VI and AMSA Marine Order 97 to minimise sulphur dioxide emissions.

Diesel fuel usage is recorded and reported in contractor daily reports.

MODU and AHTS vessels hold IAPP certificates as required under the Navigation Act 1912 Part IV Division 12D.

Refrigerant use is monitored through maintenance records which VOGA review during pre-start inspections of the MODU and on hire surveys of the AHTS vessels.

6.7.5 ALARP demonstration

The operation of diesel combustion engines on the MODU and vessels is essential to the execution of well construction activities. Consequently their emissions cannot be eliminated.

Atmospheric emissions will occur continuously as a result of the base load power generation requirements for the MODU and vessel operations. However, the mobile and fixed plant, also required to facilitate well construction operations, are only used intermittently and, as such, their contribution to the atmospheric emissions are considered minimal.

Similarly, the use of helicopters to service the well construction activities cannot be eliminated without the introduction of other significant health and safety risks.

Routine maintenance is carried out on all engines in accordance with the contractor’s management systems to ensure that they maintain their efficiency, thus optimising their emissions.

Diesel compliant with MARPOL 73/78 Annex VI, normally supplied from Dampier, is used as the primary fuel source for well construction operations carried out in the Operational Area. Specifying the use of very lower sulphur diesel, such as that compliant with Australia Fuel Standard (Automotive Diesel) Determination 2001, could be considered. However, rigs and vessels may arrive in the Operational Area from international locations and, as such, will already carry substantial volumes of diesel compliant with MARPOL 73/78 Annex VI. Replacing this fuel with diesel compliant with Australia Fuel Standard (Automotive Diesel) Determination 2001 would require:

- offloading the existing diesel via MODU to AHTS vessel transfer and returning to a supplier willing to accept it, or to a disposal facility, both involving additional transfer and shipping/trucking operations; and
- shipping of diesel compliant with the Australian fuel standard and loading this onto the MODU via AHTS vessel transfer.

While these operations are common during well construction activities, having to execute them would introduce multiple additional transfers of diesel in the Operational Area and in the Port of Dampier (if the local facilities will accept the offloaded diesel). The risk of diesel spill in the Operational Area or in port will be increased as a result of the “double handling”. There will also be an increase in the emissions associated with the additional transfer operations. The minor short-term impact of using diesel compliant with MARPOL 73/78 Annex VI is considered lower risk to the environment than introducing the additional spill risk and atmospheric emissions associated with the operations required to change it out.

The existing controls are considered to reduce the residual risks associated with atmospheric emissions to an acceptable level and to ALARP.

No alternative or additional practicable control measures were identified that would provide a net environmental benefit. Therefore the impact from the activity is considered acceptable.

6.8 Artificial light

6.8.1 Hazard report

Table 6-29: Hazard report – Artificial light

HAZARD:	Artificial light				
EP risk number:	EP-WC-R07				
Potential impacts:	Disorientation, attraction or repulsion of marine fauna. Altered foraging and breeding behaviours including increased predation risk.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
MODU and AHTS vessel operations.	No controls identified as vessel lighting is specified for safe working practices.	N/A	N/A	N/A	N/A
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.		N/A	N/A	N/A	N/A
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**		**Initial risk**		
Incidental (1)	Rare (A)		Low		
ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					
Additional control measures	**Prevention/ mitigation**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.	N/A	N/A	N/A	N/A	N/A
RESIDUAL RISK AFTER ADDITIONAL CONTROLS:					
Consequence	**Likelihood (of consequence)**		**Residual risk**		
Incidental (1)	Rare (A)		RRIV (Low)		
ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**Risk < Extreme (I)**	**EPO(s) manage impacts / risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy and Contractor PMS.	Yes – MARPOL 73/78 Annex VI and AMSA Marine Order 97.	Yes – RRIV (Low)	Yes – Relevant overarching EPOs (Table 5-2) maintained without controls.

6.8.2 Description of hazard

During the hours of darkness, artificial light emitted from the MODU and AHTS vessels may disorient marine fauna and seabirds.

Sources of artificial lighting include:

- continuous lighting of the MODU; and
- continuous lighting of the AHTS vessels.

Continuous lighting is required for the safe night-time operations on the MODU and AHTS vessels.

AHTS vessel deck lighting is kept on 24 hours a day for maritime safety purposes [Part 30 (Prevention of Collisions) of the Marine Orders made under the Navigation Act 1912].

6.8.3 Impact assessment

6.8.3.1 *Sensitive receptors*

Light-sensitive species including pelagic fauna (fish and marine invertebrates – squid, zooplankton), marine mammals, marine turtles and seabirds.

6.8.3.2 *Impacts description*

The continuous lighting of the MODU and AHTS vessels used in each campaign has the potential to attract marine species (such as fish, turtles and seabirds) and, depending on the foraging range of some species, may result in a short-term abundance or concentration of species in their immediate vicinity. Increased lighting can cause localised changes to marine fauna and bird behaviour.

The MODU Safety Case and vessel management systems specify minimum lighting requirements for safe operation. However, given that the MODU and vessels will be operating nearby or adjacent to the existing Wandoo infrastructure, which is normally lit, the additional lighting created by the presence of the MODU and vessels is not expected to induce any change that may have a substantial adverse effect on habitat critical to the survival of a Listed Threatened Species.

Artificial lighting has the potential to affect marine fauna by altering the use of visual cues for orientation, navigation or other purposes. This results in behavioural responses which can alter migration, foraging and breeding activity in marine reptiles, seabirds, fish and dolphins. It can also create competitive advantages for some species and reduce reproductive success and/or survival in others.

Previous studies have found that fish and zooplankton species are attracted to light sources (Meekan et al., 2001). The attraction of organisms to the light results in an increased food source for marine predators that aggregate around the edges of the light halos. This attraction is considered to be localised and, other than some opportunistic predation, is not considered to represent a significant risk of impacts and is not evaluated further.

Artificial lighting along or adjacent to turtle nesting beaches poses a particular issue as it has the potential to alter nocturnal behaviours, particularly the selection of nesting sites and the passage of adult females and emerging hatchlings from the beach to the sea (Limpus, 2009). There are no turtle hatching beaches within or in the vicinity of the Operational Area, which is located approximately 40km from the nearest turtle nesting beaches (Section 4.3.4.6) in the Dampier Archipelago and about 100km northeast of those in the Montebello Australian Marine Park. Consequently, lighting from the MODU or AHTS vessels is not expected to result in the displacement of marine turtles from nesting / interesting BIAs. Therefore, potential impacts or risks are not evaluated further.

Seabirds are known to aggregate around permanent offshore structures, such as platforms (Verhejen, 1985; Weise et al., 2001) due to the aggregation of marine life at all trophic levels, creating food sources and shelter for seabirds (Surman, 2002). Bright lights can also disorientate birds, thereby increasing the likelihood of seabird mortality through collision with infrastructure. Studies in the North Sea indicate that migratory birds are attracted to lights on offshore platforms when travelling within a radius of 3km to 5km from the light source. Outside this area their migratory path will be unaffected (Marquenie et al., 2008).

As per the recommendations of the draft lighting impacts guidelines (DotEE, 2019), important habitat for listed species is located more than 20km away from the Operational Area, and therefore potential impacts or risks are not evaluated further.

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 cues (Simmonds et al., 2004). Therefore light is not considered to be a significant factor in cetacean behaviour or survival, as such potential impacts or risks are not evaluated further.

6.8.4 ALARP demonstration

Consideration could be given to reducing lighting levels, however, the levels in use are those required to provide a safe working environment for MODU and AHTS vessel personnel, as well as to provide for navigational safety in the area. Reduction in lighting levels is unacceptable because it would introduce navigational and occupational safety hazards and result in operations being non-compliant with codes and regulations. Lights on the MODU and AHTS vessels will be kept on for 24 hours a day for safety purposes in accordance with requirements of the Navigation Act 1912.

As discussed in the previous sections, the only marine life likely to be adversely affected by the increased lighting is turtle hatchlings. However, because of the significant distance of the operation from sensitive receptors (MODU is located at least 40km away from the nearest turtle nesting beach) there is no risk of interference with natural patterns.

6.9 Discharge of cooling water/reject water

6.9.1 Hazard report

Table 6-30: Hazard report – Discharge of cooling water/reject water

HAZARD:	Discharge of cooling water/reject water
EP risk number:	EP-WC-R08
Potential impacts:	Thermal impacts to marine organisms. Reduced dissolved oxygen concentrations and dilute hypochlorite content, leading to localised impacts on pelagic fauna. Toxicity effects to marine organisms in the immediate vicinity of the discharge.

PREVENTION:

Activity/cause:	Existing control measures	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
Use of seawater for cooling MODU and AHTS vessel main engines.	Engines on board the MODU and AHTS vessels to be maintained in accordance with manufacturer's specifications.	Administrative	MODU and AHTS vessel engines maintained in accordance with contractor's PMS.	VOGA inspection or audit shall confirm application of contractor's PMS. Contractor's servicing and maintenance records shall be validated by VOGA to ensure they are up to date.	VOGA inspection or audit confirms application of contractor's PMS. Contractor's servicing and maintenance records are up to date.

MITIGATION:

Existing control measures	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A

INITIAL RISK WITH EXISTING CONTROLS:

Consequence	Likelihood (of consequence)	Initial risk
Incidental (1)	Unlikely (B)	Low

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:

Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.

Additional control measures	Prevention/ mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:

Consequence	Likelihood (of consequence)	Residual risk
Incidental (1)	Unlikely (B)	RRIV (Low)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:

Principles of ESD not compromised	External Context – objects or claims considered	Internal Context – VOGA environment policy / procedures met	Other Requirements met	Risk < Extreme (I)	EPO(s) manage impacts to acceptable level(s)
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy and Contractor PMS.	N/A – no other requirements identified	Yes – RRIV (Low)	Yes – EPOs specify compliance with Contractor's PMS given no other identified acceptable level limits. Relevant overarching EPOs (Table 5-2) maintained without controls.

6.9.2 Description of hazard

Seawater is often used for cooling of the power generation system on the MODU and the AHTS vessels. To prevent marine growth in the seawater circulation system, seawater is treated by a "Marine Growth Prevention System", which involves producing chlorine electrically and continuous dosing at 2mg/L. The heated seawater is discharged directly to the ocean after usage at a rate of 80 to 100 m^3/hour. Seawater discharged to the ocean from the cooling system, is elevated in temperature by 0.5 to 3°C.

Reject water (residual seawater that has been passed through a steam system to obtain freshwater) will be discharged to the ocean, with slightly higher salinity than ambient seawater.

6.9.3 Impact assessment

6.9.3.1 *Sensitive receptors*

Pelagic fauna (fish and plankton), marine mammals and marine reptiles.

6.9.3.2 *Impact description*

When discharged to sea, cooling water is initially subject to turbulent mixing and some transfer of heat to the surrounding waters and atmosphere. The plume disperses and rises to the sea surface where further dilution and loss of heat will occur. The plume of heated water moves in accordance with the prevailing currents. Temperatures drop swiftly with distance from the discharge point.

Potential thermal impacts to marine organisms include alteration of the physiological processes, especially enzyme mediated processes (Wolanski, 1994). These alterations may cause a variety of effects, ranging from behavioural response (including attraction and avoidance behaviour), to minor stress, to potential mortality after prolonged exposure. Fish have a tendency to avoid outfalls in the warmer (summer) months and actively enter them in winter months. Changes to breeding patterns of various invertebrates have also been noted.

The temperature of the discharge is 0.5 to 3°C higher than the ambient sea temperature. These water temperatures are within the range of temperatures recorded on the NWS and naturally occurring organisms in the area would likely be tolerant of such increases. Potential thermal impacts are also limited by the dilution of the discharge and by convection losses.

The only biota that may be exposed to the thermal discharge for long periods are fouling species (e.g. barnacles), and possibly fish, marine turtles, marine mammals and seabirds in the immediate vicinity of the discharge point, or planktonic species that drift with the cooling water discharge as it disperses and decreases in temperature. The heated water will prevent species that are less tolerant to elevated temperatures from settling and becoming established in close proximity to the discharge point. However, given that the area of raised water temperature will be highly localised and within the range of seawater temperature on the NWS, significant impacts on a larger ecosystem or population level to fish or plankton are not expected to occur.

The small volumes of discharged sodium hypochlorite would also be rapidly dispersed due to turbulent mixing and therefore will have no toxic impacts on marine organisms passing through the Operational Area.

No change in water quality parameters is expected that may modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Listed Threatened Species is likely to decline. Therefore, potential impacts or risks are not evaluated further.

6.9.4 Control measures

Engines on board MODU and AHTS will be maintained in accordance with manufacturer's specifications in order to prevent an increase in cooling water required and a subsequent increase in discharge.

6.9.5 ALARP demonstration

A review of the risks and impacts to determine that the risks are acceptable and ALARP has assessed that:

- Cooling water is required to ensure the efficiency of turbine generators and gas lift compressors. Any reduction in cooling may lead to increased fuel consumption or equipment failure, with associated environmental impacts;
- Cooling water discharge temperature is only marginally (0.5 to 3°C) higher than the sea temperature, which is within the range of temperatures recorded on the NWS;
- The total heat load being transferred into the sea is constant and is a function of the process cooling requirements. Therefore any reduction of cooling water return temperature would require an increased volume of cooling water to be used. An increase in cooling water usage rate may result in higher velocity in discharge and improved mixing, resulting in a reduced environmental impact, however to achieve this, there would need to be changes made to the seawater lift pump capacity (with a likely increase in emissions) or changes to the cooling system (with significant cost associated to it);
- The total heat load transferred to the sea is determined by process cooling requirements. Whilst an increased cooling water flow rate would reduce the cooling water discharge temperature and increase the discharge velocity (which may improve mixing), this would require an increase to the seawater lift pump capacity (with increase in emissions) and changes to the cooling system (with significant associated cost); and
- The small quantities of sodium-hypochlorite in the discharged cooling water have no toxic impacts on marine organisms in the discharge area.

6.10 Deck drainage and bilge water discharge

6.10.1 Hazard report

Table 6-31: Hazard report – Deck drainage and bilge water discharge from MODU and AHTS vessels

HAZARD:	MODU/Vessel deck drainage and vessel bilge water discharge.				
EP risk number:	EP-WC-R09				
Potential impacts:	Reduction in water quality. Toxicity effects to marine organisms in the immediate vicinity of the discharge.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Discharge of MODU and AHTS vessel deck drainage and bilge discharge water from AHTS vessels.	Biodegradable detergents will be used during wash-down activities.	Engineering	Only biodegradable detergents are used on MODU and AHTS vessels.	Biodegradable, low phosphate detergents shall be used for wash-down activities on the MODU and AHTS vessels.	VOGA inspection or audit confirms biodegradable, low phosphate detergents are used.
	MODU and AHTS vessel are required to have oily water filtering equipment, as per MARPOL 73/78 Annex I.	Engineering	Deck drainage and bilge water from MODU and AHTS vessels will be below 15ppm prior to discharge.	MODU and AHTS vessel shall have oily water filtering equipment of a design approved by the Administration, as per MARPOL 73/78 Annex I.	VOGA inspection or audit confirms Administration approved equipment.
	Deck drainage and bilge water will be treated in an oil water separator and discharged in accordance with MARPOL Annex I (Regulation 15) and AMSA Marine Order 91.	Engineering		Oily water shall only be discharged to sea after passing through filtering equipment with an oil content not exceeding 15mg/l.	MODU and AHTS vessel OIW discharge records.
				The oily water treatment systems on MODU and AHTS vessels shall be calibrated and maintained in accordance with manufacturer's specifications.	VOGA inspection or audit confirms application of contractor's PMS. Contractor's servicing and maintenance records are up to date.
				Bunding and drip tray systems shall be maintained in accordance with contractor's PMS to ensure that leakage to the deck drain and bilge systems does not occur.	VOGA inspection or audit confirms application of contractor's PMS. Contractor's servicing and maintenance records are up to date.
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
MODU and AHTS vessels must have a SOPEP / SMPEP (equivalent to class) procedures to manage small spills on their facilities.		Administrative	All small spills are responded to in accordance with SOPEP/ SMPEP (equivalent to class).	SOPEP / SMPEP (equivalent to class) procedures shall be available during well construction activities.	VOGA inspection or audit confirms SOPEP / SMPEP (equivalent to class) procedures are available on the MODU and AHTS vessels during well construction activities.
MODU and AHTS vessels have equipment to manage small spills on their facilities.		Protective		Equipment meeting the requirements of the SOPEP/ SMPEP (equivalent to class) shall be available on the MODU and AHTS vessels during well construction activities.	VOGA pre-hire inspection confirms that the required spill kits are available during well construction activities.
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Initial risk**	
Incidental (1)	Unlikely (B)			Low	
ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					

Additional control measures		Prevention/mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.		N/A	N/A	N/A	N/A	N/A
RESIDUAL RISK AFTER ADDITIONAL CONTROLS:						
Consequence	**Likelihood (of consequence)**				**Residual risk**	
Incidental (1)	Unlikely (B)				RRIV (Low)	

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**Risk < Extreme (I)**	**EPO(s) manage impacts to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy and VOGA requirement for use of biodegradable detergents.	Yes – MARPOL 73/78 Annex I.	Yes – RRIV (Low)	Yes – EPOs specify limits on discharges. Relevant overarching EPOs (Table 5-2) maintained without controls.

6.10.2 Description of hazard

Small quantities of grease and oil accumulate on deck surfaces in operational areas on the MODU and AHTS vessels creating potential slip hazards. In order to minimise the risk of injury, the deck areas are washed down periodically with water and detergent. The wash-down process flushes the small accumulations of into the MODU and AHTS vessel contained drain systems. The contents of the drain system will pass through an oily water separator to remove as much hydrocarbon as possible and, as a minimum, will conform to Marine Orders – Part 91 Marine Pollution Prevention Oil (<15ppm Oil in Water (OIW)) before being discharged overboard. The separated contaminated waste is collected for disposal on shore.

Higher risk areas, e.g. lube oil stores, will be bunded or contain drip trays to ensure deck drainage does not contain contaminants through leaks or spills. Wash-down from these areas to the marine environment will not be undertaken.

The discharge of contaminated bilge water from vessels can contain water, oil, dispersants, detergents, solvents, chemicals, particles and other liquids, solids or chemicals and, therefore is treated in the same way as the deck drainage.

6.10.3 Impact assessment

6.10.3.1 *Sensitive receptors*

Pelagic habitat and species (fish and plankton), marine mammals and marine reptiles.

6.10.3.2 *Impact description*

Discharge of detergent results in the addition of inorganic nutrients and surfactants to the ocean. It is expected that nutrient addition will have limited environmental consequences, as the phytoplankton and microbial activity in the surrounding waters would ensure that any environmental impact would be minimal. Reduction in water quality will only affect surface waters (<5m in depth) and the discharged water would be rapidly diluted in the dynamic oceanic environment.

In the abnormal event of elevated levels of oily water being discharged, the potential impacts to the marine environment will be the localised toxicity and bioaccumulation of hydrocarbons to plankton. However, the volume of oily water from deck drainage that is likely to be discharged at any given time is expected to be very low. Consequently, the concentrations of oil, grease and trace metals and other contaminants are also expected to be very low.

Hinwood *et al.,* (1994) predicted dilution factors in excess of 10,000 within 100 m of the discharge point. Black *et al.,* (1994) state that potential environmental impacts from deck drainage are considered to be slight given the rates of dilution that are likely offshore.

Diesel evaporates relatively rapidly in NWS waters, so it is expected that the diesel would evaporate and dissipate quickly through natural processes, thus reducing the potential for impact on the marine environment.

Given the open ocean environment, the short duration of typical well construction activities (30 to 100 days for each campaign) and the small volumes and concentration of oily water discharged, no change in water quality parameters is expected that may modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Listed Threatened Species is likely to decline. Therefore, potential impacts or risks are not evaluated further.

As MODUs and AHTS vessels with similar specifications will be used during each campaign, similar oily water discharge and environmental impacts can be expected for each campaign.

6.10.4 Control measures

The following preventative controls and standards are in place for each campaign to mitigate the risks associated with contaminated deck drainage and bilge water being discharge into the environment:

- Biodegradable detergents are used during wash-down activities;
- Oily water will pass through an oily water separator to remove as much hydrocarbon as possible and, as a minimum, conform to Marine Orders – Part 91 Marine Pollution Prevention Oil (<15ppm OIW);
- Work areas where machinery is present are bunded or the machines have drip trays to minimise the risk of oil from machinery entering the deck drainage system;
- Internal spill recovery procedures, such as the MODU and vessel SOPEPs.

6.10.5 ALARP demonstration

An alternative is not to wash-down the decks of the MODU and AHTS vessels during the well construction campaigns. However, this would make the deck surfaces slippery and significantly increase the risk of injury to personnel.

Another alternative is to not use detergent when washing down the decks, but this would make the wash-down process ineffective or worse, spread the oil and grease further across decks, increasing the safety hazards.

The described controls and mitigation strategies reduce the risks associated with the use of biodegradable detergents to an acceptable level and reduce the residual risk to ALARP.

The following alternatives to discharge of deck drainage were considered:

- Collection and disposal onshore;
- Enhanced treatment of waste water; and
- Additional bunding around each machinery space of the MODU and AHTS vessels.

Onshore treatment was considered, but rejected due to the additional potential risks associated with transportation and disposal onshore (e.g. lifting and transport incidents along with increased fuel related emissions). This trade-off was considered undesirable given the limited potential impact of treated deck drainage water passing into the marine environment.

Similarly, enhanced treatment prior to disposal was considered, but rated as undesirable, due to the high cost of retrofitting additional treatment packages to the existing MODU and vessel water treatment systems, which are already designed to meet or exceed AMSA and MARPOL 73/78 requirements.

Although it may be possible to add additional bunding around each machinery space on the MODU and vessels, it would be extremely costly to reengineer existing machinery spaces and could impact on safety in terms of ergonomics and increased tripping hazards and the retention of combustible fluids.

6.11 Non-hazardous and hazardous waste

6.11.1 Hazard report

Table 6-32: Hazard report – Non-hazardous and hazardous waste

HAZARD:	Non-hazardous and hazardous waste.				
EP risk number:	EP-WC-R10				
Potential impacts:	Marine pollution (litter). Injury and entanglement of marine fauna and seabirds. Potential toxicity effects to marine fauna.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Generation of non-hazardous waste (general and recyclable) and hazardous waste.	MODU and AHTS vessels procedures which are compliant with MARPOL Convention Annex V, Prevention of Pollution by Garbage from Ships and Marine Orders 95 (Marine Pollution Prevention – Garbage).	Administrative	Prevention of the unplanned loss of hazardous solid and liquid wastes and non-hazardous solid waste material to the environment.	All vessels licensed to carry more than 15 persons or over 400 gross tonnage, including the MODU and AHTS vessels, shall have a Waste Management Plan and maintain a Garbage Record Book.	VOGA inspection or audit of MODU and AHTS vessels to ensure compliance with Waste Management Plan. Garbage Record Book details the wastes (type and volume) disposed.
	Non-hazardous and hazardous wastes are managed in accordance with contractor's Waste Management Plan.	Administrative	No unplanned discharge of non-hazardous solid waste or hazardous solid or liquid waste to the marine environment.	Hazardous and non-hazardous wastes shall be segregated into recyclable and non-recyclable.	VOGA audit or inspection confirms hazardous and non-hazardous wastes are segregated into recyclable and non-recyclable wastes. Compliance records from VOGA's waste management audit.
				Waste shall be stored in clearly marked containers, and hazardous wastes bunded, in accordance with the relevant Safety Data Sheet (SDS).	VOGA inspection or audit confirms compliance.
				Wastes for onshore disposal shall be transported in suitable containers as outlined in the MODU or AHTS vessel Waste Management Plan.	Inspection or audit confirms waste is transported onshore in relevant containers.
				All non-hazardous (except putrescible waste and waste water) and hazardous waste shall be transported to shore and disposed of in appropriately licensed facilities.	Waste disposal receipts confirm appropriate disposal of wastes (type and volume).
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.		N/A	N/A	N/A	N/A

INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Initial risk**	
Minor (2)	Unlikely (B)			Low	
ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					
Additional control measures	**Prevention/mitigation**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.	N/A	N/A	N/A	N/A	N/A
RESIDUAL RISK AFTER ADDITIONAL CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Residual risk**	
Minor (2)	Unlikely (B)			RRIV (Low)	
ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**RR < Extreme (I)**	**EPO(s) manage impacts / risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy and VOGA requirement for use of biodegradable detergents.	Yes – MARPOL Convention Annex V, Prevention of Pollution by Garbage from Ships and Marine Orders 95 (Marine Pollution Prevention – Garbage).	Yes – RRIV (Low)	Yes – EPOs specify no discharge of hazardous waste to the marine environment. Relevant overarching EPOs (Table 5-2) maintained providing controls maintained.

6.11.2 Description of hazard

Wastes generated during well construction activities are divided into two streams:

- Non-hazardous waste (general and recyclable).
- Hazardous waste.

Recyclable waste generated during well construction activities includes aluminium cans, glass, paper and recyclable scrap metal.

General waste includes plastic, cardboard, wood and putrescible waste, which comprises galley waste, sewage and grey water. The management process for the discharge of putrescible waste is outlined in Section 6.13.

Hazardous wastes generated during well construction activities may include:

- solid hazardous waste such as insulation offcuts, batteries, empty paint cans, empty drums and hydrocarbon-contaminated materials, such as oil filters; and
- liquid hazardous waste such as liquid hydrocarbon wastes (oily water BOP hydraulic fluids, grease, etc.) and miscellaneous chemical waste such as acids and solvents.

There may also be unplanned releases/discharges to the marine environment of non-hazardous and hazardous solid wastes (i.e. littering or dropped objects) from the MODU or vessels during operational activities. Unplanned releases/discharges might occur because of deviation from procedures, poor equipment maintenance, inadequate staff training or adverse weather conditions (storm that results in goods rolling or blowing off decks).

The amount of refuse generated typically averages about 30t per month. Wastes will be segregated in accordance with MODU and vessel waste management plans, with subsequent transfer of the waste to the mainland for recovery or disposal at the Karratha municipal waste facility.

All hazardous wastes generated on the MODU during well construction activities, such as residual chemicals, waste oil, solvents and batteries, will be segregated according to hazard type, labelled and contained to enable safe back-loading to shore for suitable treatment and disposal in accordance with VOGA's waste management procedures. Hazardous wastes generated by the vessels (and the MODU when not carrying out VOGA's well construction activities) will be handled in accordance with the contractor's own procedures and waste management plans.

There will be no planned overboard discharge of solid waste during normal operations.

The potential environmental hazards associated with liquid wastes (chemicals/ancillary hydrocarbons) are addressed in Section 6.14.2.

6.11.3 Impact assessment

6.11.3.1 *Sensitive receptors*

Pelagic habitat and species (fish and plankton), marine mammals, marine reptiles, seabirds and benthic habitat.

6.11.3.2 *Impact description*

Non-hazardous

In the event of an unplanned discharge of solid waste (i.e. dropped object during vessel transfers), there is potential of smothering of benthic habitats as well as injury or death to marine fauna or seabirds through ingestion or entanglement (e.g. turtles mistaking plastics for jellyfish, rope getting caught around the necks of marine fauna and seabirds).

All waste will be segregated. It will then be returned to the mainland for disposal or recycling onto support vessels in closed containers/skips/bins, tanks or 'bulky-bags', in accordance with the MODU waste management plan. As such, the risk of potential impact associated with the discharge of solid waste is expected to be minimal.

Furthermore, the benthic habitat in the operational area primarily comprises bare sediments and, as such, any impacts of garbage would be negligible. However, if an incident was to occur, VOGA would attempt to retrieve the dropped object(s).

Hazardous waste

The potential impacts of hazardous solid wastes are contamination of the marine environment including localised changes to water quality and toxic effects on marine species.

Items of solid hazardous waste, such as paint cans containing paint residue, or batteries, would settle on the seabed if dropped overboard. Over time, this would 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 impacts of liquid hazardous wastes such as hydrocarbons and chemicals on the marine environment are described in Section 6.11. A description of the impacts of hydrocarbons on the marine and social environment is provided.

The inappropriate discharge of hazardous wastes onshore (i.e. illegal dumping or disposal to an unauthorised landfill that is not properly lined) may also result in those wastes creating land and/or groundwater contamination.

Given all waste will be disposed of at appropriately licensed facilities, no impacts are predicted from non-hazardous solid and hazardous waste generated from well construction operations in the Operational Area.

6.11.4 Control measures

MODU and Vessel procedures that are compliant with MARPOL Convention Annex V, Prevention of Pollution by Garbage from Ships and Marine Orders 95 (Marine Pollution Prevention – Garbage) ensure that:

- no non-putrescible waste is discharged from vessels;
- all vessels licensed to carry more than 15 persons or over 400 gross tonnage, including the MODU and AHTS vessels, have a Waste Management Plan and maintain a Waste Record Book;
- waste products are segregated offshore to facilitate appropriate disposal or recycling at approved facilities onshore;
- waste is either loaded into closed containers or into open top containers with netting or tarpaulins to prevent spillage;
- hazardous waste is only loaded into closed containers;
- waste details are recorded in a garbage record book; and
- VOGA Materials Coordinator conducts at least one audit per campaign of MODU and AHTS vessel garbage record book.

Given the proposed controls above, no change in water quality parameters is expected that may modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Listed Threatened Species is likely to decline. Therefore, potential impacts or risks are not evaluated further.

6.11.5 ALARP demonstration

Non-hazardous and hazardous waste will be generated on the MODU and vessels. All wastes will be loaded in closed containers, or into open top containers with covers, to prevent spillage, transported to land and disposed of at approved waste disposal sites onshore. Loss or partial loss of this material could occur during the transfer from MODU to vessel. However, transfer of cargo is a standard operation for the MODU and vessels which is managed under is strictly controlled by the MODU and vessels and monitored by VOGA, MODU and AHTS vessel personnel.

The segregation of wastes into different streams, the use of closed containers or open top containers with covers to prevent spillage and the logging of waste streams in a Waste Management Log provides robust controls which significantly reduce the risk of loss of waste overboard during well construction activities.

The transfer of waste to land and its disposal at approved sites provides assurance that the wastes are being disposed of in a manner that ensures the lowest possible environmental impact.

No other reasonable approaches for the handling waste have been identified. Consequently, the processes in place reduce the residual risk of loss of waste overboard and, in turn the residual risk to the environment, created by the loss of waste overboard, is considered to reduce the residual risk to the environment to ALARP.

6.12 Discharge of drill cuttings, cement, steel shavings and well drilling and completions fluids

6.12.1 Hazard report

Table 6-33: Hazard report – Discharge of drill cuttings, cement and well construction fluids

HAZARD:	Discharge of drill cuttings, cement, steel shavings and well fluids.
EP risk number:	EP-WC-R11
Potential impacts:	Burial and smothering of benthic habitat and fauna; Increased water turbidity and localised changes to water quality; and Potential toxicity effects to marine fauna.

PREVENTION:

Activity/cause:	Existing control measures	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
Drill cuttings, excess water-based drilling and completion fluids and cement residue are discharged to the sea.	Drilling and completion fluids and cement components are selected using the chemical assessment process outlined in Section 7.3.7	Administrative	Only chemicals that comply with the chemical selection process will be used.	Any chemical to be discharged to the marine environment during well construction activities shall meet at least one of the following criteria: • The chemical is listed on the OSPAR List of Substances Used and Discharged Offshore which are considered to Pose Little or No Risk (PLONOR); or • The chemical has a Hazard Quotient (HQ) banding of Gold or Silver or an Offshore Chemical Notification Scheme (OCNS) grouping of E or D in accordance with the OCNS Definitive Ranked List of Registered Substances.	Chemical assessment records indicate selection of chemicals in accordance with selection procedure in Section 7.3.7
				An ALARP justification or consideration of an alternative chemical is required when: • LC50 <10mg/l or EC50<10 mg/l; or • the bioaccumulation octanol-water partition coefficient (log Pow)>3; or • the percentage biodegradation within 28 days is <20%.; or • the chemical has a Substitution Warning	Management of change form.
	Solids Control System used to remove fines from drilling fluids in order to keep fluids in specification for reuse, to minimise the volume of fluids being discharged.	Engineering	Drilling fluids reused.	Solids Control System is used.	Contractor's daily report demonstrates use of Solids Control System.
				Maintenance of Solids Control System in accordance with the MODU preventive maintenance system.	Documentation of planned and completed maintenance and testing of Solids Control System in accordance with the MODU preventive maintenance system.

MITIGATION:

Existing control measures	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A

INITIAL RISK WITH EXISTING CONTROLS:

Consequence	Likelihood (of consequence)	Initial risk
Minor (2)	Unlikely (B)	Low

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:

Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.

Additional control measures	Prevention/mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:

Consequence	Likelihood (of consequence)	Residual risk
Minor (2)	Unlikely (B)	RRIV (Low)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:

Principles of ESD not compromised	External Context – objects or claims considered	Internal Context – VOGA environment policy / procedures met	Other Requirements met	Risk < Extreme (I)	EPO(s) manage impacts / risk to acceptable level(s)
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy and VOGA offshore chemical assessment process.	Yes – VOGA offshore chemical assessment process aligns with OPSAR list, OCNS and IFC guidance.	Yes – RRIV (Low)	Yes – EPOs specify restrictions on chemical use. Relevant overarching EPOs (Table 5-2) maintained when controls maintained.

6.12.2 Description of hazard

Drill cuttings, water-based drilling fluids, water-based completion fluids and small quantities of cement will be discharged to the environment as part of the well construction process. These waste discharges have the potential to impact on water quality, marine habitats and fauna through the introduction of chemical toxicity or water column turbidity. Turbidity can result in a temporary reduction of light or smothering of benthic fauna.

6.12.2.1 *Discharge of drill cuttings, steel shavings and cement products*

Drilling operations during well construction activities in the Operational Area may utilise both the open and closed drilling systems. Drill cuttings will be disposed of to the seafloor as part of the drilling fluid when drilling the conductor and surface hole sections of a new appraisal well, as an open (riserless) system will be utilised. This may result in between 7 to 13 m^3 of cuttings being disposed of to the seabed. A closed system will be utilised all other hole sections. In this case the cuttings will be returned to the MODU in the drill fluid where it will be separated and discharged overboard. The volume of drill cuttings will vary depending on many parameters including hole diameter and section depth, however it is expected to be in the order of between 135 m^3 and 380 m^3 per well discharged incrementally as it is separated from the fluid.

The drill cuttings produced during well construction operations in the Operational Area will largely consist of inert sediments, ranging from very fine to very coarse (<1mm to 1.5cm) particle/sediment sizes. Cuttings disposed from the MODU will form a temporary turbid plume, and can cause localised burial/smothering of benthos.

The percentage volume of hydrocarbon on drill cuttings during drilling in the reservoir will be negligible because of the small amount recovered during the drilling process.

Steel shavings will be generated as a result of milling packers and milling ‘windows’ through existing casing. Where practicable, these shavings will be separated and contained for onshore disposal. Limitations on separation effectiveness of the MODU solids control systems will result in an estimated 500kg of steel shavings being discharged overboard per campaign.

Cementing fluids consist of Portland cement and minor amounts of additives such as inorganic salts, lignin, bentonite, barite, defoamers and surfactants. Cementing fluids may require discharge to the marine environment under various scenarios.

New wells will require casing strings to be run and cemented. The cementing process used for the installation of a conductor results in the return of minor volumes (approximately 5m^3) of cement slurry to the seabed to ensure that the conductor is fully cemented and structural integrity is achieved.

Contingency discharges of cement may be required if a cementing job does not meet technical and safety standards and needs to be circulated out of the well (up to approximately 18m^3)

After each cement job, left over cement slurry in the cement pump unit and the surface lines is flushed and minor volumes (2m^3) discharged to the sea to prevent clogging of the lines and equipment.

Excess cement will either be: used for subsequent wells; provided to the next operator at the end of the drilling program (as it remains on the rig); or, if these options aren't practicable, discharged to the marine environment as a slurry (up to approximately 40m^3).

Additional products such as barite and bentonite may be discharged in bulk during or at the end of the activity if they cannot be reused or taken back to shore. Discharge may be in the form of dry bulk or as a slurry; however, discharges will not be contaminated with hydrocarbons.

6.12.2.2 *Discharge of drilling and completion fluids to the environment*

There are five drilling and completions fluids planned for use at Wandoo:

- Seawater with bentonite sweeps: used for drilling the tophole section(s), discharged to the seabed. Formulated from fresh water, bentonite clay, xanthium gum or guar gum and a small addition of sodium hydroxide.
- KCL/PHPA/Glycol: used to drill the intermediate hole section after BOPs have been installed. This fluid is recycled via the MODU shale shakers and solids control systems.
- Drill-in fluid: used for drilling the Wandoo reservoir section. Formulated to minimise long-term damage to the formation and provide hole cleaning.
- Solids free fluid: After drilling has been completed, the well is displaced to a polymer based solids free completion fluid before sand exclusion screens are run.
- Completion brine: After the completion has been run, the well bore is displaced with completion brine treated with a small amount of biocide to prevent souring of the reservoir. This is a filtered inhibited potassium chloride brine with a density of around 1.07sg.

No SBM will be used.

Water-based mud is used as a drilling fluid with seawater used as the main component, with polymers that break down naturally, being added to provide rheological properties and calcium carbonate being added for density to control losses into the reservoir.

As mentioned above, during closed system drilling, drill cuttings are returned in the drill fluid to the MODU, which alters the properties of the drilling fluid. In order to maintain drilling efficiency, the drilling fluid properties must be maintained. To minimise drilling fluid discharge, a Solids Control System is utilised to remove the drill cuttings, so that the drilling fluids can be reused. The alternative is to remove a fixed volume of the fluid and dilute the remaining volume to within required specification. This significantly increases the volume of drilling fluid being disposed of.

However, as the drilling fluids are continuously reused, they eventually lose their effectiveness and are required to be replaced. As the used fluids are of low environmental effect, comprising mostly of seawater, naturally decomposing polymers, and drill cuttings, they are disposed of overboard. Volumes of drilling fluid discharged per well will vary depending on many parameters, including hole diameter and section depth. Per well, up to approximately 1250 m^3 will be discharged during drilling, with approximately a further 100 to 450 m^3 upon completion. Discharge of drilling fluid can cause an increase in localised turbidity, and may result in smothering of benthos.

In addition to the above, seawater and bentonite sweeps are used during drilling of the conductor and surface hole sections. This fluid is used to lubricate and cool the cutting tools, to remove cuttings from the hole, and to help prevent blowouts. These fluids are not able to be recycled with up to 14,000 m^3 used per well, in order to prevent down-hole problems while drilling. The sweep fluid is formulated from fresh water, bentonite clay and a small addition of sodium.

Well completion fluids are also used during well construction, however they are normally composed largely of salty (NaCl or KCl) brine. Small quantities (up to 250 m^3) of brine treated with minor concentrations of biocide are discharged to the sea, which can cause a highly localised and minor temporary toxicity risk to small marine organisms. After drilling is completed the well is displaced to solids-free completion fluid before sand restricted screens are run. The fluid is created using polymers that break down naturally. Approximately up to 620 m^3 of solids-free drilling fluid is discharged per well. This includes any excess completion fluids remaining in the MODU tank system discharged to sea as per standard operating procedures.

All chemical additives are selected and assessed using the chemical assessment process outlined in Section 6.10. Synthetic oil based muds are not used in or near Wandoo.

6.12.3 Impact assessment

6.12.3.1 *Sensitive receptors*

Pelagic habitat and species (fish and plankton), marine mammals, marine reptiles, seabirds and benthic habitat.

6.12.3.2 *Impact description*

Burial or smothering effect of benthic habitat and fauna

The drilling involved in the scope of work for the campaigns considered under this EP will occur mostly in the *M. australis* sandstone. Overlying shale, silt and limestone formations being drilled if a slot is recovered or an exploration/appraisal well is drilled. As explained in Section 6.12.2.1, the drilled cuttings will largely consist of inert sediments, ranging from very fine to very coarse (<1mm to 1.5cm) particle/sediment sizes. The *M. australis* is made up of unconsolidated fine to coarse sands and glauconite consequently the discharged solids will be at the lower end of the size range. When drilled it produces discrete particles which will disperse into the water column, rather than cuttings solids.

The drilling of wells will result in the discharge of drill cuttings directly into the surrounding water column and onto the immediate seabed. While these direct discharges may result in the modification of benthic habitats and/or short-term smothering of existing benthic habitat dominated by soft-bottom communities, research has shown that these impacts will be short-lived and small-scale. Re-colonisation of benthic species will occur relatively quickly from settling larvae and from migration of mobile species from surrounding areas. Natural oceanic factors (i.e. water depth and strong tidal currents) ensure that turbidity changes are short lived and smothering is minimal due to dispersion and dilution.

Usually the impacts from the discharged cuttings are localised (100 m to 250 m) from the drill site, short-lived (less than 24 months) and concentrations of metals or hydrocarbons are generally not detectable beyond 1,000 m (Hinwood *et al.,* 1994). As most of the cuttings will eventually settle on the seafloor, the main disturbance to the seabed is smothering of sediment-dwelling (benthic and epibenthic) fauna and substrate modification, typically within a 100m to 200m radius of the drill site. Due to the unconsolidated sand and sandstone substrata present at Wandoo, drill cuttings are comprised of fine sediment and are likely to disperse over a much larger area.

Potential impacts include localised mortality of benthic infauna due to burial, smothering or increased water turbidity. Reduced amounts of light and oxygen may increase the potential localised mortality of sessile benthic and infaunal species. Adverse effects could result if cuttings contain contaminants or are of different particle size compared with the natural sediment. Based on extensive studies, these impacts are expected to be localised and transient (Hinwood *et al.,* 1994).

No significant impacts are anticipated from the dry cement transfer process or any from the cement slurries pumped during each campaign because of the minor quantities involved, the low or non-toxic nature of the material and the localised area of impact.

Increased water turbidity and localised changes to water quality

Disposal of drill cuttings and water-based mud will generate suspended sediments in the water column, therefore increasing turbidity. Turbidity can reduce the amount of light and oxygen available at the seabed and the lower levels of the water column, which may potentially impact light dependant biota. However, as the Operational Area is approximately 80km offshore, the turbid waters will not be transported to sensitive mainland coastlines and islands and, as the water at the location is approximately 55m in depth, it is highly unlikely that the turbidity will affect light dependant benthic biota.

Potential impacts to biota are expected to be restricted to those within the disposal period and to the immediate discharge area (i.e. tens of metres within the plume and up to 50m around the well location). Although surface turbidity generally will not exceed 50m from the well centre, the plume will expand throughout the water column as it settles to the sea floor. The Operational Area does not support sensitive marine communities, notably sensitive photosynthesising benthic fauna.

Toxicity and bioaccumulation in marine organisms

Discharge of drilling and completion fluids will occur during each campaign. This discharge could give rise to potential toxicity of and bioaccumulation of drilling and completion fluids and associated chemicals in marine organisms.

Nektonic and planktonic species could be directly affected, as these species are not able to move out of the plume due to their inherent mobility characteristics. However, discharge of water based muds and the associated cuttings to the ocean have been documented as having little or no adverse, long-term biological impact in the water column or on the seafloor (Hinwood *et al.,* 1994).

In addition, due to the highly dispersive oceanographic environment (Section 3.2.2) drilling fluid will disperse rapidly at the drill location, with minimal risk of bioaccumulation, or toxicity effects on marine organisms. Therefore, potential toxicological effects from well construction waste disposal on marine flora or fauna, or regional values or areas of environmental sensitivity beyond the immediate vicinity of the MODU (i.e. coastal reefs and islands) are not expected.

The percentage volume of hydrocarbon on drill cuttings during drilling in the reservoir will be negligible because of the small amount recovered during the drilling process and the associated dilution within the drilling fluids. Therefore, the hydrocarbon on drill cuttings presents a negligible risk of toxicity or bioaccumulation to the environment.

Displacement from critical habitats

No feeding, calving or resting areas for listed species occur in or in proximity to the Operational Area. Only the northern migration corridor for the humpback whale overlaps with the Operational Area. However, there is no restriction in the width of this corridor in the vicinity of the Operational Area, and based on the predicted extent of the discharge plume, any drilling fluids and cuttings discharges associated with well construction activities will not significantly affect migrating humpback whales when present during their annual northbound migration.

6.12.4 Control measures

Volume of fluid mixed will be that required to safely complete the task. This minimises waste and also minimises the impact on the environment. Chemicals proposed for use in campaigns will be reviewed by VOGA Well Construction Drilling Fluids Specialist in accordance with the VOGA chemical assessment process (Section 6.10).

The volume of liquid (excluding seawater) discharged to the environment is logged.

Drilling fluids and cuttings will be returned to the MODU and then run over the shale shakers to remove any solids in preparation for reuse. The only exception being the fluids and drill cuttings associated with drilling the conductor and surface hole sections of new wells, when cuttings will be disposed of to the seabed.

Given the proposed controls above, no change in water quality parameters is expected that may modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Listed Threatened Species is likely to decline. Therefore, potential impacts or risks are not evaluated further.

6.12.5 ALARP demonstration

Water-based drilling and completion fluids are used for well construction activities at Wandoo due to their superior environmental performance. Wherever possible the chemical additives used to create the water-based drilling and completion fluids are rated Gold under CHARM (Chemical Hazard and Risk Management) or E under OCNS. Disposal of any excess fluids results in a brief reduction in water quality. However, in water depths of approximately 50m, the effect is rapidly diluted to an unmeasurable level.

Cement residue is disposed of into the ocean. The cement products used will be reviewed by in accordance with the VOGA chemical assessment process. Similarly, drill cuttings are disposed of into the ocean. However, over the life of the field, many wells have been drilled from the two well centres at WNA and WNB. Consequently, the Wandoo locations have a history of drill cuttings disposal, but ROV inspections have not shown any evidence of residual cuttings piles, nor any evidence of smothering.

The measures that VOGA take to minimise the discharge of drill cuttings, cement and well construction fluids reduce environmental risk to an ALARP level.

An alternative is to not discharge cuttings into the ocean, but instead to collect them and then transport them to shore for landfill. This approach is prohibitive from an operating cost and logistics perspective, as it would require modifications to the MODU to make collection of the cuttings possible, along with increased vessel and land transport activities. The transport and handling activities would increase personnel safety exposure and impact to the environment.

Onshore disposal of drill cuttings would result in an increase in the following risks:

- Increase fuel use and emissions associated with transport to shore for treatment/disposal of the cuttings;
- Increase safety and environmental risks associated with handling and transporting;
- Nuisance effects (e.g. traffic, dust, noise); and
- Increase in vessel traffic and port activity.

It is not expected that modelling of cuttings dispersion to characterise the likely distribution of cuttings on the seabed would be of benefit for the following reasons:

- The relative lack of sensitive environmental habitats around the well locations;
- Low volumes of cuttings envisaged;
- Low toxicity of water-based mud; and
- Good availability of comparable research data.

The risk of cumulative impacts from multiple campaigns is minimal due to the fine nature of the cuttings that will disperse over a large area, rather than accumulate as cuttings piles on the seabed. No evidence of cuttings piles has been seen during the debris surveys conducted as part of prior well construction campaigns, confirming there are no cumulative impacts to date. The above risk controls were also considered in the context of reducing potential cumulative impacts. As the environmental risk is negligible, there are no further controls required.

As the MODU is located in an area of low diversity, the potential short-term and small-scale impacts are not considered to be significant. Therefore, the risk associated with the discharge of drill cuttings, steel shavings and cement products is considered to be acceptable and ALARP.

The risk of cumulative impacts from multiple campaigns is minimal, due to the low toxicity of the fluids that will be used during the campaigns and the local metocean conditions that will aid dispersion and dilution of the drilling fluid additives. Potential acute impacts to biota are unlikely because of the low toxicity of the fluids and the restricted discharge to the immediate area. Due to the negligible environmental risk associated with the fluid impacts there are no further controls required.

6.13 Discharge of sewage, grey water and putrescible wastes

6.13.1 Hazard report

Table 6-34: Hazard report – Discharge of sewage, grey water and putrescible waste from MODU and vessels

HAZARD:	Discharge of sewage, grey water and putrescible waste from MODU and vessels.				
EP risk no.:	EP-WC-R12				
Potential impacts:	Nutrient enrichment and increased biological demand of surrounding waters. Low level contamination of organisms caused by ingestion of waste materials. Increase in scavenging behaviour of marine fauna and seabirds.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Discharge of putrescible waste from MODU and AHTS vessels.	Putrescible waste from MODU and AHTS vessels is macerated and discharged in accordance with MARPOL 73/78 Annex V.	Engineering	MODU and AHTS vessels have appropriate certification to treat sewage and putrescible waste in accordance with MARPOL 73/78 regulations prior to discharge.	Putrescible waste shall be macerated to 25mm prior to discharge.	Records show macerator is operational and operating to the required specification.
				Putrescible waste maceration system shall be maintained in a functional state in accordance with manufacturer's specifications.	Macerator maintenance records.
Discharge of sewage from MODU and AHTS vessels.	Sewage discharge from AHTS vessels and MODU is treated in accordance with MARPOL 73/78 Annex IV and AMSA Marine Order 96.	Engineering		MODU and AHTS vessels shall have either a MARPOL compliant sewage treatment plant or sewage comminuting and disinfecting system or holding tank.	VOGA audit or inspection process demonstrates that MODU and AHTS vessels have current International Pollution Prevention Certificate and that the sewage treatment plant is operational.
				The sewage treatment plants aboard the MODU and AHTS vessels shall be MARPOL 73/78 Annex IV compliant and maintained in accordance with manufacturer's specifications.	VOGA inspection or audit confirms compliance of STP and application of contractor's PMS. Contractor's servicing and maintenance records are up to date.
Discharge of grey water from MODU and AHTS vessels.	Biodegradable, low phosphate detergents will be used in the laundry.	Substitute	Biodegradable, low phosphate detergents will be used in the laundry.	Contracted AHTS vessel and MODU Operators shall be informed of the requirements to use biodegradable, low phosphate detergents in the laundry.	VOGA inspection or audit process confirms biodegradable, low phosphate detergents are used.
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**N/a**
None identified.		N/A	N/A	N/A	N/A
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Initial risk**	
Incidental (1)	Unlikely (B)			Low	
ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					
Additional control measures	**Prevention/mitigation**	**Control hierarchy**	**Performance outcome**	**N/a**	**N/a**
None identified.	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:		
Consequence	**Likelihood (of consequence)**	**Residual risk**
Incidental (1)	Unlikely (B)	RRIV (Low)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**Risk < Extreme (I)**	**EPO(s) manage impacts / risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Impact managed in accordance with VOGA HSE policy and VOGA requirement for use of biodegradable detergents.	Yes – MARPOL 73/78 Annex V, MARPOL 73/78 Annex IV and AMSA Marine Order 96	Yes – RRIV (Low)	Yes – EPOs specify discharge parameters. Relevant overarching EPOs (Table 5-2) maintained when controls maintained.

6.13.2 Description of hazard

Operation of the MODU and AHTS vessels will typically result in the generation of approximately 35 m^3 per day of domestic discharges (based on 200L/day/person) including grey water, sewage and putrescible waste.

Treated sewage will be discharged into the marine environment after treatment in an extended aeration system.

Food scraps will be macerated then discharged into the marine environment. Scraps that cannot be macerated, or are not readily degradable, such as bones, onion peels and orange rinds are bagged and disposed of onshore with the general rubbish.

Grey water is discharged from the MODU and AHTS vessels. The grey water is comprised of potable water, soaps and detergents and is discharged directly to the ocean.

The MODU and AHTS vessels used in VOGA's well construction campaigns will have similar specifications. Consequently, discharge volumes of sewage, grey water and putrescible wastes and their associated environmental impacts are unlikely to vary significantly from one campaign to the next.

6.13.3 Impact assessment

6.13.3.1 *Sensitive receptors*

Pelagic habitat and species (fish and plankton), marine mammals, marine reptiles and seabirds.

6.13.3.2 *Impact description*

The primary impacts related to the discharge of sewage, grey water and putrescible waste are nutrient enrichment of surrounding waters and increased biological oxygen demand, which may result in changes to plankton in the immediate area. In a study of sewage discharge in deep ocean waters, Friligos (1985) reported no appreciable differences in the inorganic nutrient levels between the outfall area and background concentrations, suggesting rapid uptake of nutrients and/or rapid dispersion in the surrounding waters. Given that the MODU and vessels are typically on site for a relatively short periods of time (e.g. approximately 30 to 100 days per campaign for the MODU and less for the vessels), sewage discharge is unlikely to result in a significant environmental impact. In the open ocean environment, the effect of the effluent biological oxygen demand on seawater oxygen concentrations is expected to be insignificant (Black *et al*., 1994).

Ingestion of sewage discharges by fish, cetaceans, marine reptiles or foraging seabirds could result in bioaccumulation of contaminants. However, dilution in the open ocean environment is rapid, with study results showing 1-in-1000 dilution within 30 minutes of release (Costello and Read, 1994).

Sewage and putrescible waste disposal from the MODU and AHTS vessels is localised and short duration, with high dispersion and dilution rates because of the open ocean environment in the Operational Area (i.e. water depth, strong ocean currents and metocean conditions). The Operational Area is also remote from any sensitive receptors and is located more than 12nm from the nearest land.

While marine mammals and reptiles may transit through the area, there are no feeding, calving or other aggregation areas for listed species in the vicinity of the Operational Area. It is likely that the highly dispersive open ocean environment and high water column productivity are preventing long term accumulation of organics under the platform.

6.13.4 Control measures

Putrescible waste from the MODU and vessels is macerated to 25mm prior to discharge in accordance with MARPOL 73/78 Annex V.

The discharge of sewage from the MODU and AHTS vessels will conform to MARPOL 73/78 requirements, which require any vessel (MODU or AHTS vessels) over 400t or certified for greater than 15 persons to *"...be equipped with either a sewage treatment plant or a sewage commuting and disinfecting system or a sewage holding tank"*. The vessels contracted for VOGA's well construction campaigns will be equipped with sewage treatment facilities.

MODU and AHTS vessels have current International Pollution Prevention Certificate.

The macerators and sewage treatment plants are maintained in accordance with manufacturer's specifications.

Grey water is discharge from the laundry shower and hand basins on the MODU and vessels. The use of biodegradable low phosphate detergents is required to minimise the environmental impact of grey water discharge.

Given the proposed controls above, no change in water quality parameters is expected that may modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Listed Threatened Species is likely to decline. Therefore, potential impacts or risks are not evaluated further.

6.13.5 ALARP demonstration

An alternative would be to take all food scraps, sewage and grey waste to shore for land-based disposal.

This is not feasible from an increased logistics (MODU and AHTS vessels) space, increased transportation), HSE risk and cost perspective. In addition, onshore disposal would introduce alternate environmental impacts, that may be greater than those created by offshore disposal, e.g. additional energy needed (and associated emissions) for sewage and grey water treatment and disposal. Onshore disposal also provides an increased exposure to society from biological health hazards.

The potential impact to environment created by this hazard has been assessed by VOGA to be acceptable, due to the relatively small impact area and potential increased environmental and safety impacts presented by the alternative disposal strategies. Impacts to the marine environment are expected to be minimal because of the biodegradability of the waste, short period of activities and the large dilution factor in the open ocean environment.

As the MODU is located in an area of low diversity, the potential short-term and small-scale impacts are not considered to be significant. Therefore, the risk associated with the offshore discharge of food scraps, sewage and grey waste is deemed to be acceptable and ALARP.

The risk of cumulative impacts from multiple campaigns is minimal because of the low toxicity of the discharges and the local metocean conditions that will aid dispersion and dilution of the discharges. The above risk controls were also considered in the context of reducing potential cumulative impact. However, due to the negligible environmental risk associated with the discharges there are no further controls required.

6.14 Ancillary hydrocarbons or chemical spills

6.14.1 Hazard report

Table 6-35: Hazard report – Ancillary hydrocarbon or chemical spills/discharges

HAZARD:	Ancillary hydrocarbon or chemical spills/discharges.				
EP risk number:	EP-WC-R13				
Potential impacts:	Reduction in water quality. Toxic effects on marine biota.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcomes**	**Performance standard**	**Measurement criteria**
Hydrocarbon or chemical spill due to materials handling and storage.	Intermediate Bulk Containers (IBCs) are transferred to/from vessel using a lifting cradle or are containerised.	Engineering	No unplanned discharge of hydrocarbons or chemicals to the marine environment.	IBCs shall be transferred to/from AHTS vessels using a lifting cradle or will be containerised.	Audit or inspection against contractor Lifting Procedure.
	Cranes and lifting equipment are certified.	Engineering		Cranes and lifting equipment shall be certified.	IBCs, cranes and lifting equipment certification records.
	All MODU and AHTS vessel equipment including lifting equipment and cranes is covered by the contractor's PMS.	Administrative		Lifting equipment and cranes shall be maintained in accordance with contractors' PMS.	VOGA inspection or audit process confirms lifting equipment and cranes are included in the contractor's PMS. Contractor's servicing and maintenance records are up to date.
	Chemical storage on MODU compliant with MODU contractor's storage requirements.	Administrative		All hazardous chemicals shall be stored in bunded areas or below deck.	VOGA inspection or audit process confirms chemicals are stored in bunded areas or below deck.
	Crane driver meets contractor's competency requirements.	Administrative		Crane Operators shall be certified for offshore tower crane operations.	Review of contractor's CMS.
Hydrocarbon or chemical spill from MODU or AHTS vessels due to failure of hydraulic hoses.	Pre-hire inspection validates Contractor's PMS includes hydraulic hose maintenance and replacement schedule	Engineering		Pre-hire inspection shall be undertaken to validate the Contractor's PMS includes hydraulic hose maintenance and replacement schedule.	Pre-hire inspection report.
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
MODU and AHTS vessels must have a SOPEP / SMPEP (equivalent to class) procedures to manage small spills on their facilities.		Administrative	All small spills are responded to in accordance with SOPEP/ SMPEP (equivalent to class).	SOPEP / SMPEP (equivalent to class) procedures to shall be available during well construction activities.	VOGA inspection or audit confirms SOPEP / SMPEP (equivalent to class) procedures are available on the MODU and AHTS vessels during well construction activities.
MODU and AHTS vessels have equipment to manage small spills on their facilities.		Protective		Equipment meeting the requirements of the SOPEP/ SMPEP (equivalent to class) is shall be available on the MODU and AHTS vessels during well construction activities.	VOGA pre-hire inspection confirms that the required spill kits are available during well construction activities.
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Initial risk**	
Minor (2)	Unlikely (B)			Low	
ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					

Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					
Additional control measures	**Prevention/mitigation**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.	N/A	N/A	N/A	N/A	N/A
RESIDUAL RISK AFTER ADDITIONAL CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Residual risk**	
Minor (2)	Unlikely (B)			RRIV (Low)	
ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**RR < Extreme (I)**	**EPO(s) manage impacts / risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Risk managed in accordance with VOGA HSE policy.	Yes –Potential spills to be managed in accordance with SOPEP/ SMPEP (equivalent to class).	Yes – RRIV (Low)	Yes – EPOs specify no spills to marine environment. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.14.2 Description of hazard

Maintenance chemicals and lubricating oils are transported by AHTS vessels to the MODU and stored in fit-for-purpose containers. Materials handling and storage damage to containers could result in a spill. A spill could result in chemical or lubricating oil being discharged to the environment. Any spills are likely to be small in nature with the largest credible event being the volume of a 205L drum.

Inboard leaks could be generated from any of the wide range of equipment on a MODU or AHTS vessels. The types of fluids on a MODU or vessel range from lubricating fluids to hydraulic, fuel and cooling fluids. The leaks may come from a failure of a mechanical component, fitting or hose.

Waste lube oil from mud pumps, compressors, equipment crankcases and drip pans drains into the dirty-oil holding tank. The dirty-oil holding tank is discharged to portable tanks for transport ashore for reprocessing or disposal at an approved facility.

Bulk chemicals products will be transferred to/from and stored on the MODU and AHTS vessels. Transfer between vessel and MODU is by MODU crane via lifting cradles or dedicated containers. Any spills are likely to be small in nature, with the largest credible event being the dropping of an entire IBC (approx. 1.5 m^3). The unplanned loss of these products into the sea would only occur in the event of a lifting equipment incident or loss of station by the AHTS vessels resulting in hose failure during the transfer. A lifting equipment incident is highly unlikely due to crane and lifting equipment certification and maintenance requirements and MODU lifting procedures. Similarly, inspection criteria for transfer hoses ensure that the likelihood of hose failure is extremely unlikely. The use of dry break couplings on hoses used for critical fluid transfers, ensure that, in the unlikely event of failure, the volume of fluid lost to the environment is small.

Hose failure, due to loss of station by a vessel is extremely unlikely, as the vessels are typically operated in DP mode when in close standby. Failure of the DP system is extremely unlikely, as these systems are maintained under the vessel preventative maintenance systems.

6.14.3 Impact assessment

6.14.3.1 *Sensitive receptors*

Plankton, infauna, fish (pelagic), marine mammals, marine reptiles and seabirds.

6.14.3.2 *Impact description*

The impacts associated with the unplanned discharge of hydrocarbons or chemicals are related to the nature of the material spilled, the volume and its behaviour in the marine environment (sink/float/disperse etc.). Potential impacts include toxicity and bioaccumulation of the product in benthic organisms, surface dwelling plankton or pelagic fauna and localised reduction in water quality.

In the event of a spill, the impacts will be localised and temporary. The chemical products would be subjected to rapid dispersion and dilution by the open ocean conditions.

In the event of an unplanned chemical or hydrocarbon discharge, potential impacts will include a temporary and highly localised decline in water quality, with limited potential for toxicity to marine fauna due to the temporary exposure and low toxicity resulting from the rapid dilution in the marine environment. Potential impacts are likely to be limited to the immediate vicinity and unlikely to affect overall population viability. A visible oil sheen on the water surface may also occur in the event of minor hydrocarbon spills. Importantly, these hydrocarbon compounds (lower molecular weight PAHs) are also volatile and will evaporate rapidly, due to natural processes, during early stages of a spill. For this reason and, given the minor volumes of hydrocarbons spilled, mortality of organisms because of lethal concentrations of dissolved hydrocarbons is expected to be rare, with contact with sensitive marine habitats (>40 km) or the shoreline also predicted to be highly unlikely. Refer also to Section 5.3.

Any leaks from inboard fittings and connections would be contained within bunded areas, which drain to a sump through the closed drain system. Any spill to deck will be cleaned up using absorbents. Spills to ocean are considered very unlikely and, if they were to occur, would be of tiny quantities (so small as to be negligible environmental impact).

6.14.4 Control measures

The following preventative controls are in place for well construction campaigns in the Operational Area:

- End use containers are transported to the MODU within certified transport containers;
- IBCs used for lifting have certified lift points and are certified containers;
- MODU crane operators are qualified and meet the MODU competency requirements;
- Lifting equipment certification and maintenance requirements are in place for the MODU lifting equipment and cranes;
- Storage areas for chemicals are bunded or below decks on the MODU;
- The MODU has a SOPEP and carries spill kits to manage small spills; and
- MODU and vessel equipment, including bunding, hoses etc. are all managed in accordance with the contractors' preventative maintenance systems.

6.14.5 ALARP demonstration

The Operational Area is in water approximately 55 m deep and is distant from the coast (80 km) and other sensitive environments (40 km). The natural oceanic conditions present in the Operational Area (i.e. water depth, strong tidal currents and metocean conditions) enhance the dispersion and dilution rates of any unplanned release. Consequently reducing the likelihood of its concentration in a small area, making ingestion by seabirds and marine life, along with significant pathological impact on fish larvae and plankton, unlikely.

The existing preventative controls and the location of the Operational Area reduce the residual risk of environmental impact from an unplanned release of ancillary hydrocarbons or chemicals to low. Consequently, no further risk reduction measures are considered necessary and the risks are considered acceptable and to be at ALARP.

An alternative is for the MODU to return to port each time it is required to transfer bulk products. However, suspending well operations and moving the MODU into a port capable of handling a MODU for restocking purposes is not cost effective. The move process, along with the activities required to suspend and recommence operations, would introduce substantially more HSE risk than conducting the relatively simple, controlled AHTS vessels to MODU cargo and fuel transfers.

As an example, for Wandoo operations, the MODU would have to return to a port every ~20 days to resupply the bulk mud requirements. This process would take six to eight days (if Dampier is capable of handling a MODU for restocking purposes) and require the MODU to take a complex tow route transiting very close to sensitive areas such as the Dampier Archipelago.

Bulk products are transferred using double containerised packaging and stored in bunded areas. The largest credible spill event that could occur during bulk transfer is approx. 1.5 m^3 which is the entire volume of the IBC. Consequences will be limited, due to the small volumes of bulk product lost to the environment, the low number and very short duration of the transfer processes during well construction operations.

The Operational Area is in water 55m deep and distant (80 km) from the coast and other sensitive environments (40 km). This separation and the natural oceanic factors in the Operational Area (i.e. water depth, strong tidal currents and metocean conditions) enhance the dispersion and dilution rates of any lost product, reducing the likelihood of its concentration in a small area making significant reduction in water quality or pathological impact on fish larvae and plankton in the event of a spill unlikely.

Transfer of materials from AHTS vessels to the MODU is a routine activity controlled by established operating procedures using equipment covered by the contractors' preventative maintenance systems. In light of these controls and the likelihood and consequences involved, the risk of this incident is considered acceptable and to be at ALARP.

6.15 Physical presence of MODU and AHTS vessels

6.15.1 Hazard report

Table 6-36: Hazard report – Physical presence of MODU and AHTS vessels

HAZARD:	Physical presence of MODU and AHTS vessels.
EP risk number:	EP-WC-R14
Potential impacts:	Disturbance marine fauna including marine mammals, reptiles and birds. Interaction with commercial and recreational fishing and shipping.

PREVENTION:

Activity/cause:	Existing control measures	Control hierarchy	Performance outcomes	Performance standard	Measurement criteria
Moving a MODU onto Location MODU Operations Support Vessel Operations within Operational Area	Functional communication equipment on board MODU and AHTS vessels to communicate with commercial and recreational shipping vessels in the vicinity of the Facility.	Engineering	No collision with commercial and recreational fishing and shipping.	Communication equipment on board MODU and AHTS vessels, shall be functional and maintained in accordance with the contractor's PMS.	VOGA inspection or audit process confirms communication equipment on board MODU and AHTS vessels are included in the contractor's PMS.
	Notification of intent to move MODU to or from field is notified in advance to AMSA.	Administrative		AMSA shall be advised of planned rig moves at least two prior to scheduled move date.	Copy of Notice to Mariner's noting location of MODU maintained by VOGA.
	Wandoo Facility has a permanent Petroleum Safety Zone and the MODU has restricted zone of 500m for unauthorised vessels.	Isolation		AHTS vessels shall to monitor the Petroleum Safety Zone and 500 m restricted zone around the MODU and engage / intercept errant vessels.	Radio logs indicate actions taken if errant vessel approaches or is within the 500 m restricted zone.
	Vessels operating in the Operational Area must adhere to Part 8 of EPBC Regulation 2000 to minimise exposure of marine fauna to noise impacts.	Administrative	No vessel collision with marine fauna.	Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.05 and 8.06) Interacting with cetaceans to minimise potential for vessel strike	Records demonstrate no breaches of EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans.

MITIGATION:

Existing control measures	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A

INITIAL RISK WITH EXISTING CONTROLS:

Consequence	Likelihood (of consequence)	Initial risk
Minor (2)	Unlikely (B)	Low

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:

Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.

Additional control measures	Prevention/mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.					

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:

Consequence	Likelihood (of consequence)	Residual risk
Minor (2)	Unlikely (B)	RRIV (Low)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:

Principles of ESD not compromised	External Context – objects or claims considered	Internal Context – VOGA environment policy / procedures met	Other Requirements met	Risk < Extreme (I)	EPO(s) manage impacts to acceptable level(s)
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Risk managed in accordance with VOGA HSE policy.	Yes – Notice to Mariners issues via AMSA in a timely manner. Compliance with Part 8 of the EPBC Regulation 2000. Management of Gazetted PSZ.	Yes – RRIV (Low)	Yes – EPOs specify no collisions. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.15.2 Description of hazard

Physical presence relates to the presence on the water surface of MODU and vessels required to support well construction activities. The potential for subsea infrastructure to cause seabed disturbance is addressed below in Section 5.16 (Seabed disturbance).

The VOGA well construction campaigns involve positioning a MODU alongside or near to the Wandoo platforms, in very similar areas for each campaign. The AHTS vessels generally remain outside the MODU restricted zone, but may approach the MODU from time to time for loading or unloading of materials. The AHTS vessels also depart the MODU location to visit the port of Dampier to take on new stores and equipment and to offload excess materials and waste.

6.15.3 Impact assessment

6.15.3.1 *Sensitive receptors*

Marine mammals, fish, marine reptiles, seabirds; commercial and recreational fishing and shipping.

6.15.3.2 *Impact description*

Disturbance to marine mammals, fish, and marine reptiles

The physical presence of the MODU and AHTS vessels has the potential to disturb transient individual marine fauna such as cetaceans and turtles. The Operational Area is approximately 80 km off the coast, in water approximately 55 m deep, with no MODU operations in proximity to shallow water habitats and from mainland and island shorelines and beaches used by turtles.

The Operational Area is not known to support critical resting, feeding or calving areas for EPBC listed species and consequently, fauna are not expected to be sedentary but transiting through the area. The Operational Area is however within the northern migration route for humpback whales.

Given that the MODU used for drilling campaigns will be stationary and adjacent to or nearby existing fixed structures, it is highly unlikely that the physical presence of the MODU will have any impact on migrating cetaceans or turtles in the area. During the movement of the MODU into or out of the Operational Area, or between the WNB platform and WNA monopod, it will be moving slowly (5 knots or less), allowing time for any marine fauna to move out of the immediate area. Any interaction with cetaceans is expected to result in a recoverable injury, not death, because vessel speeds within the operational area are inherently slow.

Where cetaceans are sighted, the AHTS vessels supporting the well construction activities will maintain safe distances in accordance with Part 8 of the EPBC Regulations 2000. As a result, it is highly unlikely that there will be any collision with a marine species.

Similarly, potential impacts to other marine species, including sea snakes and turtles, which may also pass through the Operational Area, is considered minimal as the infrastructure is mainly stationary and moves at a speed of 5 knots or less.

However, if an interaction with marine fauna (either via suction through water intakes or fauna strike) resulted in death, it is expected that impacts will be limited to individuals, not local populations. The recovery plan for marine turtles in Australia (Commonwealth of Australia, 2017) confirm that this is the likely outcome noting that although vessel strikes can be fatal for individual turtles, it has not been shown to cause population-level declines.

Consequently, this event is expected to result in a limited short-term effect and not affect any populations.

Disturbance to fishing activity and commercial shipping during transit

There is potential for minor/temporary disturbance of fishing activity during transit to and from the Operational Area. However, impacts associated with the well construction activities are minimal as they will occur in, or near to, a permanent restricted zone which exists in the Operational Area. Commercial and recreational fishing is not permitted in the restricted zone.

The MODU Contractor will issue a Notice to Mariners to AMSA prior to moving to the Operational Area. Access to the AMSA's website and their Maritime Safety Information updates allows members of the Western Australian Fishing Industry Council (WAFIC) and other commercial vessels to be made aware of the presence of the MODU within the Operational Area. Consultation has been conducted with WAFIC through the years of operation at Wandoo and will be ongoing for future campaigns (Section 9).

Commercial shipping vessels move through the offshore waters en route to or from the marine terminals at Barrow and Varanus Islands. Ships using NWS waters include iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland. However, these are predominantly heading north from these ports. Large cargo vessels carrying freight bound or departing from Fremantle transit along the WA coastline heading north and south in deeper waters. The Operational Area is approximately 25 km from the northbound shipping fairway from Dampier. As a 500 m restricted zone exists around the facility where shipping traffic is not permitted, as well as a cautionary zone (2.5 nm around the Wandoo facilities), the MODU and AHTS vessels within the Operational Area are unlikely to interact with shipping traffic.

Potential impacts to seabirds (helicopter operations)

Although helicopter movements have the potential to affect birds through direct strike, birds are expected to avoid collisions with helicopters due to their high visibility and noise levels. The number of helicopter flights required is relatively low; estimated at six to seven flights per week. Flights also occur in the daylight and not within major roosting areas, thereby reducing potential interactions and subsequent physiological impacts. Collisions are therefore considered unlikely.

6.15.4 Control measures

The following preventative controls are in place for well construction campaigns in the Operational Area:

- VOGA consults with stakeholders to advise them of the presence of the MODU operation during well construction campaigns;
- Communication equipment on board MODU and AHTS vessel in compliance with IALA and SOLAS requirements and maintained in accordance with manufactures specifications;

- During rig moves, AMSA is advised of the move in advance and the move is communicated to others via Notices to Mariners;
- Vessel movements within the Wandoo restricted zone are restricted to less than 5 knots; and
- Vessels operating in Operational Area must adhere to Part 8 of EPBC Regulation 2000.

6.15.5 ALARP demonstration

The combination of navigation controls and procedures, plus the issuing of a Notice to Mariners reduces the risk of an environmental incident with the fishing industry to a low level.

The low vessel speeds within the platform restricted zone ensures that marine mega-fauna have adequate time to avoid vessels in transit.

The relatively short duration of the VOGA well construction campaigns ensures that any impacts on local industry or marine fauna are very low.

In light of these controls and the low likelihood of occurrence, the residual risk posed by the presence of the MODU and its supporting AHTS vessels is considered acceptable and to be at ALARP.

As an alternative, well construction operations could be scheduled outside of whale migration season. However, this is not feasible from a MODU availability, or a workload and logistics point of view. This is not considered necessary based on the low level of risk involved.

Mandating compliance with the Australian national guidelines on whale and dolphin watching was considered with regard to observing caution and no approach zones during rig move operations. However, unlike a vessel under its own steam, it is not practicable to bring the MODU to a sudden halt when under tow in open water. Furthermore, given the slow speeds involved, it is likely that any cetaceans will move out of the tow route without the need for the MODU and AHTS vessels to stop.

In light of the described control and mitigation measures and the low likelihood of occurrence, the residual risk posed by the MODU impacting with cetaceans is considered acceptable and to be at ALARP.

Aerial surveillance could be implemented to identify and communicate with vessels within the area that could potentially interact with the MODU during the well construction campaigns. However, this is not cost effective given the use of radar on the AHTS vessels, provision of Notices to Mariners and the increased environmental impacts that would be created by use of aerial surveillance or minimal additional risk reduction this would achieve.

Whilst located inside Operational Area WA-14L, the MODU will be surrounded by a 500m restricted area for unauthorised vessels. This restricted area includes commercial and recreational fishing vessels.

Application of the described control and mitigation measures reduces the risks to commercial fishing activities to low. the residual risk posed by interaction with commercial fishing activity during well construction campaigns in the Operational Area is considered acceptable and to be at ALARP.

6.16 Seabed disturbance

6.16.1 Hazard report

Table 6-37: Hazard report – Seabed disturbance

HAZARD:	Seabed disturbance				
EP risk number:	EP-WC-R15				
Potential impacts:	Seafloor scour. Increase in turbidity of the water column/reduction light penetration. Localised smothering of benthos. Localised reduction in benthic productivity.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
MODU positioning and spud can contact.	Rig move plan will be prepared in general accordance with Drilling Contractor's Marine Operations Manual.	Administrative	Minimise seabed disturbance when positioning MODU.	A rig move plan shall be developed and signed off ready for use in accordance with Drilling Contractor's Marine Operations Manual.	Rig move plan agreed and signed by VOGA and MODU contractor.
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Objects are very infrequently dropped from the MODU during the work process. At the completion of the well construction campaign, a video record is made of the seabed around the MODU location and any dropped objects are recovered or plans are made for recovery in the future (if safe to do so).		Engineering	No dropped objects on seabed.	An ROV survey shall be undertaken post campaign to demonstrate clear seabed.	ROV video record.
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Initial risk**	
Incidental (1)	Unlikely (B)			Low	
ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					

Additional control measures	Prevention/mitigation	Control hierarchy	Performance outcome	Performance standard	Measurement criteria
None identified.	N/A	N/A	N/A	N/A	N/A
RESIDUAL RISK AFTER ADDITIONAL CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Residual risk**	
Incidental (1)	Unlikely (B)			RRIV (Low)	

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**Risk < Extreme (I)**	**EPO(s) manage impacts to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Risk managed in accordance with VOGA HSE policy and Drilling Contractor's Marine Operations Manual.	N/A – no specific requirements identified	Yes – RRIV (Low)	Yes – EPOs specify no dropped objects. Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.16.2 Description of hazard

The physical presence of drilling equipment and well construction related activities may cause seabed disturbance, due to the potential smothering of benthic habitats and sea floor scour along the seabed. The key activities/causes are as follows:

- Installation of temporary moorings (subsea infrastructure) associated with placement of the MODU alongside the Wandoo platforms. The footings (known as 'spud-cans') on the bottom of the MODU legs cover an area of about 145 m^2 (based on approximately 2m penetration of the seabed), at both a temporary holding location about 80m from the final location, and at the final position of the MODU spud-cans.
- Drilling activities (wellbore diameter)
- Dropped objects from support vessels and the MODU, and
- Anchoring of vessels. AHTS vessels do not anchor within the platform restricted zone, but may do so outside the restricted zone if on standby.

6.16.3 Impact assessment

6.16.3.1 *Sensitive receptors*

Benthic habitat and fauna.

6.16.3.2 *Impact description*

The MODU has three legs fabricated in a lattice structure terminating with a footing (known as a spud-can) at the base. Each spud can cover an area of about 145 m^2 (based on approximately 2 m penetration of the seabed), totalling a total seabed disturbance of 870 m^2 for both locations. Additional impacts from well construction activities will be much smaller in comparison, including the footprint of any anchors that may be used by support vessels and the diameter of each wellbore.

The jacking-up of the MODU will have a localised impact on the benthic habitat. The disturbance may affect the benthic habitats involved and cause a reduction in benthic productivity. The substrate in the Operational Area consists of soft sandy unconsolidated sediments, with no significant seabed or benthic features/values recorded within the Operational Area (Section 3).

The effect of the MODU spud-cans is expected to be minimal given the natural movement of the sand to fill any voids, including the area impacted by the MODU spud-cans. Benthic organisms are expected to re-colonise quickly after the MODU is moved off location. An experimental study showed that the full recovery of soft sediment assemblages from physical disturbance could take between 64 and 208 days following physical disturbances of different intensities (Dernie *et al.,* 2003). Where seabed sediments are soft and there are no sensitive communities or other underwater obstructions, it has been suggested that damage caused by anchoring is likely to be minimal and any disturbance is generally temporary (UK Marine SAC 2001 cited in NERA 2018), with the underlying conditions present to support re colonisation and recovery (Ingole *et al.,* 2005).

Given the localised nature of the disturbance and the lack of significant benthic habitat in the region, potential impacts from jacking-up the MODU are considered minimal.

6.16.4 Control measures

The MODU rig move plan is prepared in accordance with the MODU contractor's Marine Operations Manual. The guidelines contained within move plan ensure that the rig spud cans do not contact the seabed until it is positioned over its final location.

The AHTS vessels only anchor within a designated anchoring zone. The anchoring zone is selected as being outside the platform restricted zone, clear of seabed infrastructure and in an environmentally non-sensitive area.

AHTS vessels are expected to recover anchors and sail slowly if the weather is such that there is a risk of dragging an anchor.

6.16.5 ALARP demonstration

Using a jack-up MODU for each campaign minimises the impacts associated with anchoring, which can disturb large areas of benthic habitat because of the inability to use the same anchor location for each campaign.

Use of a dynamically positioned or semisubmersible drilling platform is not practicable, as they cannot execute the required operations over the Wandoo platforms.

The use of platform based rigs to conduct the planned activities has been reviewed. However the Wandoo facilities are too small to permit the installation of a suitable unit.

The benthic habitat around the platform has been disturbed during previous well construction campaigns carried out at the location and as a result of scouring of the seabed from currents around the platform. Negligible change to the seabed area around the Wandoo facilities is evident over regular site surveys carried out after each drilling campaign at a suitable time. It is expected that current and future campaign activities will not cause significant additional impacts.

As the MODU has a small footprint and is located in an area of low biological diversity, which can quickly recover from disturbance, the potential impacts are not considered to be significant. Natural recovery will occur through re-colonisation by planktonic larvae and migration of benthic organisms from outside the area of impact. Therefore, the risks from activities relating to seabed disturbance are considered ALARP.

6.17 Introduction of invasive marine species

6.17.1 Hazard report

Table 6-38: Hazard report – Introduction of invasive marine species

HAZARD:	Introduction of invasive marine species				
EP risk number:	EP-WC-R16				
Potential impacts:	Changes to habitat structure. Predation of native species. Potential introduction of invasive marine species.				
PREVENTION:					
Activity/cause:	**Existing control measures**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Vessel use	If it becomes necessary to use a MODU or AHTS vessel from outside Australian waters the MODU or AHTS vessel is contractually obliged to meet Biosecurity Act 2015	Administrative	No incursion or establishment of marine pest species within the operational area due to vessel use.	VOGA shall validate that the MODU and AHTS vessels have completed a Quarantine Pre-Arrival Report prior to entering Australian waters (if arriving to the Wandoo field direct from international waters).	Quarantine Pre-Arrival Report.
Ballast water exchange	Australian Ballast Water Management Requirements (DAWR, 2017) consistent with the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) (IMO, 2004)	Administrative	No incursion or establishment of marine pest species within the operational area due to vessel ballast water exchange.	VOGA shall validate that, consistent with Australian Ballast Water Requirements, MODU and vessels will have an approved ballast water management plan and valid ballast water management certificate, unless an exemption applies or is obtained.	Ballast water management plan or record of exemption. Valid ballast water management certificate or record of exemption
				MODU and project vessels will manage their ballast water using one of the approved ballast water management options, as specified in the Australian Ballast Water Management Requirements.	Ballast water records that an approved ballast water management option has been used.
Bio-fouling	Vessels comply with the Annex 1 of the International Convention on the Control of Harmful Anti-Fouling Systems on Ships.	Administrative	No incursion or establishment of marine pest species within the operational area due to biofouled equipment.	VOGA shall validate that project vessels have an anti-fouling coating applied that is in accordance with the prescriptions of the International Convention on the Control of Harmful Anti-fouling systems on ships, 2001, and the Protection of the Sea (Harmful Antifouling Systems) Act 2006 (Cwlth) (as appropriate to vessel class).	International Anti-fouling System Certificate in place for contracted vessels.
	IMS Risk Assessment Procedure for MODU and vessels aligned with National Biofouling Guidelines for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009) and the Western Australian Department of Fisheries Biofouling Risk Assessment Tool.			VOGA shall ensure that a biofouling risk assessment is undertaken for contracted MODU (including immersible equipment) and project vessels entering the Operational Area internationally or domestically (from other regions of Australia), and implement mitigation measures commensurate to the risk.	Biofouling risk assessment records and any records of mitigation measures implemented.
MITIGATION:					
Existing control measures		**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
Bio-fouling on the Wandoo facilities will be managed in accordance with the National Bio- fouling Management Guidance (2009).		Administrative	The spread of bio-fouling species is minimised.	If a new/different bio-fouling species is observed growing on the Wandoo facilities a sample will be collected and sent to the WA Museum for identification and to develop a strategy to control the species.	Record of submission of sample to the WA Museum. Control strategy developed.
INITIAL RISK WITH EXISTING CONTROLS:					
Consequence	**Likelihood (of consequence)**			**Initial risk**	
Moderate (3)	Rare (A)			Low	

ADDITIONAL CONTROLS/DEMONSTRATION OF ALARP - VOGA WORKSHOP:					
Following the adoption of standard industry good practice controls, a low risk is defined as tolerable under the VOGA risk level action criteria. The impacts and risks have been deemed ALARP given there are no additional and reasonably implementable controls to further reduce potential impacts and risks.					
Additional control measures	**Prevention/mitigation**	**Control hierarchy**	**Performance outcome**	**Performance standard**	**Measurement criteria**
None identified.	N/A	N/A	N/A	N/A	N/A

RESIDUAL RISK AFTER ADDITIONAL CONTROLS:		
Consequence	**Likelihood (of consequence)**	**Residual risk**
Moderate (3)	Rare (A)	RRIV (Low)

ACCEPTABLE LEVEL OF RISK DEMONSTRATED:					
Principles of ESD not compromised	**External Context – objects or claims considered**	**Internal Context – VOGA environment policy / procedures met**	**Other Requirements met**	**RR < Extreme (I)**	**EPO(s) manage impacts / risk to acceptable level(s)**
Relevant principles of ESD not compromised given proposed controls	N/A – no external objections or claims received	Yes – Risk managed in accordance with VOGA HSE policy.	Yes – Biosecurity Act 2015, Australian Ballast Water Management Requirements (DAWR, 2017) consistent with the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) (IMO, 2004), National Biofouling Guidelines for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009) and the Western Australian Department of Fisheries Biofouling Risk Assessment Tool and Australian Biofouling Management Requirements (Proposed) consistent with International Maritime Organization (IMO) 2011 Guidelines	Yes – RRIV (Low)	Yes – EPOs specify no incursion or establishment of marine pest species within the operational area Relevant overarching EPOs (Table 5-2) maintained providing controls measures maintained.

6.17.2 Description of hazard

Invasive Marine Species (IMS) are non-indigenous marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish founder populations. IMS are widely recognised as one of the most significant threats to marine ecosystems worldwide.

Shallow coastal marine environments in particular, are thought to be amongst the most heavily invaded ecosystems, which largely reflects the accidental transport of IMS by international shipping to marinas and ports where the preferred artificial hard structures are commonly found.

Vessels used for the activity will unlikely be mobilised from overseas; however, mobilisation of the MODU from international waters may occur. This has the potential to act as a pathway for IMS to be translocated into offshore Commonwealth waters, if unmanaged, via the discharge of high-risk ballast water containing IMS and/or via the presence of IMS within biofouling communities on the MODU and/or subsea equipment.

Vessels on domestic journeys (e.g. support vessels transiting between the Operational Area and WA mainland) may, if unmanaged, act as a pathway through the uptake and subsequent discharge of high-risk ballast water containing IMS and/or IMS recruitment on submerged vessel hulls while in the vicinity of confirmed IMS sources. Such sources could include other offshore infrastructure i.e. other vessels or platforms that may have support vessel sharing arrangements; and artificial substrates such as jetties and wharves already colonised by mature IMS, such as in Broome Port.

The introduction and establishment of IMS into the marine environment may result in impacts to benthic communities and associated receptors dependent on these, including fishing.

6.17.3 Impact assessment

6.17.3.1 *Sensitive receptors*

Marine invertebrate communities, marine mammals, marine reptiles, fish, commercial fishing, and offshore infrastructure.

6.17.3.2 *Impact description*

The introduction and establishment of marine pests can result in a localised impact on native marine fauna and flora, and include:

- competition, predation or displacement of native species;
- alteration of natural ecological processes;
- introduction of pathogens with the potential to impact on human and/or ecological health;
- reduction and/or competition with commercial fish and aquaculture species; and
- increased maintenance of vessels and marine infrastructure.

Marine pest species are organisms that have established within a marine environment outside of their natural area of distribution and impact on local ecosystems. Not all marine species introduced into an area have the potential to establish themselves and become a pest. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities.

Studies have found that most introduced marine species are temperate. Of the 60 species known to have become established in WA, only six are tropical species that occur north of Shark Bay (Wells *et al*., 2009). Most introduced marine species are concentrated in port areas and relatively few have expanded their range beyond these presumed introductory points (Wells *et al.*, 2009). Consequently, the introduced marine pests that have established themselves in WA marine waters have, so far, only resulted in changes to faunal assemblages of highly localised port areas, with few repercussions for the broader marine environment.

Introduced marine species are generally found in shallow coastal locations and generally utilise hard substrata on which to settle.

Values and sensitivities within the Operational Area are limited to soft sediment benthic habitats that are widespread and homogenous in the NWMR. Remote Operated Vehicle (ROV) surveys on the NWS, at similar water depths to those in the Operational Area, have indicated a sea floor is comprised of fine silt/sand substrates (RPS, 2012 unpublished data) (Section 4.3.2.1).

Due to the deep-water, open-ocean environment at the Wandoo facilities, it is anticipated there will be little potential for pest organisms to accumulate and multiply due to lack of habitat. The greatest potential for the introduction of a marine pest species is the colonisation of subsea infrastructure by fouling organisms, particularly sessile invertebrates or marine algae closer to the sea surface, where light availability is greater.

Natural dispersal barriers such as water currents or wave exposure are however likely to reduce densities of IMS larvae or algal spores by limiting successful reproduction and establishment of founder populations, whereby IMS is dispersed too far apart for successful reproduction and establishment of a population (Forrest *et al.,* 2009).

Due to the relative isolation of the Operational Area, any introduction is likely to remain localised.

6.17.4 Control measures

MODU and vessel ballast water will be managed in accordance with the Australian Ballast Water Requirements (DAWR 2017) and the Biosecurity Act 2015.

Biofouling will be managed through MODU and vessel and equipment risk assessments and mitigation measures, in accordance with the National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2018).

If an internationally or domestically sourced MODU or vessel is used, a biofouling risk assessment will be completed by VOGA that is aligned with National Biofouling Guidelines for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009) and the Western Australian Department of Fisheries Biofouling Risk Assessment Tool.

The assessment will include aspects of the vessels history with respect to IMS risk e.g. MODU/vessels origin and previous locations of operation (including whether these locations have reported IMS occurrences), periods out-of-water and inspections/cleaning undertaken, age of anti-fouling coatings, presence and condition of internal treatment systems etc.

Based on the outcomes of each IMS risk assessment, management measures commensurate with the risk (such as the treatment of internal systems, IMS inspections or cleaning) will be implemented to minimise the likelihood of IMS being introduced.

6.17.5 ALARP demonstration

An alternative is for VOGA to carry out hull inspections of all MODUs and AHTS vessels that will be used for each campaign, prior to them entering the Operational Area. However, this would require the MODUs and AHTS vessels to be moved to a suitable location for inspection and, given that the MODU and AHTS vessels are already legally required to observe the conditions outlined above, this additional step will not reduce the environmental risks associated with the operations, but it will increase health and safety risks and is not practical from a logistics and cost perspective.

MODU and AHTS vessel inspection or cleaning is not warranted given the mitigation measures in place and the low risk for establishment of marine pests.

Although using only local vessels is possible for the activity, using only a local MODU would result in delays when sourcing an appropriate available MODU. The potential cost and time needed to source a capable MODU locally is disproportionate to the minor environmental gain potentially achieved.

Additional to this, there are known locations within Australia which harbour IMS and could potentially act as a source for the further spread of IMS within Australian regions. Therefore, substituting to the use of a locally available MODU will not provide any environmental benefit.

7 Implementation strategy

7.1 Overview

The primary goals of VOGA's Wandoo Well Construction EP implementation strategy is to direct, review and manage well construction activities so that environmental impacts and risks are continually being managed to ALARP and acceptable levels, and to ensure that performance outcomes and standards are being met over the life of the project.

The VOGA HSE Management System (HSE MS) provides the procedures and practices that will be followed to ensure environmental risks of operations are reduced to ALARP.

The following approaches are used to ensure VOGA's HSE MS, practices and procedures are implemented:

- Activities will be undertaken in accordance with VOGA's HSE MS (Section 7.2.1);
- Activities will be undertaken in accordance with VOGA's HSE Policy (Section 7.2.3);
- Activities will be assessed in accordance with the VOGA Risk Management Manual [VOG-2000-MN-0001] (Section 5);
- Contractors are managed (Section 7.5)
- Roles and responsibilities are outlined (Section 7.6);
- All personnel working in the Operational Area will undertake the VOGA site-specific induction which contains information on the EP, environmental legislation and environmental sensitivities (Section 7.7.1);
- There is ongoing hazard identification and evaluation (7.9)
- Performance outcomes, standards and measurement criteria are implemented (Section 7.8);
- Chemicals used in offshore applications are appropriately managed (7.11)
- An inspection and audit plan developed and implemented (Section 7.15.4);
- Non-conformance and change is appropriately managed (8.5)
- ERPs are in place (Section 7.8.1);
- Spill response will be regularly tested (Section 7.9);
- Environmental performance reporting is undertaken (Section 8);
- There is ongoing engagement with relevant Stakeholders (Section 9); and
- Opportunities for continual improvement are identified (7.13)

7.2 HSE Management System

7.2.1 Overview

The VOGA HSE MS provides the procedures and practices that will be followed to ensure that the environmental risks associated with its activities are reduced to ALARP.

The HSE MS has been developed to be consistent with the requirements of the following standards:

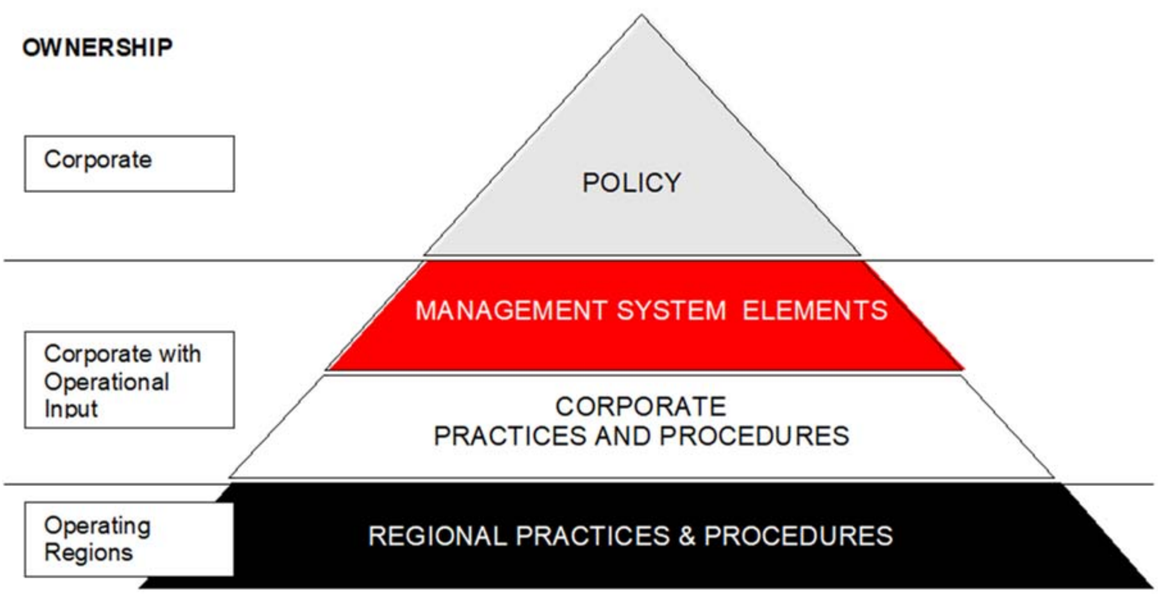
- ISO 14001: Environmental Management System;
- OHSAS 18002:2000 Occupational Health & Safety Management Systems (an international standard equivalent to AS/NZS 4801); and
- API 9100 Model Environmental, Health and Safety Management System.

HSE MS is also consistent with AS/NZS 4360:2004 Risk Management although it has not been developed specifically to meet that standard.

7.2.2 Structure

The following section describes the structure of the HSE MS, how it integrates top level management through to operational activities on the facilities, and how the elements of the HSE MS are linked in a logical manner to all activities. The overall HSE MS documentation hierarchy is illustrated in Figure 7-1.

Figure 7-1: HSE MS Framework



7.2.3 Policy

The VOGA HSE Policy applies to all VOGA activities. The written policy statement provides an overall commitment in terms of key principles for managing health, safety and the environment. The Policy sets the overall HSE intentions of the organisation and contains a commitment to continuous improvement. The Policy is the starting point for setting VOGA's HSE objectives and targets. A copy of VOGA's HSE Policy is provided in VOGA Health, Safety and Environment (HSE) Policy.

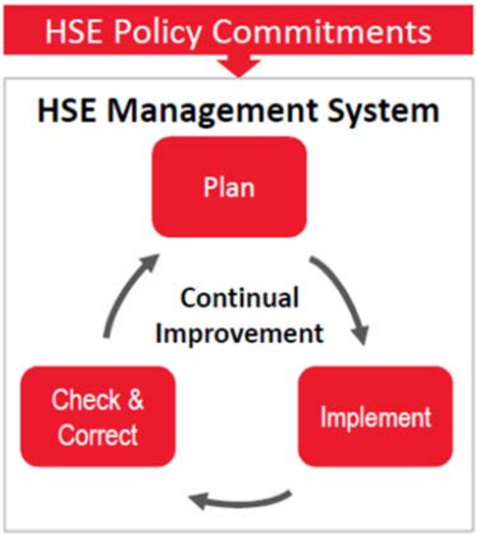
7.2.4 Contents

VOGA has developed an HSE MS that consists of three phases as follows:

- Phase 1: Plan.
- Phase 2: Implement.
- Phase 3: Check and correct.

As outlined in Figure 7-2, the three-phase structure provides a continual improvement feedback cycle consistent with management system concepts that underlie the various standards. Each phase has one or more component element and each element has multiple expectations.

Figure 7-2: Outline of HSE MS Process – Plan-Implement-Check and Correct



The HSE MS is structured into 12 elements as outlined in Table 7-1; each element has been developed within the overall three-phase HSE MS process (Plan-Implement-Check and Correct). As such, each element connects to one or more of the other elements within the overall continual improvement cycle.

Table 7-1: Elements of HSE MS and objectives

Phase	HSE MS Elements	Objectives
Plan	Element 1: Management, Leadership and Policy	Management provides vision, resources and the environment for HSE MS success. All employees understand and are held accountable for the success of HSE MS. Performance excellence in HSE is recognised as a priority and prerequisite to successful business results.
	Element 2: Corporate and Social Responsibility and Communication with Stakeholders	VOGA is committed to protecting health, safety and the environment, and reducing and managing the HSE risks associated with its operations. In doing so, it is important that VOGA commit to an open dialogue with employees, the communities in which they operate, and other relevant stakeholders with respect to HSE issues associated with VOGA operations.
	Element 3: Risk Management	VOGA will ensure that risks are identified and managed to minimise the potential for incidents and liabilities.
	Element 4: MoC	Risks associated with change to personnel, organisations, procedures, practices, designs, facilities and regulatory requirements are identified, evaluated and managed.
Implement	Element 5: Training and Competency	Personnel are required to have the necessary skills and competencies to carry out their responsibilities in a safe and effective manner. Managers will ensure all employees have the appropriate skills and knowledge and will provide training where necessary.
	Element 6: Operations and Maintenance	HSE practices and procedures are necessary for the construction and operation of each asset. Practices and procedures are prescriptive "how to's" of job tasks. The purpose of this element is to identify the requirements for practices and procedures necessary for each business/facility to ensure employees, contractors, the general public and the environment are protected from accidents/incidents.
	Element 7: Contractor Management and Procurement	It is important that controls are in place to ensure that activities undertaken by contractors, vendors and service providers are carried out in an efficient, safe and environmentally responsible manner.
	Element 8: Emergency Preparedness Management and Response	All operating areas have the necessary ERPs, skills and equipment to respond quickly to any emergency associated with our operations.
	Element 9: Incident Management	Reporting, investigating, analysing, follow-up and sharing information from incidents (and near misses) are used to minimise future occurrences.
	Element 10: Security Management	VOGA protects its people and assets from security risks and threats.
	Element 11: Documentation and Records	Operating regions ensure relevant documentation and records required to meet regulatory and VOGA business entity internal performance requirements, are maintained, organised and accessible.
Check and correct	Element 12: Performance Assessment	Continual improvement is assured through regular assessments, audits and reports to management.

7.2.5 Review of the HSE MS

To ensure ongoing effectiveness and continual improvement of the HSE MS, VOGA and Vermilion Energy Inc. periodically review the elements of the HSE MS, including Element 12. This review process is intended to provide a mechanism for making changes to the HSE MS as necessary to achieve the organisational goals and meet the expectations of stakeholders. VOGA and Vermilion Energy Inc. Senior Management review VOGA HSE MS performance in order to achieve the following:

- determine its continuing suitability, adequacy and effectiveness;
- address possible needs for changes to the HSE Policy, procedures, objectives, targets and other elements of the management system; and
- identify opportunities for continual improvement.

VOGA and Vermilion Energy Inc. Senior Management review the effectiveness of the VOGA management system and provide formal feedback to assure continual improvement through:

- an annual review of VOGA HSE MS performance;
- monthly review of HSE KPIs;
- incident reports (as required); and
- audit reports (as required).

Checklists detailing content, inputs and outputs of the annual review and monthly review of HSE KPIs are provided in Appendix B and Appendix C of the Management System Manual: Performance Assessment [VOG-1100-YG-1201].

7.3 Implementation of controls

7.3.1 Well Construction Management System

All activities carried out during the planning and execution of well construction campaigns are carried out in accordance with VOGA's HSE MS. However, the HSE MS is focused on the design, operation and maintenance of production operation systems. As such it does not provide the appropriate focus for management of well construction operations. The WCMS was created to provide a structure that is consistent with the HSE MS but focused on guiding the safe and efficient management and execution of well construction activities. The WCMS is directly aligned to the HSE MS. It is headed by the VOGA HSE Policy and meets the objectives of each HSE MS Element. The objectives attached to each element of the HSE MS are detailed in Table 7-2, along with a description of how the WCMS meets these objectives.

In addition to execution of activities in accordance with VOGA's WCMS, well construction operations must also be carried out in accordance with the MODU Contractor's management systems. To ensure compliance with both management systems, they are aligned through the facility Safety Case Revisions.

Table 7-2: Elements of HSE MS/WCMS and objectives

HSE MS/WCMS elements	HSE MS/WCMS objectives	Well construction expectations
Element 1: Management, Leadership and Policy	Management provides vision, resources and the environment for HSE MS success. All employees understand and are held accountable for the success of HSE MS. Performance excellence in HSE is recognised as a priority and prerequisite to successful business results.	The Well Construction Manager and Drilling Superintendent demonstrate visible leadership and proactive commitment to HSE performance through personal example. Management are expected to visit the MODU at least once a month during a campaign, to interact with the workforce and observe operational practices. Refer to Section 7.3.5
Element 2: Corporate and Social Responsibility and Communication with Stakeholders	VOGA is committed to protecting health, safety and the environment, and reducing and managing the HSE risks associated with its operations. In doing so, it is important that VOGA commit to an open dialogue with employees, the communities in which they operate, and other relevant stakeholders with respect to HSE issues associated with VOGA operations.	Operations will only be carried out when residual risk associated with known hazards is reduced to ALARP to protect health safety and the environment. VOGA has a process for managing external communications with relevant persons during the well construction process. There is also a process in place to respond to public concerns related to HSE issues (Sections 7.4 and 9).
Element 3: Risk Management	VOGA will ensure that risks are identified and managed to minimise the potential for incidents and liabilities.	Well construction activities will be undertaken in accordance with VOGA Risk Management Manual [VOG-2000-MN-0001] (Section 5). Separate HAZID and HAZOP assessments are held for all well construction activities and a project specific Risk Register will be maintained. This is to ensure the environmental impacts and risk of the activity continues to be identified and reduced to ALARP. Further details are provided in Section 6. A project specific Commitments Register will also be developed for all well construction projects (Section 7.4.2).
Element 4: Management of Change	Risks associated with change to personnel, organisations, procedures, practices, designs, facilities and regulatory requirements are identified, evaluated and managed.	The Well Construction Management of Change Process (MOC) meets the expectations of the HSE MS by ensuring that any changes to well construction operations are managed to ensure that the HSE risks arising remain at an acceptable level. This process will be followed throughout well construction activities. Further details on the MOC process are provided in Section 7.5.

HSE MS/WCMS elements	HSE MS/WCMS objectives	Well construction expectations
Element 5: Training and Competency	Personnel are required to have the necessary skills and competencies to carry out their responsibilities in a safe and effective manner. Managers will ensure all employees have the appropriate skills and knowledge, and will provide training where necessary.	The Well Construction Manager has responsibility for ensuring the competency of personnel for each position in the VOGA well construction team and for providing required training to close any identified competency gaps within the team. Further details on training and competency are provided in Section 7.3.6.
Element 6: Operation and Maintenance	HSE practices and procedures are in place for each business/facility to ensure employees, contractors, the general public and the environment are protected from accidents/incidents.	All well construction campaigns are planned and executed in accordance with the Well Construction Process Manual. Wells are designed and constructed in accordance with the Well Construction Standards Manual (refer to Section 7.3.2).
Element 7: Contractor Management and Procurement	Controls are in place to ensure that activities undertaken by contractors, vendors and service providers are carried out in an efficient, safe and environmentally responsible manner.	Contractors and vendors will be selected in accordance with the VOGA Contractor and Vendor Selection and Management Manual [VOG-1000-MN-0001]. Each high risk contractor is assessed to ensure they meet a minimum level of service capability inclusive of management systems to ensure acceptable QHSE performance and personnel competency. Further detail is provided in Section 7.3.4.
Element 8: Emergency Preparedness and Response	All operating areas have the necessary emergency response plans, skills and equipment to respond quickly to any emergency associated with our operations.	The following emergency response documents are revised during the Detailed Design Planning Phase of well construction: • Emergency Response Plan [VOG-2000-RD-0017]; • Oil Spill Contingency Plan [WAN-2000-RD-0001]; and • Source Control Contingency Plan [WNB-3000-PD-0007]. These documents include plans for managing credible unplanned incidents, emergency response and recovery. Further details are provided in (Section 7.7).
Element 9: Incident Management	Reporting, investigating, analysing, follow-up and sharing information from incidents (and near misses) are used to minimise future occurrences.	All incidents and near misses are systematically reported, investigated and corrective and preventative actions undertaken in accordance with the Event Management Manual [VOG-2000-MN-0003]. On VOGA contracted rigs, all incidents and accidents are investigated in accordance with the Drilling Contractor Safety Management System which has been reviewed for alignment with VOGA expectations. Further details are provided in Section 8.

HSE MS/WCMS elements	HSE MS/WCMS objectives	Well construction expectations
Element 10: Security Management	VOGA protects its people and assets from security risks and threats.	Potential risks to security during the well construction campaigns and any prevention or mitigation strategies are reviewed as part of the development of the project-specific Risk Registers.
Element 11: Information Management	Operating regions ensure relevant documentation and records required to meet regulatory and VOGA business entity internal performance requirements are maintained, organised and accessible.	Critical well construction documents will be issued and maintained under the VOGA Document Management System.
Element 12: Performance Assessment	Continual improvement is assured through regular assessments, audits and reports to management.	A program of internal and external inspections and audits will be established to ensure, regulatory, corporate and company commitments including performance standards and outcomes outlined in the EP are being met during the well construction campaigns. Further details of inspections and audits are provided in Section 7.9.

7.3.2 Well Control

VOGA designs its wells and plans and executes its well construction and intervention operations in a manner that complies with its Well Construction Management System (WCMS).

One of the major environmental hazards associated with well construction activities is the potential for loss of well control. The WCMS specifies engineering standards and well design and operational practices to be implemented during the planning, design and execution phases of a well construction campaign to mitigate the risks associated with the activities are reduced to ALARP for the life of a well.

Key elements are:

- **Well integrity critical equipment (e.g. casing, tubing, Xmas Tree, safety valve, etc.) selection**: The equipment specification and operational processes ensure that the well integrity critical equipment installed in a well or used during the well construction process provides a suitable pressure envelope for well integrity purposes;
- **Well cementing design**: The well design and operational processes ensure that casing strings are adequately cemented into the well to provide a suitable annular pressure envelope for well integrity purposes;
- **Drilling fluids:** The well design and operational processes ensures that fluids are specified and maintained such that primary well control is maintained at all times during well construction activities; and
- **Directional drilling**: The well design and operational processes ensure that well bore positioning is planned and executed in a manner that ensures collisions with other wells are avoided.

VOGA's WCMS provides a structured approach to the engineering, design, planning and preparation for well construction and intervention operations. This process enables the activities to be carried out in a manner that provides a safe working environment for its employees and contractors and ensures that potential environmental impacts are reduced.

A critical component of the well design, operational planning and execution processes is to ensure that the risks that could have a material impact on project success, health, safety and/or the environment are identified.

Risks are captured in the Project Risk Register, which is maintained as a living document throughout the planning process (Risk Management Process). Risk review and HAZID workshops, involving both VOGA and contractor personnel, are used throughout the planning process to assess the risks and controls associated with specific activities. This allows appropriate risk mitigation strategies to be put in place, where relevant, as the operations programs are prepared, thus ensuring that residual risk associated with the planned activities are reduced to ALARP.

The Well Construction Standards Manual (WCSM) [VOG-5000-MN-003], a key reference document within the VOGA WCMS, specifies the required barrier standards to be applied during the well design and operational planning and execution processes.

Relevant performance standards have been identified and are associated with the management controls for loss of well control which are documented in the Performance Standard WAN-WNAB-CP-PR-06 Well Construction - Well Control.

Deviation from the VOGA standards is managed in accordance with the documented Management of Change process.

Peer review and Drill Well on Paper workshops are held with both internal and external peers to review well designs and operations plans and risks (and to identify potential improvements prior to operations).

Performance monitoring is used throughout the planning and execution phases to provide assurance that the required controls are established:

- Critical controls are subject to performance verification and monitoring and deviation management processes to ensure continual management of risk to ALARP;
- The campaign-specific Commitments Register identifies commitments made under the WCMS, campaign-specific Safety Case Revisions, EPs and other relevant campaign documents. Ongoing update and review of the Commitments Register provides VOGA management with assurance that campaign commitments are being met;
- MODU equipment and MODU Contractor management systems are assessed during pre-hire inspections and management system audits;
- Pre-start MODU inspection and audit processes ensure that well and pressure control and monitoring equipment is present on the rig and is maintained and functioning. VOGA audits contractors to ensure fit-for-purpose well and pressure control equipment is provided and that the contractors' PMS includes their well and pressure control equipment; and
- Well and pressure control equipment testing requirements have been met and the relevant testing has been verified by a senior member of the MODU Contractor and VOGA offshore supervisory teams.

In addition, VOGA conducts internal reviews to demonstrate compliance with its WCMS.

Application of the well design and operational planning and execution processes ensure that project risks are identified and appropriately managed, reducing the residual risk associated with the planned activities to ALARP.

7.3.3 Operational controls and recovery mechanisms

VOGA's WCMS provides a structured approach to the management of operations, ensuring that:

- operations are carried out while ensuring that commitments made under the VOGA management system, the Facility Safety Cases and the Project Simultaneous Operations (SIMOPS) Plan are met; and
- change is managed in accordance with the Change Management Process.

Operating in accordance with the MODU's Safety Case and VOGA's operating standards ensures:

- The various controls associated with maintaining well integrity are in place. This includes ensuring that well control equipment and well barriers are tested and verified, and well control drills are regularly carried out to ensure personnel react instinctively at critical times;
- VOGA's barrier verification process is applied, which provides assurance to all stakeholders that well integrity is being managed in accordance with the VOGA Well Construction Standards Manual. This confirms that a minimum of two independent and verified barriers are in place at all times in order to prevent the uncontrolled release of well fluids to the environment; and
- Management of Change procedures are applied to ensure that a rigorous process is followed to assess and manage any risk associated with changes to designs or plans and their potential impact on related critical control measures.

7.3.4 Contractor management and procurement

7.3.4.1 *Contractor selection*

The manner in which VOGA executes its well construction activities means that many risks are embedded in activities and processes that are controlled and progressed by service or contractor organisations and contractor personnel. VOGA selects well construction contractors and service providers in accordance with the VOGA Contractor and Vendor Selection and Management Manual [VOG-1000-MN-0001]. Each high-risk contractor is assessed to ensure they meet a minimum level of service capability, inclusive of management systems to ensure acceptable QHSE performance and personnel competency. If shortcomings are identified during the assessment process, they are reviewed with the contractor in question and, where necessary, management processes are applied to address critical areas of concern.

When carrying out activities on a VOGA-contracted MODU, all contractors are required to work in accordance with the MODU and Wandoo Facility Safety Case Revisions for which compliance with the HSE MS and this EP are fundamental requirements.

VOGA requires that:

- the specifications of equipment or materials that have potential QHSE impacts are reviewed to verify suitability for the intended use and to mitigate against the introduction of additional risks;
- all requisitions for materials and equipment specify, where relevant, appropriate certification and inspection requirements; and
- induction programs are in place to ensure that personnel are aware of the management systems in use during the operations and to communicate any major HSE risks and their management strategies.

VOGA commissions pre-mobilisation inspections of the MODU and vessels to ensure their compliance with applicable standards and contractor management systems and to confirm that they can operate in a safe and environmentally responsible manner. Further detail on inspections and audits undertaken is provided in Section 6.13.

7.3.4.2 *Procurement*

The VOGA Well Construction Standards Manual [VOG-5000-MN-0003] stipulates the technical standards to be applied for the design, manufacture and testing of equipment used during well construction operations. All Purchase Orders specify the technical standards to be applied during the design, manufacture and testing process.

VOGA's wells are designed from a life-of-field perspective in accordance with sound engineering principles and to comply with relevant legislative requirements. VOGA utilises existing API or ISO standards as a basis for equipment and material specification rather than developing VOGA specific standards.

For well integrity critical equipment, VOGA only procure or rent equipment that meets relevant API or ISO standards. The relevant standards for the various equipment types used during VOGA's well construction and intervention activities are specified in the VOGA Well Construction Standards Manual.

Independent third party validation of the application of a manufacturer's quality assurance system is carried throughout the manufacturing process for any critical equipment purchased by VOGA for installation during a well construction operation.

VOGA uses internal resources, or contracts third party QA/QC specialists, to supervise the inspection and testing of well integrity critical equipment during its manufacture, or during its preparation for operations. This process provides assurance that the well integrity critical equipment used in VOGA's well construction process conforms to VOGA's specified standards. As such, the process ensures that the residual risk associated with the failure of well integrity critical equipment has been reduced to ALARP.

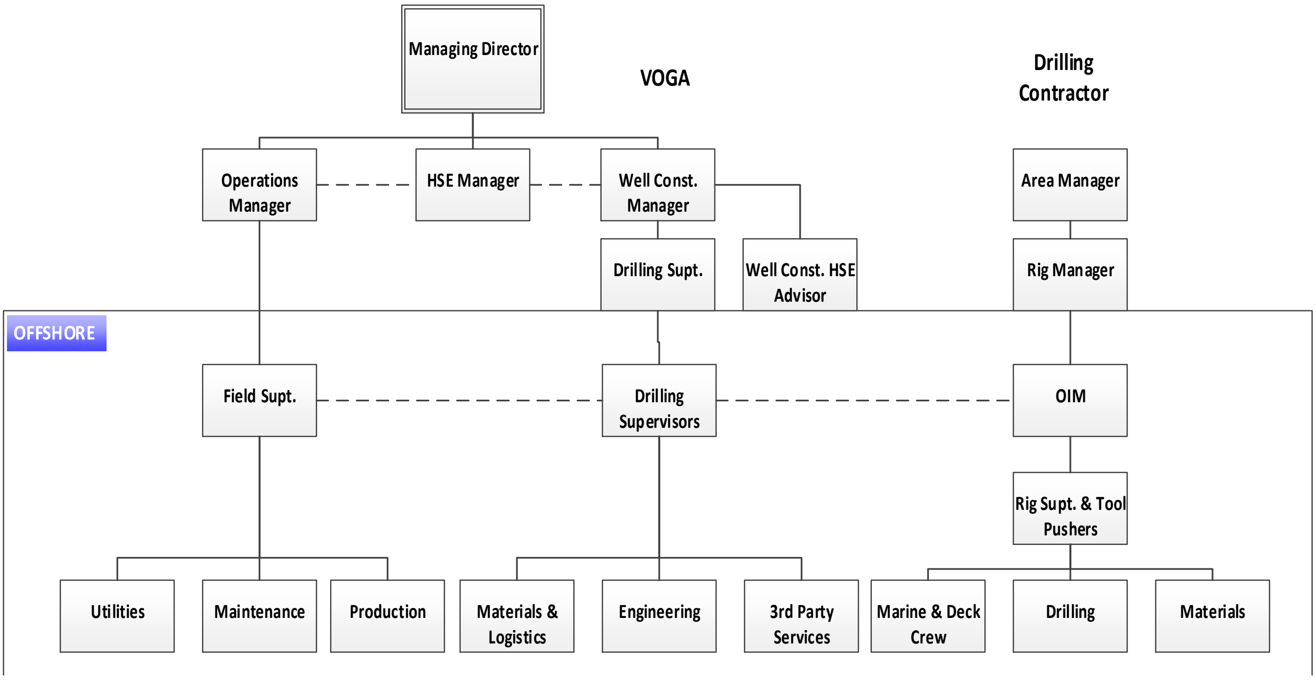
VOGA requires all new or refurbished critical equipment to be supplied with manufacturer/ supplier's Certificate of Conformance to demonstrate compliance with design, manufacturing and testing specifications.

7.3.5 Key roles and responsibilities

Key roles and responsibilities for VOGA and its contractors have been identified for future well construction activities to ensure all elements of the EP Implementation Strategy are effectively applied.

The organisational chart (Figure 7-3) indicates the relevant key personnel for a well construction project.

Figure 7-3: Combined organisation chart – VOGA and MODU



A description of the roles and responsibilities of the key positions within the organisational chart are outlined in Table 7-3.

Table 7-3: Environment Plan key roles and responsibilities

Role	Responsibility
VOGA Managing Director	Review and approve EP and OSCP. Ensures that appropriate resource and competence levels are available to deliver safe, efficient and effective operations within VOGA's organisation. Ensures overall compliance with the VOGA HSE MS. Ensures overall compliance with the EP and OSCP with advice from the HSES Advisor. Responsible for facilitating an emergency response strategy in the event of an incident.
VOGA Well Construction Manager	Ensures that VOGA's WCMS is applied and maintained. Ensures EP has been accepted by NOPSEMA before activity commences. Ensures compliance with EP. Reviews EP prior to each well construction campaign and confirms that appropriate performance outcomes, standards and measurement criteria are in place for all identified environmental risks.

Role	Responsibility
	Ensures that all well construction personnel (including contractors) are aware of their responsibilities in regard to ensuring compliance with the Commitments Register and that processes are in place to meet them. Oversees all aspects of contracting, procurement, logistics, QHSE, planning, design, execution and review for well construction and intervention activities. Ensures appropriate resources and competence levels are available to deliver safe, efficient and effective well construction and intervention activities. Ensures that effective emergency response systems are in place for well construction operations. Ensures that VOGA's stated obligations are met during all well construction and intervention activities. Ensures that the policies and procedures of the various well construction and intervention contractor companies are consistent with the VOGA Management Systems. Ensures that project objectives are clearly communicated to all well construction personnel including contractors. Ensures activities specified in the project specific Commitments Register are appropriately closed out. Ensures that all significant changes that may increase risk to environment are managed via the Well Construction MOC Process. Ensures NOPSEMA notified at least 10 days prior to the commencement and within 10 days after the completion of well construction activities.
VOGA Well Construction QHSE Advisor	Coordinates the QHSE process associated with the planning, design, execution and review for well construction and intervention activities. Assists in the development and ongoing maintenance of VOGA's WCMS components. Assists with the development of this EP. Ensures risk management and change control is implemented in the planning and execution of well construction and intervention activities. Ensures monitoring is undertaken as outlined in the EP. Prepares and ensures delivery of environmental content at inductions. Prepares monthly report to NOPSEMA outlining non-conformances with performance standards for submission by the VOGA HSES Adviser. Leads/participates in incident investigations and analyses. Retains specialist services to assist in the audit and inspection process. Tracks close-out of action items resulting from investigation, audit and review processes. Liaises with the VOGA HSES Advisor for interfaces between the well construction and VOGA management system requirements. Coordinates collation of monthly QHSE statistics and reporting during well construction campaigns. Ensures EP compliance report is prepared and submitted to NOPSEMA. Ensures that any non-conformances are reviewed and the implementation strategy of the EP revised as a result. Participates in review of EP for applicability prior to campaigns. Conducts HSE inductions. Acts as the HSE support in well construction related emergency response events. Participates in emergency response drills.

Role	Responsibility
	Facilitates QHSE interface with contractors and MODU sharing partners. Maintains the project-specific Commitments Register. Approval of chemicals proposed for use at the start of each well construction campaign.
VOGA Drilling Superintendent	Ensures appropriate resources are available on the MODU to deliver safe, efficient and effective well construction and intervention activities. Ensures that contractors have appropriate arrangements necessary for compliance against this EP. Ensures compliance with the provisions of this EP and OSCP by both VOGA and contractor personnel. Reviews the EP to assure all EP related risks are stated and communicated. Ensures that all personnel are inducted to the requirements of this EP. Ensures all audits, reviews, monitoring records identified in this plan are progressed and appropriately reported. Ensures that all environment-related incidents are reported to the Well Construction Manager and the Wandoo Field Superintendent. Assists with ensuring that all environment-related incidents are reported and appropriately analysed for causes. Ensures that all significant changes that may increase risk to environment are managed via the Well Construction MOC Process.
Logistics Coordinator	Ensures all VOGA purchased/supplied materials and equipment for use in well construction and intervention operations meet the standards laid out in the WCMS prior to acceptance and dispatch. Maintains records of independent review and inspection activities associated with the purchase/supply of materials and equipment. Ensures appropriate logistical resources are available in the field and in the supply base to deliver safe, efficient and effective well construction and intervention activities. Coordinates the efficient unloading of materials and unloading of waste in accordance with procedures outlined in the EP.
Wandoo Field Superintendent	Ensures compliance with VOGA HSE MS, EP and OSCP. Leads/participates in audits and inspections. Ensures that environmental incidents are: reported to statutory authorities; reported to the VOGA Managing Director, the VOGA Operations Manager, the VOGA Well Construction Manager and the VOGA Well Construction QHSE Advisor; and also ensures that incident investigations are conducted and corrective actions are completed. Ensures drills and exercises for emergency response are completed. Ensures corrective actions arising from audits and emergency response drills are complete. Manages coordinating and controlling of all field operational activities (production, maintenance, procurement and logistics). Acts as Permit to Work custodian, in accordance with the project-specific SIMOPS Plan, for well construction and intervention activities and ensures that the potential impact of a SIMOPS environment is considered during the preparations for all activities. Provides leadership and stewardship for environment protection.

Role	Responsibility
	Meets all operational and HSE Key Performance Indicators (KPIs) as set by VOGA. Executes duties as the emergency commander during emergency response.
VOGA Drilling Supervisor	Supports the induction of the offshore supervisory team. Implements the MODU-based elements of the campaign audit plan and environment commitment schedule. Provides primary liaison and interface management between the MODU Offshore Installation Manager and the Wandoo Field Superintendent for implementing the campaign-specific SIMOPS Plan. Manages the offshore aspects of well construction operations to meet QHSE and project objectives. Ensures that the VOGA WCMS is actively implemented during operations. Ensures that all HSE and operational commitments are met and standards are adhered to. Ensures that the deviations to well programs are managed in accordance with the Well Construction MOC process. Works with the AHTS vessel masters to ensure a very high focus is placed on HSE for all vessel activities while they are operating for VOGA. Monitors relevant critical risk controls and ensuring that these are in place and effective prior to the commencement of activities. This includes ensuring that the commitments made in the VOGA management systems, the Wandoo Field Safety Case update, the MODU Safety Case Revision and the campaign-specific SIMOPS Plan are honoured and that MODU-related actions in the Project Commitments Register are closed out as required. Provides technical and logistical support to the Offshore Installation Manager during emergency response or incident management. Leads the MODU-based QHSE audit and review activities and ensuring close-out of action items resulting from investigations, audits and review processes.
MODU (Rig) Offshore Installation Manager	Ensures all operations carried out on-board the MODU are consistent with environmental legislative requirements and ensures compliance with the requirements laid out in this EP. Notifies the VOGA Drilling Supervisor of any deviations from VOGA Well Construction EP performance standards for MODU-based risk controls measures. Ensures monitoring is undertaken in accordance with EP requirements. Ensures that personnel appointed to positions with responsibility for emergency response (including well control) are trained and competent to fulfil those responsibilities and are familiar with the MODU’s emergency response equipment (including that associated with well control). Ensures corrective actions identified during environmental audits are implemented. Implements the MODU’s Well Control Plan as defined in the company’s Well Control Procedures and the company emergency response plans. Ensures that the MODU Contractor’s HSE MS are implemented and effective. Provides input to EP and OSCP if required. Reports all incidents to the Wandoo Field Superintendent and the VOGA Drilling Supervisor.

Role	Responsibility
MODU (Rig) Manager	Ensures that the MODU Contractor's HSE MS is implemented and effective on the MODU. Ensures that the MODU Contractor's HSE MS will meet the requirements of this EP. Ensures that the environmental performance data is collected and reported in accordance with this EP. Conducts audits and reviews in accordance with the MODU Contractor's HSE MS. Provides leadership and stewardship with respect to performance against this EP. Provides input to EP and OSCP as required.
Vessel master	Ensures that all operations on board the vessel are carried out in accordance with environmental legislative requirements, commitments, conditions and procedures as provided in this EP. Ensures monitoring is undertaken in accordance with EP requirements. Report all incidents to the VOGA Drilling Supervisor. Provides input to EP and OSCP as required.

7.3.6 Training and competency

The Well Construction Manager has responsibility for ensuring the competency of personnel and for providing required training to close any identified competency gaps within the well construction team. The Well Construction Manager ensures that HSE awareness and commitment are an integral part of team selection and subsequent training, and that a process is in place to ensure employees, contractors and visitors are aware of relevant hazards, risks and controls.

The Well Construction Process Manual [VOG-5000-MN-0002] describes a process for selecting a competent and fully trained well construction team for each campaign. Responsibilities are assigned in the Well Construction Process Manual to ensure that single-point accountabilities exist for the execution of essential activities, thereby ensuring that vital work necessary for the maintenance of controls is not overlooked.

Expectations are that:

- HSE critical positions are identified;
- job descriptions, which clearly describe individual responsibility towards HSE, are agreed with key department personnel;
- personnel are competent in their assigned roles or tasks;
- all personnel hold relevant qualifications, certification and experience for their job;
- induction programs are in place to ensure all personnel are aware of any major HSE hazards and the management systems in operation at their site; and
- VOGA staff are appraised for their performance, including HSE performance.

7.3.6.1 *Induction*

All personnel working in VOGA's well construction campaigns will receive an induction that provides the following information:

- VOGA's HSE Policy;

- An overview of the VOGA HSE MS, WCMS and EP with particular emphasis on performance outcomes, standards and measures;
- Major project risks and their associated mitigation strategies;
- Emergency response roles and responsibilities;
- Regulatory and procedural requirements;

Inductions will be conducted at the following locations:

- **VOGA Perth Office** – to communicate and assign responsibility for office-based EP performance standards;
- **VOGA Supply Base/AHTS vessel** – to communicate expectations to Supply Base personnel and AHTS vessel crews are aware of relevant EP performance standards (Supply Base Manager and Vessel Master to assign specific responsibilities) and emergency response roles and responsibilities;
- **MODU** – to communicate expectations to all personnel on board and assign responsibilities for MODU-based EP performance standards and emergency response roles and responsibilities; and
- **Ongoing awareness** will be maintained through discussion at Pre-Tour Meetings, daily SIMOPS Coordination Meetings, weekly HSE meetings and weekly contractor communication meetings.

7.3.6.2 *Competence of Personnel*

VOGA assures the competence of personnel working on its operations through a combination of the verification of personal knowledge, qualifications and training, and through the provision of additional project specific training.

VOGA requires that their contractors demonstrate that they operate under a competency management system that ensures their personnel are competent for their assigned positions. More specifically, the Drilling Contractor’s personnel must be compliant with the competency matrix defined within the MODU Safety Case.

VOGA’s senior well construction personnel and the MODU Contractor’s MODU-based senior drilling personnel must maintain current well control certification from the International Well Control Forum (IWCF) or International Association of Drilling Contractors (IADC) accreditation organisations, providing an internationally recognised level of well control competence assurance.

VOGA and the Drilling Contractor conduct inductions for personnel coming onto the MODU to communicate the project objectives along with risks and specific controls to ensure that the activities described in the Well Construction Program are achieved safely.

During operations, drills are conducted in accordance with the MODU Safety Case to ensure that personnel react promptly to changes in well parameters, suspend operations and, if necessary, shut-in the well without deferring to a higher authority.

The combination of competence assurance, induction and drills demonstrate that personnel working on VOGA’s well construction operations are competent, providing a key element towards ensuring that safety, environmental and well integrity related risks are managed to ALARP.

7.3.7 Chemical assessment process

VOGA has a chemical assessment and selection process to manage the risks and impacts associated with discharge of chemicals to the marine environment to ALARP during well construction activities.

VOGA uses the chemical ranking scheme developed through the OSPAR Commission decision 2000/2 and the OSPAR list of substances considered to PLONOR to the environment to determine the risk of discharge of chemicals to the environment in order to select the lowest toxicity chemicals practicable.

Under the OSPAR list, chemicals are ranked using the CHARM model. The CHARM model calculates the ratio of Predicted Effect Concentration against Predicted No Effect Concentration (PEC:PNEC). This is expressed as a HQ, which is then used to rank the product. HQ is converted to a colour banding to denote its environmental hazard (refer to Figure 7-4) which is then published on the Definitive Ranked Lists of Approved Products by the OCNS.

Products not applicable to the CHARM model (i.e. inorganic substances, hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping, A-E. Group A includes products considered to have the greatest potential environmental hazard and Group E the least.

Any chemical that will be discharged to the marine environment during well construction activities shall meet at least one of the following criteria:

- The chemical is listed on the OSPAR List of Substances Used and Discharged Offshore which are considered to PLONOR; or
- The chemical has a HQ banding of Gold or Silver or an OCNS grouping of E or D in accordance with the OCNS Definitive Ranked List of Registered Substances.

Chemicals planned for use during well construction operations will be listed with their classifications in the campaign fluids program.

If the chemical is not OCNS listed the ecotoxicity data will be assessed in accordance with the OCNS system. The OCNS system requires bioaccumulation, biodegradation and aquatic toxicity data from relevant species such as algae, crustacea or fish to be assessed. Once appropriate ecotoxicity values are obtained they will be evaluated against the OCNS grouping data.

An ALARP justification is required for any chemicals not OCNS listed, if listed with a substitution warning, if there is no available ecotoxicity data, or if ecotoxicity is available but:

- LC50 <10 mg/l or EC50 <10 mg/l;
- the bioaccumulation octanol-water partition coefficient (log Pow)>3; or
- the percentage biodegradation within 28 days is <20%.

The ALARP justification assesses the chemical requiring approval and available alternative options in accordance with the following factors (in order of priority):

- Health and safety criteria (Dangerous Goods Class and Safe Work Australia risk phases);

- Ecotoxicity criteria (aquatic toxicity, bioaccumulation and biodegradation data for relevant species);
- Effectiveness on Wandoo process; and
- Cost.

The change of chemical will be risk assessed and documented in a MOC and will be approved by the VOGA Well Construction Manager.

Figure 7-4: OCNS HQ and colour bands

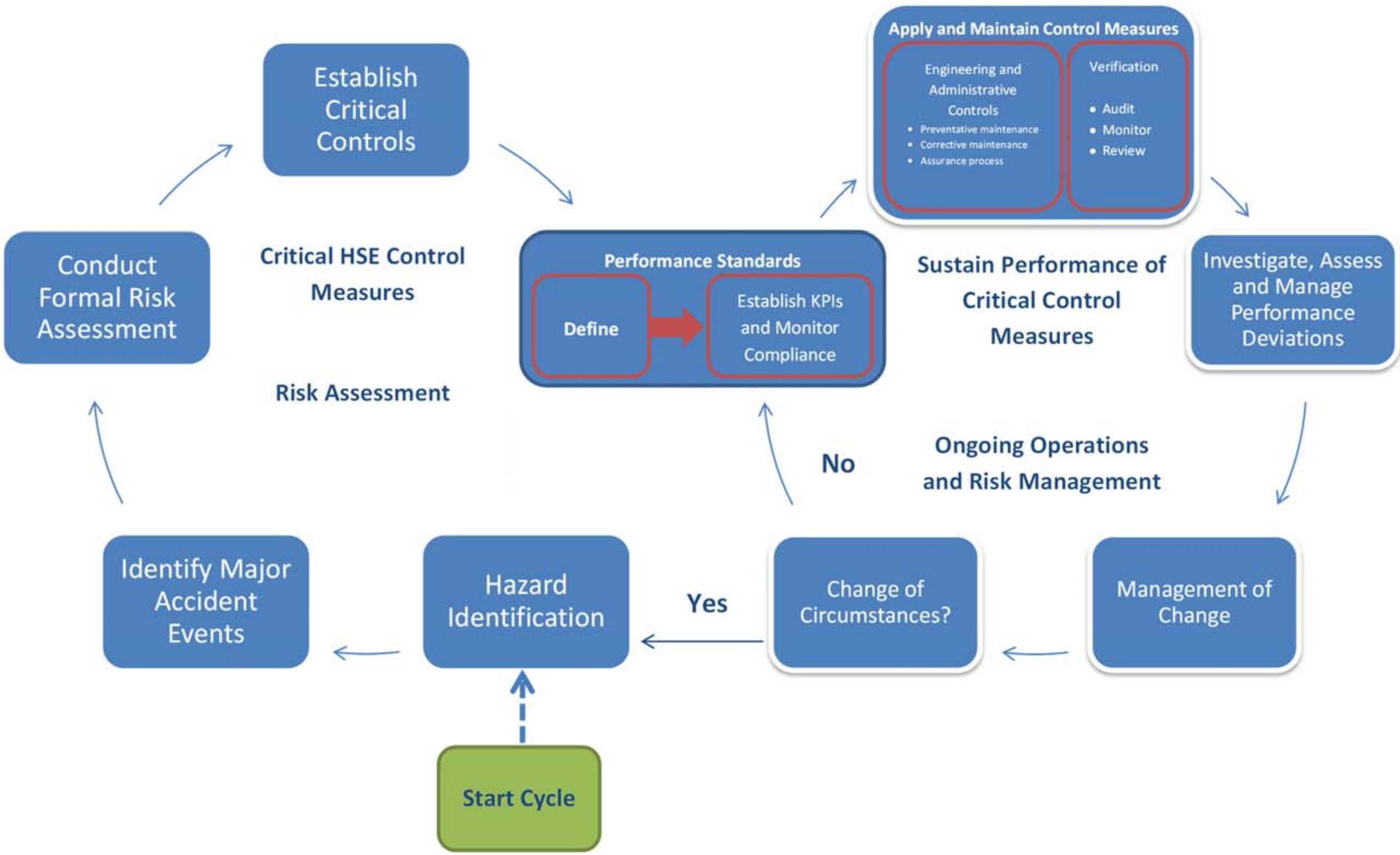
Minimum HQ value	Maximum HQ value	Colour banding	
>0	<1	Gold	Lowest hazard
≥1	<30	Silver	
≥30	<100	White	
≥100	<300	Blue	
≥300	<1000	Orange	
≥1000		Purple	Highest hazard

7.3.8 Managing critical controls

The process of defining and determining VOGA's performance outcomes, standards and measurement criteria are defined in Section 5. The implementation framework is based on the right-hand side loop of the Performance Standards cycle in Figure 7-5, 'Sustain Performance of Critical Control Measures,' as part of the Ongoing Operations and Risk Management component of the performance improvement process (Figure 7-5). The framework includes four key areas:

- **Apply and maintain control measures**: Addressed through the implementation of VOGA's HSE MS and operations and maintenance routines;
- **Verify and monitor compliance**: Conducted using the Wandoo Well Construction EP Commitment Register. This is discussed in Section 7.4.2;
- **Investigate, assess and manage performance deviations**: When a control fails to meet its defined performance standard the Well Construction team utilises the MoC process to assess the change in risk and identify appropriate risk management strategies;
- **Management of change**: Changes to the facility for operational purposed, changes due to investigation into a performance deviation and changes to performance standards themselves are all assessed through VOGA's MoC process which addresses the potential impact of the change to the environment. This is discussed in Section 7.5.

Figure 7-5: Performance standards and continuous improvement (adapted from NOPSEMA's Control Measures and Performance Standards' Guidance Notes, 2011)



7.3.9 Hazard identification and evaluation (ongoing)

Project risks, including environmental risks, are managed during the well construction process in accordance with the principles of AS/NZS ISO31000:2009, the requirements of the OPGGS(E)R and the VOGA Risk Management Manual [VOG-2000-MN-0001] and is in line with the requirements of the OPGGS(E)R. The Risk Management Process is described in the Well Construction Process Manual and in Section 5 of this EP.

Activity-related risks are reviewed during all phases of the project. The WCMS identifies 11 points of planning reference for identification, review of and management of risks. The Risk Management Process runs in parallel with the well construction core processes and interfaces with them at various key stages.

7.3.9.1 *Planning phase*

Separate HAZID and HAZOP assessments are held for all planned wells, sequences of similar wells, or well intervention activities to identify hazards and establish mitigation measures and contingency plan requirements that are specific to the project or well.

Environmental hazards and their respective controls have been documented in Section 5 of this EP along with the associated performance standards and measurement criteria. This forms the pre-operational risk assessment process.

7.3.9.2 *Operational phase*

During well construction operations, risk management is achieved through routine and programmed activities and utilises the following tools to maintain environmental awareness for personnel working in the Field:

- Daily pre-job meetings are held on the MODU prior to crews commencing work for the day. During this meeting operational and HSE issues and opportunities for improvement are discussed. Personnel are required to sign an attendance sheet;

- JSAs are carried out for new and critical activities to ensure personnel involved are aware of the planned activities, their roles and the associated operational and HSE risks and mitigation strategies;

- Toolbox meetings are held on a task based/as required basis to review a planned task and any controls required. This provides the crew members with clear directions and an opportunity to suggest improvements;

- A safety observation system will be in place on the MODU to identify report and manage exposures as well as to compliment positive behaviour. The process provides a feedback loop from the workforce which is reviewed by VOGA and MODU management on a daily basis; and

- A lessons learned action tracking system is maintained during the project to provide input into after action reviews and assist in continuous improvement in VOGAs well construction operations.

During well construction and intervention operations, changes to planned operations may be required. VOGA applies a Well Construction MOC process to evaluate potential changes to an approved well program. The process assesses the impact of the change on:

- the operational and HSE risks profiles of the task and/or any dependent tasks;
- safety and well integrity critical controls;
- level of authorisation required for approval of the change; and
- to determine if the deviation should be progressed or declined.

7.3.9.3 *Review phase*

VOGA reviews operational and HSE performance at the conclusion of each campaign to ensure key learning points are captured for future projects and to ensure incidents have been adequately closed out and audit actions have been addressed. Environmental performance is reviewed and any identified opportunities for improvement are incorporated into subsequent well construction planning and revisions to this EP.

7.4 Monitoring and review

7.4.1 Overview

VOGA recognises that an effective 'monitoring and review' process is an essential part of an overall risk management process. Monitoring and review is applied to achieve environmental performance outcomes and commitments identified within the EP.

VOGA will monitor compliance with EP performance standards and commitments by applying a number of methods including:

- management internal audits and inspections;
- third party audits and verification;
- daily operations meetings; and
- performance review of construction activities.

The frequency of environmental monitoring is based on the risk level. VOGA personnel and management are responsible for ongoing monitoring of operational activities to ensure compliance with the EP.

7.4.2 Commitments Register

A commitments register is developed to verify compliance with the commitments in the WCMS and those outlined in this EP, including the well construction environmental performance standards. The Commitments Register provides assurance that the standards and measurement criteria specified in this EP are being meet.

The register also outlines the phase of the well construction campaign that the commitment applies to, and the personnel responsible for monitoring the compliance with each commitment. A detailed description of the phases of the well construction campaign is provided in the Well Construction Process Manual [VOG-5000-MN-0002]. These phases include:

- **Planning and design:** This phase of the planning process occurs well in advance of execution, includes preliminary planning and detailed design;
- **Execution:** Period when well construction operations are undertaken;
- **Campaign wrap up phase:** Review of HSE performance including lessons learnt; and
- **Emergency:** During an emergency and its immediate aftermath.

The Well Construction Manager will ensure that all relevant well construction personnel (including contractors) are aware of their responsibilities with regard to ensuring compliance with this EP and ensuring that the processes are in place to meet them during well construction activities.

The VOGA QHSE Advisor is responsible for ensuring compliance with the Commitments Register.

Assurance of compliance with the Commitments Register will be undertaken by inspections and internal and external inspections and audits. Details of assurance inspections and audits are provided in Section 7.10.

7.4.3 Monitoring emissions and discharges

VOGA will maintain a quantitative record of emissions and discharges, as required under Regulation 14(7) of the OPGGS(E)R. This record will include all emissions and discharges to the air, marine, seabed and sub-seabed environment and can be monitored and audited against the environmental performance standards and measurement criteria. Results will be reported in the EP Compliance Report.

Table 8-1 provides a summary of the routine environmental monitoring protocols that will be undertaken during well construction campaigns, as well as the reporting requirements.

7.4.4 Monitoring impacts from oil pollution

The process and arrangements for monitoring the impacts from oil pollution is outlined in the Wandoo Field Operational and Scientific Monitoring Plan [WAN-2000-RD-0001.03]

Monitoring may include:

- operational monitoring (Type I) which provides information of direct relevance to spill response operations; and/or
- scientific monitoring (Type II) which relates to non-response objectives and includes short term environmental damage assessments, longer-term damage assessments (including remediation), purely scientific studies and all post-spill monitoring activities.

7.4.5 Review of Environment Plan and Oil Spill Contingency Plan

7.4.5.1 *Review of EP*

A review of the implementation of the Well Construction EP will be undertaken after every well construction campaign.

The review will include an assessment of:

- compliance with the campaign Commitments Register;
- the continued relevance of environmental performance outcomes and standards;
- effectiveness of the implementation strategy within the EP;
- the adequacy of auditing and monitoring; and
- any amendments to the EP that may need to be communicated to NOPSEMA.

7.4.5.2 *Review of OSCP*

The Wandoo Field OSCP [WAN-2000-RD-0001] shall be reviewed:

- three months prior to commencement of well construction activities;
- post a significant event;
- when major changes (e.g. new service providers) have occurred which may affect the Oil Spill Response coordination or capabilities; and
- after a change to spill profile where spill risk has been identified as potentially greater to that previously identified.

Contractors on standby will provide readiness reports to the Well Construction Manager on a fortnightly basis outlining spill response capability.

The full review schedule is outlined in the Wandoo Field OSCP [WAN-2000-RD-0001].

7.5 Management of change

7.5.1 Overview

The MOC, including deviations from critical controls, during well construction operations is managed through the Well Construction MOC Process, which is consistent with the VOGA Risk Management Manual [VOG-2000-MN-0001];

The WCMS MOC process evaluates a proposed deviation from approved plans by:

- outlining the deviation and the impact it may have on environmental risk levels;
- assessing whether any alternative/contingency controls should be implemented to manage risk to ALARP; and
- assessing the residual risks and determining the conditions under which the activity can continue.

The risk assessment must be approved by the VOGA Well Construction Manager (or delegate). For any risk with potential to impact the WNA or WNB facilities, the VOGA Production Operations Duty Manager must also approve the assessment.

VOGA manages temporary and permanent changes through an MoC process which utilises an approval form (MoC) and MoC Checklist.

The MoC form provides a documented record of the change, including justification for the change, duration of change, engagement and communication, implementation, monitoring and review and authorisation and sign-off.

The MoC checklist is completed for every proposed change. The checklist includes high level screening of those changes which may impact on environmental aspects of regulatory compliance (refer Section 7.5.3).

Actions required to assess the impact of the change are identified through the MoC checklist and recorded on the MoC Form.

7.5.2 Regulatory compliance

For those changes which have been assessed as having the potential for environmental regulatory compliance aspects the following questions are addressed:

- Could the change modify an existing Environment Performance Outcome or Standard within the EP?
- Does the change propose significant modification, new stage of activity or are the activities to be carried out different from the activities contemplated in the accepted EP?
- Could the change result in a significant change in the overall level of risk and impacts identified in EP?
- Does the proposal change the HSE MS or an implementation plan within an accepted EP?
- Does the change require modifications to water treatment equipment or the composition of water discharge?

Consistent with sub-regulation 17 of the OPGGS(E) Regs 2009 and VOGA will revise the Wandoo Well Construction EP and submit for regulatory acceptance if there is a proposed change which will result in at least one of the following:

- a new activity not provided for within this EP, or an alternate in-force EP;
- a significant modification to the activity;
- a new stage of the activity;
- a significant change to impact or risk, a series of impacts or risks, or a new impact or risk not provided for within this EP.

In accordance with the NOPSEMA Guideline – When to submit a proposed revision of an EP (N04750-GL1705), VOGA considers the following aspects when determining whether a modification, meaning how the activity is being managed and/or conducted, is significant:

- There is a change to the spatial or temporal extent of the activity not provided for within this EP;
- continual reduction of the impacts and risks of the activity to ALARP;
- the effect the change has on the ability to demonstrate environmental performance outcomes and standards are being met;
- the criticality of the aspect being changed (i.e. a management system change is likely more critical because of its coverage of all impacts and risks as opposed to an individual item of equipment);

- the degree of deviation from how the activity was described in the EP.

A new stage of an activity is considered to be any change to the timing or spatial limits detailed in the accepted EP.

For individual changes, VOGA considers a change to be a "significant change to impact or risk" if:

- There is a resultant step change in overall risk level (see Section 5.6) of an environmental hazard – whether by reassessment with updated information or an actual increase in impact or risk; or
- A change in environmental impact profile from emissions introduces new relevant stakeholders or requires additional communication and agreements with existing relevant stakeholders.

For the changes assessed as "significant":

- If planned, the change will not be implemented without Regulatory acceptance; or
- If unplanned, e.g. initiated by incident, the change may be managed and implemented prior to resubmission. In this instance a report and notification to the Regulator will be made in accordance with Section (8) Depending on the situation a resubmission of the Wandoo Well Construction EP to the Regulator maybe required post the event. Cumulative impact of minor changes are reviewed as part of the annual reporting process. For these items, changes will have most likely been implemented prior to Regulatory submission.

7.6 Continuous improvement

Continuous improvement is the process of enhancing the VOGA HSE MS to achieve improvements in overall environmental performance. The VOGA HSE Policy and the VOGA HSE MS provides criteria for ongoing assessment of environmental performance. This is achieved through the Performance Assessment Manual [VOG-1000-MN-0003], which outlines the monitoring and assessment tools and processes VOGA uses to monitor HSE performance and compliance.

Performance assessment is conducted to monitor effectiveness, provide assurance and identify improvement opportunities. Assessment of HSE performance generally encompasses:

- Monitoring, measurement, analysing and reporting HSE data;
- Conducting HSE audits and inspections, according to performance standards, pre-established intervals and ad hoc safety critical situations;
- Tracking and close-out of HSE actions; and
- Conducting management reviews.

A formal 'lessons learnt' process is applied in well construction. Reviews are conducted after the completion of each well and documented in the well construction lessons learnt register. This document is reviewed prior to the commencement of each well construction campaign by the well construction team. This 'lessons learnt' review may result in the development of additional control measures, these additional controls will be added to the well construction master Risk Register and Commitments Register to ensure implementation.

HSE MS documents are updated as required to include changes of procedure, corrective actions and new guidelines. The HSES Advisor will look at methods of ensuring continual improvement over the duration of operations, focusing on incorporation of lessons learnt.

7.7 Further work to support implementation

7.7.1 Additional controls

As part of the risk assessment process detailed in Section 6, VOGA has identified additional controls or further studies required to support management of the risks to ALARP. These items are provided in the action plan contained in the table below.

Hazard	Additional management control or further work required	Action owner	Date of completion
Introduction of invasive marine species (EP-WC-R16)	Develop an IMS Biofouling Risk Assessment Procedure	HSE Manager	Prior to drilling program commencement

7.8 Emergency management

7.8.1 Emergency Response Plan

7.8.1.1 *Overview*

The Wandoo Emergency Response Plan (ERP) [VOG-2000-RD-0017] provides details on the response arrangements and responsibilities VOGA has for the management of emergencies which may occur during well construction operations. Incidents are categorised in relation to the response required:

- **Level 1 incidents:** Generally able to be resolved through the application of local or initial resources only (e.g. first strike response);
- **Level 2 incidents:** More complex in size, duration, resource management and risk and may require deployment of jurisdictional resources beyond the initial response; and
- **Level 3 incidents:** Characterised by a degree of complexity that requires the Incident Commander to delegate all incident management functions to focus on strategic leadership and response coordination and may be supported by national and international resources.

More detailed response plans have been developed to address particular events (e.g. the Wandoo Field OSCP [WAN-2000-RD-0001] and the Source Control Contingency Plan [WNB-3000-PD-0007].

7.8.1.2 *Emergency Response Structure*

Emergency response in the Field is under the overall control of the Wandoo Field Superintendent.

Figure 7-6 presents the overall emergency response structure applicable to incidents related to the Well Construction activities.

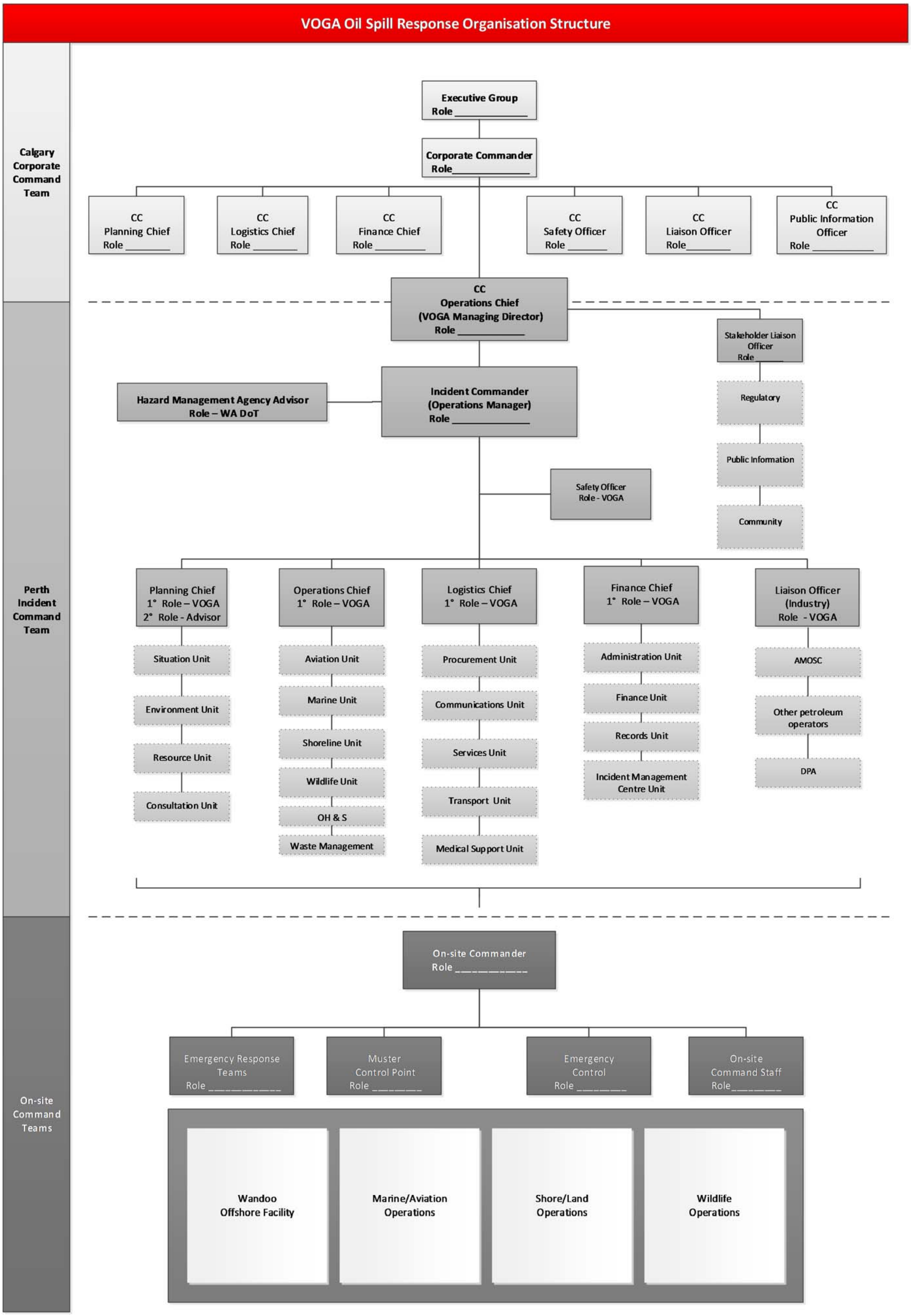


Figure 7-6: Emergency Response Structure

7.8.1.3 *Emergency training, testing and drills*

Emergency response training will be undertaken including training workshops and exercises to ensure the team understands their roles and responsibilities.

Prior to the commencement of operations on each well construction campaign, an emergency response exercise will be undertaken to verify communications arrangements and evaluate personnel responses.

VOGA require MODU contractor personnel with job classifications of derrick-man and above and its Drilling Superintendent and Drilling Supervisors to maintain current well control training certification.

The VOGA WCMS has requirements for MODU well control training drills, including:

- kick response drills both during drilling operations and tripping operations; and
- choke drills conducted prior to drilling out casing shoes to familiarise personnel with equipment usage.

7.8.2 Source Control Contingency Plan

The Wandoo Source Control Contingency Plan [WNB-3000-PD-0007] is focused on source control for wells. The plan provides campaign-specific details relating to reservoir conditions, blowout taskforce team structure, and logistics. The purpose of the document is to have as much planning as possible conducted upfront to minimise the response time of remedial measures.

There are several generic phases to bring an uncontrolled hydrocarbon release under control:

- Phase 1: Initial response, convene well construction ICT and gather information;
- Phase 2: Determine most efficient well kill method;
- Phase 3: Detailed planning of the well kill operation;
- Phase 4: Execute well kill operation;
- Phase 5: Clean-up operation; and
- Phase 6: Incident Investigation.

Source Control arrangements are further described in Section 6.2.

7.9 Oil Pollution Response

7.9.1 Overview

Vermilion Oil and Gas Australia Pty Ltd (VOGA) have developed Wandoo Field Oil Spill Contingency Plan (OSCP) to ensure that measures are in place to mitigate the oil spill hazards associated with petroleum activities within the Wandoo Field.

To achieve this, the Wandoo Field OSCP has established the following outcomes based on the following requirements:

- **Outcome 1:** The Wandoo Field OSCP is established to mitigate the oil spill hazards identified in the respective Environment Plans (EPs).
- **Outcome 2:** Response strategies provided in the oil pollution plans (OPPs) are appropriate to:
    - The nature and scale and associated environmental impact of the potential spill hazards;
    - The nature and scale and associated environmental impact of the potential spill response strategies; and
    - The environmental sensitivities and priorities as outlined within the respective EPs.
- **Outcome 3:** The Wandoo Field OSCP describes incident management system and interfaces.
- **Outcome 4:** Decision making processes support mitigation of environmental impact of spills and assessment of effectiveness of response strategies using:
    - The Incident Action Plan (IAP) which includes a consideration for environmental impact of spill and response; and
    - Operational and scientific monitoring.
- **Outcome 5:** The Wandoo Field OSCP shall contain processes to assess, test and maintain arrangements to meet the outcomes of the OSCP through:
    - Assurance processes;
    - Capability assessment; and
    - Review triggers.

These outcomes align with the VOGA Critical Procedure Performance Standard for Element 8 – Oil Spill Response [WAN-WNAB-CP-ER-02 and WAN-WNAB-CP-ER-03] key requirements.

In 2017 the Wandoo Field OSCP [WAN-2000-RD-0001] was revised and resubmitted to NOPSEMA for assessment with the Wandoo Facility Environment Plan (WPA-7000-YH-0007). The OSCP was subsequently revised in 2018 as part of a routine internal review and to address NOPSEMA inspection recommendations. The current revision of the OSCP remains in-force for both Wandoo Facility operational activities and for Wandoo well construction activities.

7.9.2 Contents and layout

To assist responders in the event of a spill, the Wandoo Field OSCP contains two documents (as illustrated in Figure 7-7):

- The Wandoo Field Oil Spill Contingency Plan – Document 1: Planning and Preparedness (WAN-2000-RD-0001.01); and
- The Wandoo Field Oil Spill Contingency Plan – Document 2: Oil Pollution Emergency Plan (WAN-2000-RD-0001.02) including the supporting Wandoo Field Operational and Scientific Monitoring Plan (WAN-2000-RD-0001.03).

In the event of a spill, responders will immediately refer to the OPEP:

Document 1, Planning and Preparedness, is focused on outlining the basis of preparation of the OPEP and the processes for monitoring and maintaining response arrangements and is structured into:

- **Part 1** - an overview of the Wandoo Field OSCP;

- **Part 2** - the VOGA incident management process; and
- **Part 3** - the management and monitoring arrangements for spill response.

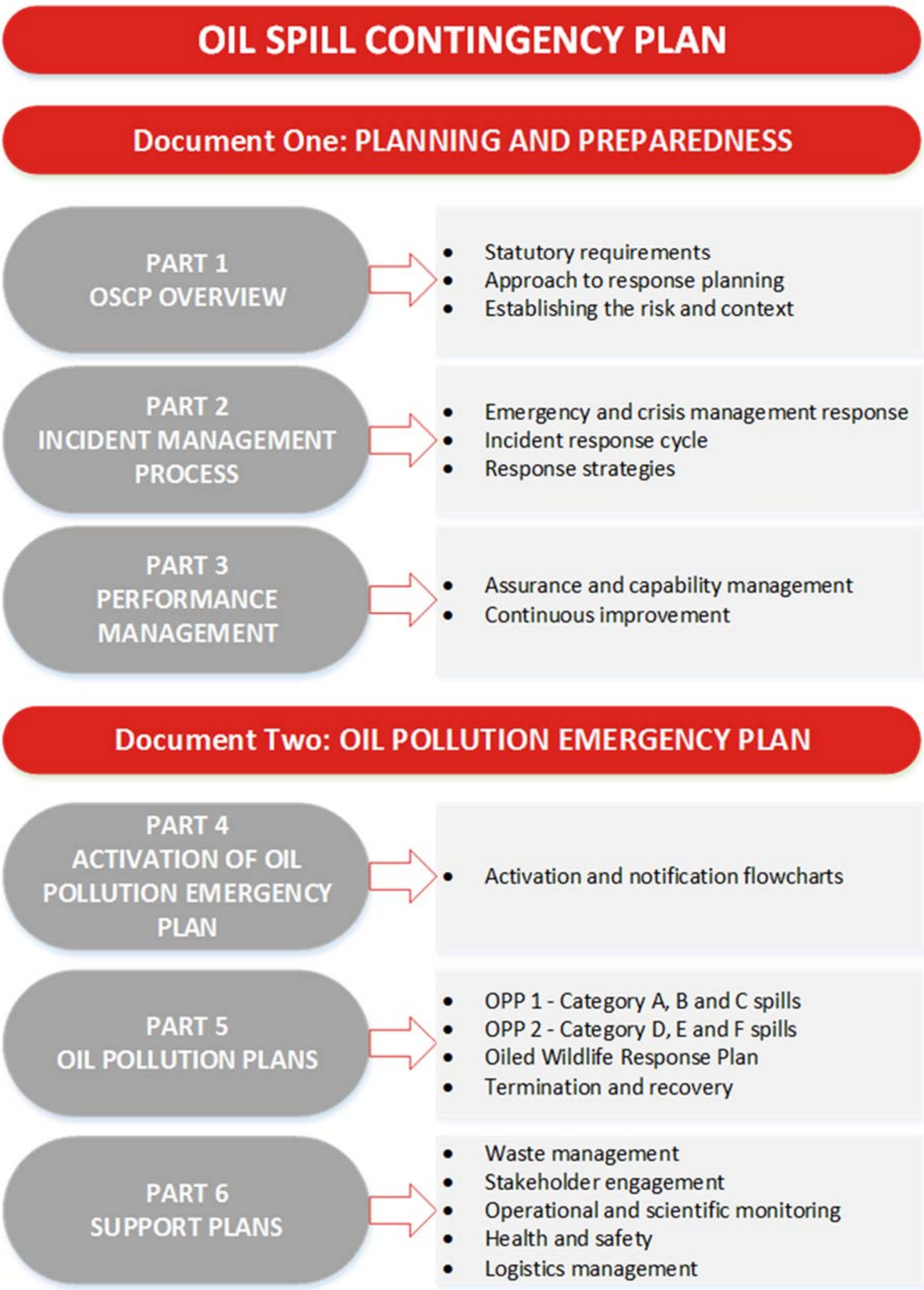
Details of Document 1 is provided in Sections 7.9.3 to 7.9.5 of this EP.

Document 2, Oil Pollution Emergency Plan (OPEP), is focused on activation and response and is structured into:

- **Part 4** - notification and activation requirements;
- **Part 5** - Oil Pollution Plans (OPPs) detailing response strategies and arrangements for the credible spill scenarios; and
- **Part 6** - spill response support plans.

Document 2, OPEP, is provided as part of the Regulatory submission to NOPSEMA along with the Operational and Scientific Monitoring Plan.

Figure 7-7: Structure and content of the Wandoo Field OSCP



7.9.3 Document One – Part 1: OSCP Overview

7.9.3.1 *Overview*

Document one – Part 1 of the OSCP provides a detailed description of the oil spill response planning and preparedness arrangements in place to response to an oil pollution emergency based upon the follow:

- Scope and location – The OSCP has been developed by VOGA to respond to oil pollution associated with production and well construction activity within Permit Area WA-14L located ~80km northwest of Dampier, Western Australia (WA) in the offshore waters of the North West Shelf (NWS) region;
- Activities - The OSCP covers oil spill scenarios from production and well construction activities within the Wandoo Permit Area WA-14L as described in the Wandoo Facility EP [WPA-7000-YH-0007] and Wandoo Well Construction EP [WPA-7000-YH-0001];
- The OSCP details the interface with other VOGA plans. Those relevant to well construction activities include:
  - Wandoo Facility Emergency Response Plan [VOG-2000-RD-0017]
  - Wandoo Source Control Contingency Plan [WNB-3000-PD-0007]
  - Wandoo Well Construction EP [WPA-7000-YH-0001]
  - Oil Spill Response Capability Review [VOG-7000-RH-0009]
- The OSCP details the interface arrangements with Government oil spill response agencies (OSRA) and industry-lead oil spill response organisations (OSRO):

  <u>OSRA</u>

  - Australian Maritime Safety Authority (AMSA) under the arrangements detailed within the National Plan for Maritime Environmental Emergencies (NatPlan);
  - Western Australian Department of Transport (DoT) under the arrangements detailed within the WA State Hazard Plan – Maritime Environmental Emergencies (MEE).

  <u>OSRO</u>

  - Oil Spill Response Limited (OSRL) under a signed Associate Agreement with OSRL for the Wandoo Production Area;
  - Australian Marine Oil Spill Centre (AMOSC) under membership with AMOSC the arrangements detailed within the Australian Marine Oil Spill Plan (AMOSPlan); and
  - Although not an OSRO, VOGA has access to industry resources and personnel under the Australian Petroleum Production and Exploration Association (APPEA) Memorandum of Understanding: Mutual Assistance.
- The OSCP details the response priorities consistent with the NatPlan; and
- The OSCP details the incident classification system consistent with the NatPlan and WA State Hazard Plan – Maritime Environmental Emergencies (MEE)

7.9.3.2 *Statutory requirements*

The OSCP provides details on all relevant statutory requirements including:

- International conventions relating to risk from oil and gas activities
- Australian Commonwealth, State and Territory legislation;
- An overview of jurisdictional authority and cross-jurisdictional arrangements of Control Agencies; and
- Stakeholder engagement requirements for both the development and implementation of the OSCP.

7.9.3.3 *Approach to response planning*

The OSCP details VOGA's oil spill response planning process based on impact and consequence scenario planning which involves establishing the context and risk; evaluating, demonstrating and defining response strategies and resources; implementation; and first response.

The process is divided into two phases: planning and spill response. The spill response is supported by the incident action planning process; Oil Pollution Plans (OPPs) are initial incident action plans (IAPs) based on existing impact assessments for the spill and response activities within the relevant EPs.

VOGA's oil spill response planning process involves:

- Understanding the hazard profile, including looking at the details of potential events and the potential consequences of the event.
- Designing a response that meets the EP objective to "mitigate the impact of a hydrocarbon release to the marine environment by responding to oil releases to the environment".
- Planning for the response and maintaining the response capabilities to meet the Critical Procedure Performance Standard objective "to ensure that measures are in place to provide effective response in the event of an emergency situation at Wandoo facilities".

Table 7-4: Steps for the response planning process and the outcomes

Response Planning Steps	Where step is addressed in this EP and/or OSCP
Step 1: Oil spill hazard is identified and context for each spill category and season described. This requires understanding the potential events (scenarios) which requires knowledge of: • API type, composition of reservoir/fluids assay. • Reservoir modelling of oil type or another geotechnical analysis. • Release rate, quantity, duration. • Location of activity and potential spill sources. • Metocean data matching the location and timing of activity. • Location of environmental receptors and method of impact from oil. • Toxicity of oil. • Timing of spill (season).	To support a hazard based approach to planning, oil spill scenarios outlined in this EP were initially grouped into spill categories based on fluid type, duration, and volume Details for each scenario are provided in Section 6 in this EP: • Liquid hydrocarbon release from wells (Section 6.2.3); • Diesel spill to sea (Section 6.4); and • Liquid hydrocarbon release from topsides process (Section 6.3)

Response Planning Steps	Where step is addressed in this EP and/or OSCP
• Thresholds. • EMBA of the activity.	
Step 2: Evaluate response parameters, is also about consideration of the hazard, as response preparation requires understanding the potential consequence including: • Probability of oiling defined environmental sensitivities. • Minimum time to impact defined environmental sensitivities. • Quantity of oil to impact defined environmental sensitivities. • Length of shoreline impacted. • Response operating area.	As a part of the hazard assessments in Section 6 of the EP, modelling was undertaken which was used to determine potential impacts and to identify the parameters for the response.
Step 3: Define response strategies for spill categories, involves designing the most appropriate response plan, such that the impacts, in the event of a spill, are reduced to ALARP. VOGA uses an assessment process for oil spill planning and response and in doing so consider: • The oil spill hazard. • The context for each spill category and season. • Operational constraints. • Assess the impacts of the hazard and the response activities. • Assess whether impacts from the hazard and the response activities are ALARP, by considering all alternatives and their relative benefits and costs. • Where not determined to be ALARP, the response strategies are adjusted as part of an iterative process. • This iterative process considers capability and in doing so looks at the potential benefits and costs of doing more sooner.	Oil spill scenarios identified are grouped into categories based on the fluid type, duration and volume. There are six categories, further grouped into two response plans (OPP1 and OPP2); The response strategies planned are summarised in the Section 2.5 as well as being described in the respective OPPs; The response strategies are also assessed in Section6.5 of this EP. This section describes the response strategy and assesses the risk of the hazard. It also identifies the critical stages of the response strategy and schedule for implementation which are evaluated further to determine if undertaking more of the techniques will provide additional benefit and/or if anything can be done sooner; Additional measures are summarised and the costs estimated in the tables in Section 6.2.6.3.
As a part of the planning the response, in **Step 4: Assess impacts of spill scenario,** VOGA also assesses the impacts of the spill response. This not only contributes to making choices about the response strategies, but also informs how the response should be undertaken to ensure that the risks and impacts of the response are managed to ALARP. This step involves: • Environmental risk and impact assessment. • OSTM of surface, entrained and subsurface oil with and without response strategies. • Identification of the controls (including environmental performance outcomes, standards and measurement criteria) to be implemented as a part of the spill.	The potential impacts of each spill response strategy have been assessed in Section 6.5 of this EP, and it is demonstrated that they are ALARP.
To ensure that VOGA has a level of preparedness to implement the response strategy **Step 5: Define**	The Oil Spill Response Capability Review [VOG-7000-RH-0009] is undertaken annually based on

Response Planning Steps	Where step is addressed in this EP and/or OSCP
the response resources is undertaken next. In this step, VOGA considers: • Operational limitations (equipment functional capacity/coverage, safety of response personnel). • Constraints of equipment effectiveness. • Scale of the spill event. • Skill-sets required for specific roles.	the response activities outlines in the OPEP. For each statutory EP submission the latest information from the Capability Review at time of the revision is provided in the OPEP, Section 6.5 and Table 6-8 to Table 6-13; This uses the worst-case scenario as a basis for the resource requirements; This document details the specification for each resource requirement (e.g. skills vessels, equipment) and identifying what contracts and arrangements are required to be in place; The following questions are considered to determined capability requirements to support the risk of the hazard to ALARP: • Are there additional tasks that can be undertaken for this strategy? • When and where the resource would be required, based on the results of consequence modelling (e.g. time to impact, thresholds and probability)? • How long would the resources be required for use? • Where and what are the size of stockpiles available to VOGA? • What are the mobilisation times for equipment from these stockpiles and contractor resources? • What are the logistical requirements for safe deployment of materials and equipment? • Is there any benefit of either increasing resource and/or reducing mobilisation times? • What are the costs of either increasing resource and/or reducing mobilisation times? • Is there any benefit in increasing the amount of resources? • Is there a better way to undertake activities associated with this strategy?
Step 6: Define the performance standards.	Some of the spill scenarios have been identified by VOGA to be CEE with "emergency preparedness, management and response" identified as a critical control, requiring a specific Critical Procedure Performance Standard. The Critical Procedure Performance Standard (Element 8 - Emergency preparedness, management and response) has the objective "to ensure that measures are in place to provide effective response in the event of an emergency situation at Wandoo facilities". To meet this objective, there are a number of key requirements of this overarching control, and performance criteria to set a level of performance, with corresponding assurance activities to measure performance identified.

Response Planning Steps	Where step is addressed in this EP and/or OSCP
	By working towards the objective, this Critical Procedure Performance Standard guides the manner in which VOGA plans for a response, and ensures that the response is appropriate and will reduce the impacts to ALARP. Section 6 in this EP includes specific control measures to achieve the overarching objectives. These are listed in Tables 6-8 to 6-13.

7.9.3.4 *Establishing the risk and context*

The OSCP provides detailed information on the credible spill risks associated with Wandoo well construction activities based upon:

- Oil characterisation for the types of oils that are used for, or may be encountered during, well construction activities;
- An overview of the credible worst-case spill scenarios that may result from well construction activities; and
- A summary of the results from oil spill trajectory modelling undertaken to assess the spill risk profile of identified credible worst-case spill scenarios.

7.9.4 Document One – Part 2: Incident management process

7.9.4.1 *Overview*

Document one – Part 2 of the OSCP provides a detailed description of the VOGA incident management process comprising the following components:

7.9.4.2 *Emergency and crisis management response*

The emergency and crisis management response process is based on the framework and arrangements in the VOGA ERP [VOG-2000-RD-0017] comprising the following:

- **Response structure** - VOGA has an emergency management response structure that is based around three levels of organisational control: tactical, operational and strategic comprising:
  - Corporate Command Team (CCT);
  - Incident Command Team (ICT); and
  - On-site ICT.
- **Command and control** - VOGA's ICT runs an incident control system analogous to the Australasian Inter-Service Incident Management System (AIIMS) to which the National Plan is also aligned including a clear chain of command for incident response;
- **Response facilities** - VOGA's ICT utilise VOGA's Perth office as the primary Incident Command Centre (ICC) for OSR monitoring or incident management activities.

This facility contains information communication technology infrastructure to communicate effectively with the range of parties required in a significant response, private and nearby break out areas, along with sufficient access controls and logistical support for the ICT to operate over a number of weeks or months. In the event a unified command ICT is established with the DoT, a co-located ICC will be established at mutually agreed location.

VOGA also has access to an alternate ICC should a business continuity event, civil unrest, security or capacity issue impede VOGA's capability to fully exercise incident control from the primary facility.

7.9.4.3 *Incident response cycle*

The response framework for incident management of a spill response is consistent with the process described in Section 7.8. The spill impact and mitigations assessment (SIMA) is embedded within the incident response cycle is an operational tool that should be revisited regularly in the response planning cycle by the Planning Chief or Environment Unit Team Leader within the Planning Team.

A SIMA takes into account the advantages, limitations and added risks associated with individual OSR techniques and strategies. It is a process that provides a means to determine the environmental gain/reduction from implementing each response strategy by considering the potential impacts on each identified protection priority and will enable informed decisions to be made.

7.9.4.4 *Response Strategies*

Response strategies which may be appropriate for each spill scenario outlined in this EP have been identified using the systematic approach to planning and the assessment of the potential impact of spill mitigation and response. This assessment is summarised in Section 6.2.6.1.2 of this EP and a Strategic SIMA is presented in the OSCP (Appendix C).

The oil spill response strategies feasible for each spill response strategy based upon the potential spill scenarios during well construction activities are summarised in Table 7.6 An outcome of this process is the creation of OPPs to assist the ICT and on-site responders in the initial response to an oil spill as a precursor to a formal IAP.

Table 7-5: Summary of feasible response options for each relevant spill category

Response strategy	Category A	Category B	Category E
	Instantaneous release 300 m^3 Wandoo Crude	Instantaneous release $300m^3$ marine diesel spill	Continuous 594 m^3/day (average for 43 days) Wandoo Crude
Source control	x	x	x
Monitoring and evaluation	x	x	x
Chemical dispersion	x	-	x
Containment and recovery	-	-	x
Mechanical dispersion	x	x	x
Protection and deflection	-	-	x
Shoreline clean-up	-	-	x

Response strategy	Category A	Category B	Category E
	Instantaneous release 300 m^3 Wandoo Crude	Instantaneous release 300m^3 marine diesel spill	Continuous 594 m^3/day (average for 43 days) Wandoo Crude
Oiled Wildlife	x	x	x

7.9.5 Document One – Part 3: Performance management

7.9.5.1 *Overview*

The OSCP details the manner in which VOGA validates the performance of oil spill response arrangements via assurance and capability management and continuous improvement.

7.9.5.2 *Assurance and capability management*

VOGA manages oil pollution response capability and assurance requirements through:

- **Training and competency** - VOGA Emergency Response personnel are trained in emergency control and leadership to ensure they are suitability prepared for decision-making in an emergency situation.

  Training requirements are identified for Onsite Command and Incident Command teams to ensure rotate testing of scenarios and equipment. Records are kept to track the completed training of personnel.

  Each member of VOGA's ICT will have completed incident management training as outlined in Table 7-6, giving them basic competencies and therefore requisite skills to undertake their required incident response roles.

Table 7-6: VOGA ICT OSR training

	Incident Commander	Planning Chief	Operations Chief	Logistics Chief	Finance Chief	ICT support roles	WNB Field Superintendent
Introduction to oil spills - familiarisation session	✓	✓	✓	✓	✓	✓	✓
Manage Emergency Incidents (PMAOHS511A)	-	-	-	-	-	-	✓
PMAOMIR320 or IMO Level 2 in OSR	-	✓	✓	✓	✓	✓	-
IMO Level 3 in OSR or PMAOMIR418	✓	-	-	-	-	-	-

The Planning Chief is supported by an Environment unit, with the minimum competency requirement for the Environment Unit Team Leader role being a tertiary qualification in marine or environmental science (or equivalent) and a minimum 3 years in an environment related role in the oil and gas and/or marine industry.

Specialised skill sets such as those required for monitoring (e.g. fluorometry, shoreline surveys), aerial observation, OWR and specialised equipment operations will be sourced from the resources available within the AMOSC Core Group, AMSA National Response Team and ESC Network, the DoT State Response Team or service providers.

- **Capability** - VOGA's capability for oil spill response are the arrangements, contracts, MOUs, directories and agreements in place with service providers who may be involved in response efforts for an oil spill incident, assessed against worst case scenario and documented under the Oil Spill Response Capability Review [VOG-7000-RH-0009].

  Capability for resources are maintained for the duration of a response through the IAP process. The IAP process provides the ICT with the ability to forecast resource requirements based on real time incident data. Capability assurance will be monitored and adjusted if required to suit to the particular situation with resources for response operations beyond day 20 being identified and provided for.

- **Assurance activities** - The two key performance and assurance activities are exercises; and inspections and audits:
  - Exercises - the VOGA Emergency Response Schedule [VOG-1100-YH-0001] addresses the scope and requirements for conducting exercises for the onsite and incident command teams and provides details regarding the reporting of recommendations arising out of exercises including changes of procedure, corrective actions and new guidelines. Table 7-7 presents the exercise schedule.
  - Inspections and audits - VOGA's auditing schedule includes all elements of VOGA's HSE MS, including environment performance. The auditing schedule includes three types of auditing processes: Internal inspections of VOGA's response capabilities and commitments: External inspections of VOGA's response capabilities and commitments; and Inspections of third-party providers.
  - The frequency of the inspection is dependent on VOGA's activity, requirements of mutual aid partners and size/capability of the organisation and is provided in Table 7-8.
  - Action management - Recommendations arising out of OSCP reviews, capability reviews, inspections, audits are reviewed and where recommendations are to address an increase spill response risk exposure identifies interim measures to manage the risk to ALARP whilst any agreed action is being completed.

Table 7-7: Testing schedule

Objectives that VOGA will test	Evidence and supporting documentation required	Well Construction activities	Wandoo Field activities	Within three months after a significant change to spill profile	Joint industry, OSRA, or OSRO exercises
		Within three months before activity starts	Annually		
Aim 1: Provide situational experience for command team personnel and enabling them to be aware of their assigned roles and responsibilities during a response					
To provide an oil spill event to test the onsite or incident command team roles specifically listed in Table 7-6	VOGA ICT exercise scenario description and attendance list.	✓	✓	-	-
	VOGA onsite command team scenario description and exercise report.	-	✓	-	-
Aim 2: Assess the effectiveness, achievability and timeliness of incident action planning for the duration of expected response					
Test the incident response cycle.	VOGA ICT exercise scenario description, IAP and decision/event log and post scenario lessons learned.	✓	✓	✓	-
	VOGA onsite command team scenario description and exercise report.	-	✓	-	-
Aim 3: Testing interfaces and deployment of equipment and resources					
To test the VOGA on-site equipment capability.	Maintenance records for simulated deployment of satellite tracking buoy.	-	✓	-	-
To assess that the ICT are aware of notification protocols in place to contact other agencies, regulatory authorities and OSRAs and OSROs.	VOGA ICT exercise scenario description, IAPs, decision/event log and stakeholder/notification contact list.	✓	✓	✓	-
Test the mobilisation ability and logistic assumptions around equipment and personnel movement, timings and capability.	ICT member/s observers role or participates in mobilisation exercise with OSRA or OSRO with lessons learned documented.	-	-	-	✓
	Updates to Oil Spill Response Capability Review as per Table 9-1, based on lessons learned provided to or sourced by VOGA.	✓	✓	✓	-

Objectives that VOGA will test	Evidence and supporting documentation required	Well Construction activities Within three months before activity starts	Wandoo Field activities Annually	Within three months after a significant change to spill profile	Joint industry, OSRA, or OSRO exercises
To participate in equipment deployment exercises (AMOSC, AMSA, DoT, contractors, other industry operators) as observers or ICT members.	ICT member/s observers role or participates in joint industry exercise: Shore-based equipment field deployment exercise.	-	-	-	✓
Aim 1: Provide situational experience for command team personnel and enabling them to be aware of their assigned roles and responsibilities during a response					
To provide an oil spill event to test the onsite or incident command team roles specifically listed in Table 7-6	VOGA ICT exercise scenario description and attendance list.	✓	✓	-	-
	VOGA onsite command team scenario description and exercise report.	-	✓	-	-
Aim 2: Assess the effectiveness, achievability and timeliness of incident action planning for the duration of expected response					
Test the incident response cycle.	VOGA ICT exercise scenario description, IAP and decision/event log and post scenario lessons learned.	✓	✓	✓	-
	VOGA onsite command team scenario description and exercise report.	-	✓	-	-
Aim 3: Testing interfaces and deployment of equipment and resources					
To test the VOGA on-site equipment capability.	Maintenance records for simulated deployment of satellite tracking buoy.	-	✓	-	-
To assess that the ICT are aware of notification protocols in place to contact other agencies, regulatory authorities and OSRAs and OSROs.	VOGA ICT exercise scenario description, IAPs, decision/event log and stakeholder/notification contact list.	✓	✓	✓	-
Test the mobilisation ability and logistic assumptions around equipment and personnel movement, timings and capability.	ICT member/s observers role or participates in mobilisation exercise with OSRA or OSRO with lessons learned documented.	-	-	-	✓
	Updates to Oil Spill Response Capability Review as per Table 9-1, based on lessons learned provided to or sourced by VOGA.	✓	✓	✓	-

Objectives that VOGA will test	Evidence and supporting documentation required	Well Construction activities	Wandoo Field activities	Within three months after a significant change to spill profile	Joint industry, OSRA, or OSRO exercises
		Within three months before activity starts	Annually		
To participate in equipment deployment exercises (AMOSC, AMSA, DoT, contractors, other industry operators) as observers or ICT members.	ICT member/s observers role or participates in joint industry exercise: Shore-based equipment field deployment exercise.	-	-	-	✓

Table 7-8: Inspection frequency and scope

Item	Third Party oil spill response providers				
	Oil Spill Response Organisations	Key OSMP provider	OWR Agency	Local/Regional Oil Spill Equipment Provider	Global dispersant
Frequency	3-yearly	3-yearly	3-yearly	2-yearly	3-yearly
Equipment: Maintenance management, logistics, training, readiness for activation/deployment.	Included	Included	Included	Included	Included
People: training and competency management, quantity and availability.	Included	Included	Included	Included	-
Activation Process: Notification processes, activation and mobilisation of people and equipment, exercises and testing.	Included	Included	Included	Included	Included
Documentation: Contracts, agreements, specialist services, authorisation lists, capturing of learning and input into training materials.	Included	Included	Included	-	Included
Management and organisation: Organisational management of change process, lessons learnt, contracts and liability.	Included	-	-	-	-

7.9.5.3 *Continuous improvement*

The OSCP may require reviews:

- following a significant change to a spill risk profile;
- following significant changes to OSR capability or performance standards; and
- post-significant event (i.e. incident, change to risk profile, change to activities, change to preparedness/capability both within VOGA and external service providers).

Reviews will take into account any issues arising from events or exercises, any changes in legislation, and also incorporate findings and recommendations from industry incidents locally and globally (if and when information is made public).

Recommendations arising out of OSCP reviews, capability reviews, inspections, audits are reviewed, assessed and considered for implementation if it is consistent with the ALARP principles outlined in the VOGA EPs. A schedule of reviews is provided in Table 7-9.

Table 7-9: Review schedule

Objective	Activity type	Well construction activities				
		Within 3 months before activity starts	During activity	After significant changes to OSR capability	After a significant change to spill profile	Post-significant event
To ensure that all contacts in the OSCP are regularly checked and updated	Contacts list check	x	-	x	-	-
To ensure that all service providers retain capability	Review OSR Capability Review [VOG-7000-RH-0009]	x	-	x	-	x
	Contractor readiness reports	-	x	-	-	-
To ensure that response strategies are consistent with oil spill mitigation requirements	OSCP review	-	-	x	x	x

7.10 Inspection and auditing

7.10.1 Audit process

The VOGA audit procedure is outlined in the Performance Assessment Manual [VOG-1000-MN-0003]. The audit process comprises:

- audit scheduling;
- preparation and planning;
- the audit;
- reporting; and
- follow up and action item close-out.

7.10.2 Inspection process

Inspection of equipment and processes are a means by which VOGA collect records pertaining to technical status of contractor equipment and compliance with certain environmental performance standards. The inspection process is similar to, but less formal than, the audit process.

7.10.3 Inspections and audits

Internal and external inspections and audits will be undertaken to confirm that commitments specified within the Commitments Register are being met.

Internal inspections and audits are conducted by VOGA personnel. Internal inspections and audits range from regular small area specific inspections conducted by field supervisors through to high level management audits focused on a single major accident event or an environmental event assessed to have a 'Catastrophic' impact under the VOGA risk matrix or HSES topic. These inspections and audits assess compliance with the HSE MS, including the performance outcomes and standards specified within this EP.

External inspections and audits are conducted by third party service providers with specific expertise to provide an independent evaluation of compliance with the HSE MS expectations and performance standards and outcomes.

7.10.4 Inspection and audit plan

VOGA develops a specific audit plan for each well construction campaign, optimised to meet that campaigns specific requirements. The audits and inspections outlined in Table 7-10 will be carried out during each well construction campaign.

Table 7-10: Audits and inspections proposed for each well construction campaign

Timing	Inspection audit objective	Internal/external
Planning and design phase	Pre-campaign inspections on MODU and AHTS vessels to verify preparedness for work including compliance with EP requirements.	Internal
	Pre-campaign EP compliance review to ensure compliance with commitments relating to this phase.	Internal or external
Execution	EP compliance audit.	Internal or external

7.10.5 Follow-up and action item close out

Following receipt of the Audit Report, the Well Construction Manager should undertake a review and develop an Action Plan. The Action Plan should finalise:

- action items;
- action parties;
- timeframe for completing action items; and
- approver.

The appropriate actions need to be taken by the designated action parties within the agreed timeframe. The process for closing out actions is detailed in the Management System Manual: Performance Assessment [VOG-1100-YG-1201] (formerly Performance Assessment Manual [VOG-1000-MN-0003]). Additionally, compliance auditing of the Commitments Register will allow for activity non-conformances to be identified, captured and tracked via the Management System Manual: Performance Assessment [VOG-1100-YG-1201]. For non-conformance and management of change see Section 8.5.

8 Reporting

8.1 Environmental records

All records generated during a well construction campaign will be maintained for at least five years, in accordance with the OPGGS(E)R. The following table outlines the records to be kept to meet performance standards and routine reporting requirements.

Table 8-1: Routine environmental monitoring and record keeping summary

Parameter	Monitoring	Record keeping
Discharges of drilling fluids and cuttings	Volumes of cuttings and fluids discharged and specific chemicals monitored	Daily Drilling Fluid Reports
Chemical management	Volume, storage and handling of chemicals	Register of chemicals
Atmospheric emissions	Diesel consumption	Daily reports (AHTS vessels and MODU)
Waste	Quantities of waste landfilled, incinerated, recycled, treated and discharged	Waste volumes (MODU Waste Log) Sewage and grey water Putrescible waste Sanitary waste discharge
Invasive marine species	Management of ballast water and bio-fouling	AHTS vessel bilge and ballast records Relevant inspection compliance records
Training	Details of crew environmental inductions	Induction record sheets
Incident reporting	Number and details of environmental incidents	Notification records of spills (recordable or reportable) Incident records (iTrak)
Compliance reporting	Compliance with EP commitments	Completed environmental inspection/audit reports Monthly NOPSEMA recordable incident reports
Consultation	Ongoing consultation with stakeholders	Consultation records Register of complaints
Spill response	Spill volume and dispersant quantity	Spill logs as per IAP (OSCP) Aerial surveillance observation logs Records of quantity of dispersant used

8.2 Statutory reporting

Regulations 14 and 15 of the OPGGS(E)R require operators to include arrangements in the EP for:

- maintaining a quantitative record of emissions and discharges to the air, marine, seabed and sub-seabed environment to enable evaluation of performance against performance standards and measurement criteria;

- recording, monitoring and reporting information about the activity (including information required to be recorded under the OPGGSA, the regulations and any other environmental legislation applying to the activity) sufficient to enable the Regulator to determine whether the environmental performance outcomes and standards in the EP are met; and
- reporting to the Regulator at intervals agreed with the Regulator, but not less than annually.

The specific monitoring and recording requirements for each relevant parameter are detailed in the following table.

Table 8-2: Statutory reporting requirements

Parameter	Reporting requirement and KPI	Responsibility
Records of complaints from fishermen or other users	MODU and AHTS vessel radio logs document interactions with other sea users	AHTS vessel masters and MODU OIM
Records of breaches of restricted zone by fishermen or other	MODU and AHTS vessel daily logs record breaches	AHTS masters vessel and MODU OIM
Records of collisions	Incident reports	AHTS vessel masters and MODU OIM
Records of oil spills	NOPSEMA written report	AHTS vessel masters and MODU OIM
Volumes of fluids discharged	Daily drilling fluid reports	Drilling Supervisor
Estimated volumes of cuttings/ shavings/cement discharged	Daily drilling fluid reports	Drilling Supervisor
Oil in water discharges from MODU and AHTS	Oil record books	AHTS vessel masters and MODU OIM
Solid waste logs (transfers from AHTS vessel and MODU to shore)	Waste manifests	Drilling Supervisor and MODU Materials Coordinator
Records of dropped objects (overboard)	Incident report	AHTS vessel masters and MODU OIM
AHTS vessel, MODU fuel use	Daily reports	Drilling Supervisor
Other non-quantitative criteria specified in WCMS	Audit reports including records of any non-compliance with stated objectives	Well Construction HSEQ Advisor

A report of these parameters will be submitted to NOPSEMA at the end of each well construction campaign by the VOGA HSES Advisor. If no activity has occurred in any given year, this will also be notified to NOPSEMA fulfilling the requirement for annual reporting.

VOGA has legal obligations under the OPGGS(E)R to submit routine reports to NOPSEMA as well as notify NOPSEMA of an incident within a specified period of time, depending on the impact or potential impact to the environment and whether the incident is deemed reportable or recordable under the regulations.

8.3 Routine internal reporting

A number of routine internal reports will be prepared during each well construction campaign, including:

- Daily Drilling Reports: prepared by the VOGA Drilling Supervisor and issued to key support personnel and stakeholders. Daily Drilling Reports outline performance information on well construction activities completed over the previous 24 hours, QHSE, logistics, equipment and fuel usage;

- The seven-day look-ahead (issued daily by the VOGA Drilling Supervisor) provides a forward projection of activities over the coming seven days and identifies AHTS vessel and helicopter movement and equipment and personnel requirements. Relevant internal reports will be collated and maintained by VOGA's HSES Advisor and will inform the preparation of external routine reports, as described below; and
- An environmental discharges log is maintained by the VOGA Offshore Materials Coordinator. This log is a consolidation of data from several sources to enhance accessibility.

8.3.1 External routine reporting

VOGA report information on environmental performance to regulators as outlined below.

Table 8-3: External routine reporting requirements

Report	Recipient	Frequency	Content
Monthly non-conformance report	NOPSEMA	Monthly by 15th of each month	Details non-conformance with performance standards that have occurred during drilling activities (if applicable).
End of Well Report	NOPSEMA	Within three months of completion of activities	In accordance with the Environment Regulations confirmation of compliance with the supplementary Performance Standards.
National Pollutant Inventory (NPI) Report	DEC	Annual, by 30 September each year	Summary of the emissions to land, air and water for drilling activities for inclusion in the Commonwealth NPI database. Reporting period from 1 July to 30 June. This report will be completed and submitted by the MODU operator.
Null Report	NOPSEMA	Regulation 14(2)(b) requires that the interval between reports will not be more than one year. Therefore, if no drilling has occurred within a year of the previous report a Null Report will be issued.	A statement that no activities have occurred in relation to this EP within the past year.
Activity Commencement/ Completion Notification	NOPSEMA	At least 10 days prior to an activity commencing and within 10 days after completion.	Notification that an activity is to commence at least 10 days prior, or notify that an activity has been completed.
Change of titleholder details	NOPSEMA	When change occurs	Change of titleholder, titleholder's nominated liaison person or a change in the contact details for either the titleholder or the liaison person.

8.3.2 Internal incident reporting

The Wandoo Event Management Manual [VOG-2000-MN-0003] outlines the reporting requirements:

- **Incidents**: All incidents that result in a loss must be reported using an approved Incident Investigation Report Form (e.g. injuries, damage to assets, spills and releases, corporate reputation and near misses);
- **Investigation Report Form**: For well construction operations, VOGA reviews the incident reporting process of the MODU Contractor. If the MODU Contractor's process is compliant with the VOGA system, then the MODU Contractor's reporting process is used in preference to VOGA's to minimise the volume of reporting. VOGA provides members to any team conducting formal investigations of major incidents;
- **Non-Compliance Incidents**: VOGA's Incident Report Form must be completed and submitted, whenever a non-compliance event is reported to a regulator;
- **Regulatory Audits and Inspections**: The results of all regulatory audits and inspections are to be reported by site supervisors;
- **Hazard Alert/Near Miss Reports**: It is expected that all near misses are reported, and all high-potential hazards are investigated and reported, using the Incident Report Form;
- **Hazard Observations**: To encourage the reporting of near misses, VOGA uses a simplified reporting form. It is expected that all high-potential hazard alerts and close calls will be investigated, and reported, using VOGA's Incident Report Form (or the MODU Contractor's if compliant with VOGA's system); and
- **Public Concerns and Complaints**: Incidents involving the public in the communities near VOGA operations should be treated as serious, and reported using the Incident Report Form.

All near misses, hazard identifications, incidents, regulatory compliance inspections, and associated action items, are entered into VOGA's event tracking system "iTrak" within 72 hours of the occurrence. All incident investigation reports must be complete within five working days of the event.

In accordance with the Wandoo Event Management Manual, all incidents should be immediately recorded within the Incident Management Database.

8.4 External incident reporting

8.4.1 Reportable incidents

The OPGGS(E)R defines a reportable incident "as an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage."

Reportable incidents are identified through the risk assessment process for a reported event and comprise any event with a potential consequence to an ecosystem or environmental asset of 3 (moderate) or greater, i.e. 4 (major) and 5 (catastrophic), regardless of the overall risk level assigned. The consequence ratings are based on VOGA Risk Management Manual [VOG-2000-MN-0001] corporate risk matrix using the ecosystem/environmental asset impact criteria.

For the Well Construction activity these include:

- loss of well control;
- loss of MODU stability and consequent discharge of fuel and/or drilling chemicals;
- collision between MODU and platform;
- AHTS vessel collision resulting in hydrocarbon spill from AHTS vessel or MODU;
- spill during AHTS vessel to MODU bunkering; and
- introduction of invasive marine species from AHTS vessel/MODU

NOPSEMA, NOPTA and the Department of the responsible State Minister are to be notified of all reportable incidents in accordance with the following requirements of the OPGGS(E)R:

- Notify NOPSEMA orally of a reportable environmental incident as soon as practicable but not later than two (2) hours after the first occurrence of the incident or after the time that the titleholder becomes aware of the incident.
- Provide a written record of the notification to NOPSEMA, the Titles Administrator and the Department of the responsible State or Northern Territory Minister as soon as practicable after the oral notification.
- Provide NOPSEMA a written report of a reportable incident as soon as practicable but not later than three (3) days after the first occurrence of the incident.
- Provide a copy of the written report to both the Titles Administrator and the Department of the responsible State Minister within seven (7) days of giving the written report to NOPSEMA.

The written report must contain the following information:

- all material facts and circumstances concerning the reportable incident that the titleholder knows or is able, by reasonable search or enquiry, to find out; and
- any action taken to avoid or mitigate any adverse environment impacts of the reportable incident; and
- the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.

MODU incident investigation and closeout procedures will be used for all environmental incidences which occur on the MODU. The VOGA HSE MS, including incident investigation and closeout procedures, will be used for all environmental related incidents occurring away from the MODU.

8.4.2 Recordable incidents

The OPGGS(E)R defines a recordable incident "as an incident arising from the operator's activities that breaches a performance objective or standard in the EP that applies to the activity and is not a reportable incident". Recordable incidents are reported by the HSES Advisor to NOPSEMA on a monthly basis.

Written reports of all recordable incidents will be reported to NOPSEMA in compliance with Regulation 26B of the OPGGS(E)R and will:

- relate to a calendar month;
- be given as soon as practical after the end of the calendar month, and not later than 15 days after the end of the calendar month; and
- will contain all the information as required under Sub-Regulation 4D of Regulation 26B of the OPGGS(E)R.

8.5 Management of non-conformances

Non-conformances include near-misses, incidents or other events or information which indicates a lack of conformance with specified objectives or compliance requirements (e.g. an audit action plan; Section 8.5).

VOGA utilises the Vermilion global incident recording and action tracking system 'iTrak'. This system is used for capturing and following up on near-misses and incidents including their associated corrective and preventive actions, ensuring that any lessons are learned in the interests of continual improvement.

In addition to iTrak, and on behalf of the VOGA Managing Director, the VOGA Administration Assistant maintains logs of outstanding actions arising from audits or other actions that do not require entry on iTrak, but which nevertheless require some form of follow-up action and confirmation of closure.

9 Stakeholder consultation

9.1 Introduction

For the activity defined in this EP, Regulations 11A, 14(9) and 16(B) of the OPGGS(E)R require consultation with relevant authorities, persons and organisations. VOGA has conducted an extensive range of consultation during the development of the Wandoo Facility Operations EP and also during the development of the Well Construction EP [WPA-7000-YH-0001] from 2012. VOGA is committed to continuing to consult with appropriate stakeholders to ensure concerns associated with the company's activities are mitigated through the management of the activity where practicable.

9.2 Objectives

The key objectives of VOGA's stakeholder consultation process are to:

- Initiate and maintain open communications between stakeholders and VOGA;
- Ensure stakeholders are kept informed of VOGA's activities;
- Provide stakeholders with an opportunity to provide feedback on VOGA's activities;
- Establish an open and transparent process for engagement;
- Manage any concerns raised by stakeholders regarding VOGA's activities; and
- Provide a means for recording all communication, issues raised and responses.

9.3 Stakeholder identification and classification

Regulation 14(9) of the OPGGS(E)R specifies a requirement for consultation with relevant authorities of the Commonwealth, State, and other relevant interested persons or organisations. Stakeholders associated with VOGA's activities were identified by:

- Reviewing records of previous stakeholder consultation undertaken;
- Engaging with government and non-government organisations, as well as commercial fishing operators licensed/administered through DPIRD;
- Workshop sessions with both internal and external parties, including regulators; and
- Review of the regional context in which VOGA operates and the EMBA associated with the activity to identify which, if any, persons or organisations may be affected by the activities, including oil spill response.

9.3.1 Relevant Stakeholders

In identifying relevant persons to be consulted on the proposed petroleum activity, VOGA prescribes to the definition provided under Subregulation 11A(1) of the OPGGS (E) Regulations, being:

a) *each Department or agency of the Commonwealth to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant*

b) *each Department or agency of a State or the Northern Territory to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant*

c) *the Department of the responsible State Minister, or the responsible Northern Territory Minister*

d) *a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the environment plan, or the revision of the environment plan*

e) *any other person or organisation that the titleholder considers relevant.*

When identifying relevant persons, VOGA considers which stakeholders perform a function in the relation to – or have a function, activity or interest that may be impacted by – the planned, physical petroleum activity.

The planned activity for this EP is the well construction activity to be undertaken in Commonwealth waters. Therefore, in determining who is a relevant person for engagement on the petroleum activity, VOGA sought to identify and engage with stakeholders whose functions, interests or activities could be affected by the drilling activity.

9.3.1.1 *Unplanned event (emergency conditions)*

VOGA undertakes a more targeted approach to consultation with stakeholders in relation to unplanned emergency conditions.

Stakeholders who may perform a function in VOGA planning for, or management of an unplanned activity, and whose information is integral to the development of those management plans, are considered relevant and are engaged during the development of the EP and OPEP.

Stakeholders whose functions, interests or activities otherwise overlap the Hydrocarbon Area or EMBA are not considered relevant to the planned activity and so not engaged during the development of those plans but may be engaged in the event of an unplanned emergency condition. This approach has been adopted to reduce consultation fatigue for stakeholders who will not be impacted by the (physical) petroleum activity.

9.3.1.2 *Commercial Fishery stakeholders*

In addition to the process outlined above for planned activities and unplanned events, identification of relevant commercial fishing stakeholders distinguishes between:

• Fisheries with legal boundaries that overlap the planned petroleum activity and have active operations in the vicinity; and

• Fisheries with legal boundaries and have active operations that overlap the Hydrocarbon Area and EMBA but not the location of the planned petroleum activity.

To minimise stakeholder fatigue, VOGA restricted stakeholder engagement to licence holders in fisheries with legal boundaries that overlap the location of the planned petroleum activity. VOGA also considered if and where licence holders are active (or potentially active) within a fishery to assess whether that licence holder should be engaged.

Table 9-1: Stakeholder mapping

Stakeholder Group	Stakeholder	Relevance and engagement approach
State Government	Department of Mines, Industry Regulation and Safety (DMIRS)	Relevant Directly consulted
	WA Department of Primary Industries and Regional Development (DPIRD)	Relevant Directly consulted
	Department of Transport – Marine Safety	Relevant Directly consulted
	Department of Biodiversity, Conservation and Attractions (DBCA)	Relevant Directly consulted
Commonwealth	Director of National Parks	Relevant Directly consulted
	Australian Maritime Safety Authority (AMSA)	Relevant Directly consulted
	Australian Fisheries Management Authority (AFMA)	Relevant Directly consulted
Fishery Associations	Commonwealth Fisheries Association (CFA)	Relevant Directly consulted
	Western Australian Fishing Industry Council (WAFIC)	Relevant Directly consulted
	Pearl Producers Association	Relevant Directly consulted
Commercial fisheries overlapping the planned petroleum activity (active)	Mackerel Managed Fishery (Area 2) (WA)	Relevant Directly consulted (individual fishers)
	Pilbara Fish Trawl (Interim) Managed Fishery (WA)	
	Pilbara Line Fishery (WA)	
Commercial Fisheries in the Hydrocarbon Area or EMBA (unplanned event – emergency conditions) (active)	North-West Slope Trawl Fishery (Cth)	Not relevant to planned activity Licence holders to be informed in the event of unplanned emergency event
	Western Deepwater Trawl Fishery (Cth)	
	Western Tuna and Billfish Fishery (Cth)	
	Mackerel Managed Fishery (Areas 1 & 3) (WA)	
	Nickol Bay Prawn Managed Fishery (WA)	
	Mackerel Managed Fishery (WA)	
	Kimberley Mud Crab Fishery (WA)	
	Pilbara Crab Managed Fishery (WA)	
	Onslow Prawn Managed Fishery (WA)	

Stakeholder Group	Stakeholder	Relevance and engagement approach
	Kimberley Gillnet and Barramundi Fishery (WA)	
	Broome Prawn Managed Fishery (WA)	
	Kimberley Prawn Managed Fishery (WA)	
	North Coast Demersal Scalefish Fishery (WA)	
	Exmouth Gulf Prawn Fishery (WA)	
	Gascoyne Demersal Scalefish Fishery (WA)	
	Pearl Oyster Fishery (WA)	
	Beche-de-mer (Sea Cucumber) Fishery (WA)	
	Northern Shark Fishery (WA)	
	West Coast Rock Lobster Managed Fishery (WA)	
	Shark Bay Crab Interim Managed Fishery (WA)	
	Shark Bay Scallop Fishery (WA)	
	Shark Bay Prawn Fishery (WA)	
	Inner Shark Bay Scalefish Fishery (WA)	
	Abrolhos Islands and Mid West Trawl Limited Entry Fishery (WA)	
	West Coast Demersal Scalefish Interim Managed Fishery (WA)	
	West Coast Deep Sea Crustacean Fishery (WA)	
	Octopus Fishery (WA)	
	West Coast Purse Seine Fishery (All Zones) (WA)	
	Abalone Managed Fishery (WA)	
	Pilbara Trap Managed Fishery (WA)	
Shipping	Australian Hydrographic Office (AHO)	Relevant Directly consulted
	Commonwealth Department of Defence (DoD)	Relevant Directly consulted
Industry (Adjacent Titleholder)	Jade stone Energy	Relevant Directly consulted
Tourism and Recreation	Boating Industry Association WA (BIAWA)	Relevant Directly consulted
	RecFishWest	Relevant Directly consulted

Stakeholder Group	Stakeholder	Relevance and engagement approach
Other	Australian Petroleum Production and Exploration Association (APPEA)	Relevant Directly consulted
	Pilbara Port Authority	Relevant Directly consulted
	National Offshore Petroleum Titles Administrator (NOPTA)	Relevant Directly consulted

9.4 Stakeholder Engagement Process and EP Update

Feedback is sought from the identified stakeholders on the proposed activity, including the proposed management approach detailed in the EP. Based on the feedback received, VOGA may review relevant controls and update them as required. The stakeholder engagement process is outlined in Figure 9-1.

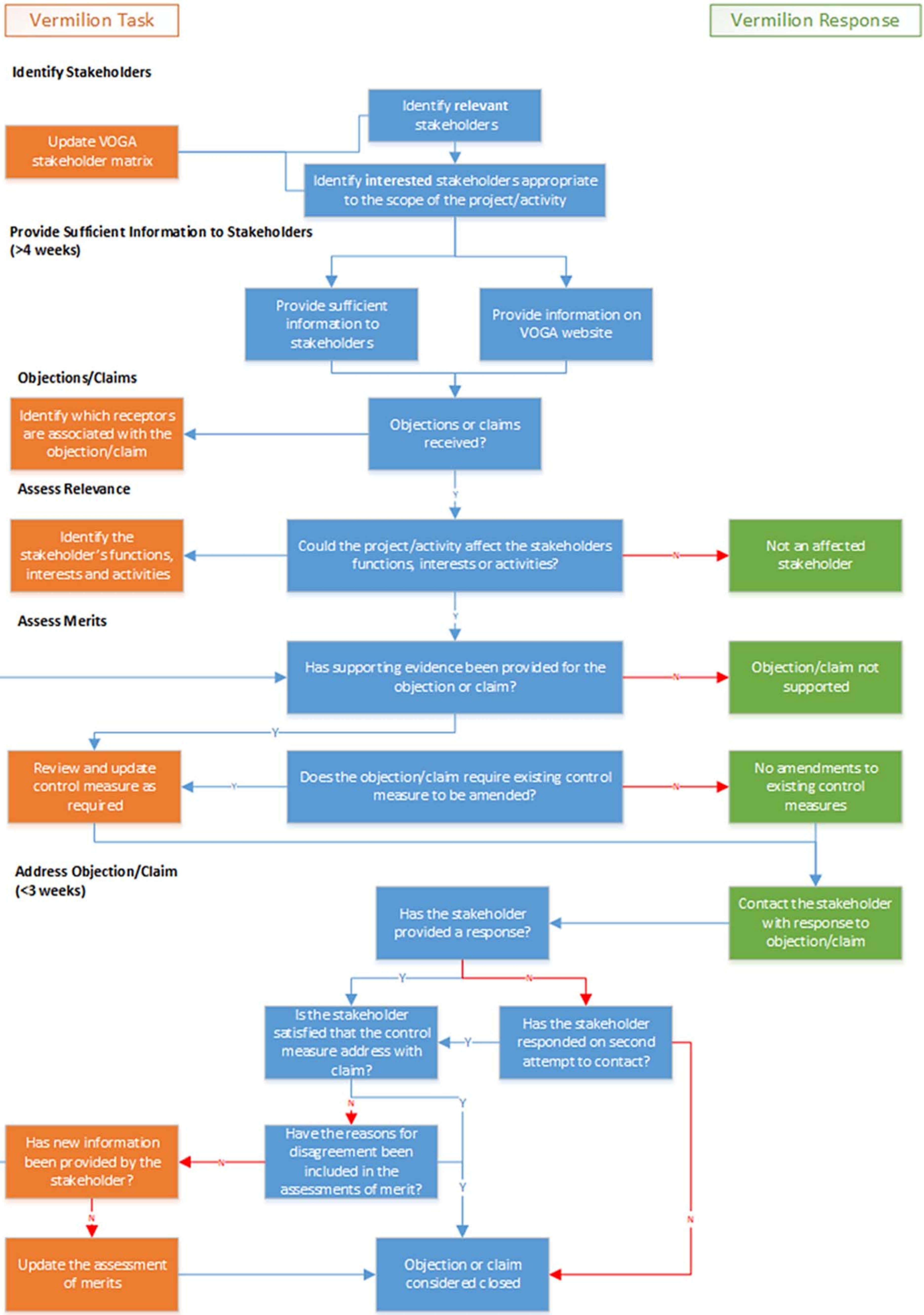


Figure 9-1: Stakeholder consultation workflow

9.5 Summary of stakeholder consultation

9.5.1 Historic Stakeholder Engagement Relevant to the Activities

During the period November 2013 to June 2014, VOGA engaged with stakeholders by telephone and email, and held briefing meetings (when applicable) to present an overview of its current and planned operations, the Wandoo Field OSCP [WAN-2000-RD-0001] and spill modelling, and seek feedback and comment.

More consultation was undertaken in the period July to December 2016 with WAFIC, DOF (now DPIRD) AFMA, DPaW (now DBCA), Pearl Producers Association and Recfishwest to provide an update on Wandoo activities and review current engagement arrangements with licence holders.

Stakeholders were also engaged prior to the 2015, 2016 and 2018/19 well construction campaigns, as per the Well Construction EP [WPA-7000-YH-0001].

A full copy of the VOGA briefing packages, correspondence and full text of the stakeholder replies are held in the VOGA's Document Control System and are available for review on request.

9.5.2 Current Stakeholder Engagement Feedback

Letters containing information relevant to the activity, tailored to each stakeholder category, were issued during November 2019.

The relevance of the stakeholder objections or claims received to date have been assessed based on their functions, interests and activities and supporting information provided. Appropriate responses to all stakeholders have been provided where required. Table 9-2 provides a summary of stakeholder engagement conducted for this activity.

Table 9-2: Stakeholder engagement summary

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
WA DMIRS (previously DMP)	Provide DMIRS with information and opportunity to comment proposed activities. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. A mail response from DMP on 11 February requested additional information on the proposed activity. VOGA issued copy of EP summary and covering letter to DMP on 20 February, addressing DMP's information request from 11 February 2014. DMP confirmed via email (on 6 March 2014) that no additional information was required. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. DMP confirmed via email (on 21 August 2015) that no additional information was required. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. DMP acknowledged the 19 February 2016 letter with a reminder to notify the DMP of commencement and cessation notifications. VOGA sent an email on 22 April 2016 informing the DMP of the commencement of the 2016 well construction activities. DMP acknowledged the commencement email on 20 May 2016 with no comments. VOGA sent an email on 15 June 2016 informing the DMP of the cessation of the 2016 well construction activities. DMP acknowledged the commencement email on 20 July 2016 with no comments. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	2014 - DMP requested additional information on: • the activities particularly drilling that is planned; • the potential impacts of the activity; • spill modelling data; and potential for any impacts to State Waters/coast? 2019 – No response to consultation to date.	2014 - VOGA provided the DMP with details on the planned activity; spill modelling data; and the potential impacts of the activities to State Waters and the WA coast. DMP reviewed the notification and in their response did not require any further information. N/A	Continue to keep stakeholders informed during operations.
Pilbara Port Authority	Ongoing DPA participation in exercises. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent follow-up email on 26 February 2014 giving then Dampier Port Authority (DPA) further opportunity to provide input. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. The Pilbara Port Authority acknowledged the 19 February 2016 letter with no comments	No	No response to consultation to date.	N/A – No feedback received from DPA to date.	Continue to engage through Pilbara Critical Infrastructure Security Forum and regional spill response activities. Seek DPA participation in VOGA & industry exercises.

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
APPEA	Improve collective industry spill response capability through engagement with other APPEA member companies. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA followed up during participation in APPEA Safety, Environment and Oil Spill Response forums and through its attendance at twice yearly oil spill planning and capability workshops. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	No issues raised at forums to date.	Review and support actions within the industry on an ongoing basis.	Continued attendance at relevant forums and working groups.
AMOSC	Confirmation of oil spill resources, capability and command as per OSCP. Ongoing AMOSC participation in emergency response/oil spill scenario exercises. Obtain confirmation that AMOSC has a copy of an executed agreement for the provision of emergency response services to VOGA. AMOSC to have opportunity to comment on revised OSCP. Ensure MOU is in place allowing VOGA to access AMOSC equipment. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent request to AMOSC to provide its spill response resource list on 14 February 2014. AMOSC spill response resource list confirmed as part of OSCP preparations (14 and 20 February 2014). AMOSC issued update to VOGA (and other members) regarding its oiled wildlife response capability in the event of a spill (6 March 2014). VOGA representative participated in an AMOSC Oiled Wildlife Plans Presentation and Discussion Session on 8 July 2014 – to agree that a common WA Oiled Wildlife Response Plan be adopted. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	No issues raised in consultation to date.	VOGA included AMOSC resources and capability as part of OSCP review.	Ongoing engagement as required, as outlined in Section 9.5.3 - Issue revised OSCP to AMOSC once accepted.

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
AMSA	Confirmation of oil spill resources, capability and command as outlined in OSCP. Clarify AMOSC and AMSA Memorandum of Understanding (MOU). Confirmation of emergency contacts within AMSA. Confirm AMSA's ongoing participation in emergency response/oil spill scenario exercises. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA called and emailed AMSA 31 January 2014 re MOU between AMSA and offshore petroleum operators AMSA clarified arrangements relating to its involvement in an offshore oil spill, as detailed in its industry level MOU. AMSA confirmed industry level MOU has replaced need for individual operator consultation with AMSA. AMSA has provided MOU for VOGA signing and this is being reviewed by VOGA Corporate. VOGA has requested a meeting with AMSA to discuss spill risks from the Wandoo asset and to confirm responsibilities and command transition arrangements for marine spill events under the National Plan – requests issued to AMSA on 18 and 24 February and 27 August 2014. MOU signed by VOGA and sent to AMSA for signature on 15 October 2014. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	No issues raised in consultation to date.	VOGA included AMSA resources and capability as part of OSCP review.	Ongoing engagement as required, as outlined in Section 9.5.3 - Issue revised OSCP to AMSA once accepted.

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
WA DoT	Provide briefing/overview of OSCP. Confirmation of oil spill resources, capability and command with DoT as per OSCP. Confirmation of approval process for dispersant use. Ongoing DoT participation in emergency response/oil spill scenario exercises. Notification of well construction activities.	VOGA sent an email 24 January 2014 requesting a meeting in February to discuss the spill scenarios in the Wandoo Field OSCP. VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. DoT confirmed WA Government's role in marine oil spill response. DoT confirmed WestPlan Marine Oil Pollution only requires confirmation that an operator's OSCP is aligned with State and National response frameworks. DoT provided information on dispersant quantities and access (14 February 2014) and the dimensions of boom required for single vessel side sweep operations (26 February 2014). Meeting held with DoT on 25 February 2014 regarding oil spill scenarios and response plans. DoT confirmed its role as hazard management agency in the event of a spill and advised no MOU was required to access resources. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. Meetings held with WA DoT 15 December 2015 and 20 January 2016 to discuss changes to the WestPlan Marine Oil Pollution and State water arrangements. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA met with DoT in October 2017 regarding the Wandoo OPEP, cross jurisdictional arrangements and compliance with the Industry Guidance Note (IGN). VOGA sent relevant information from the OPEP and supporting documentation to DoT in accordance with the IGN (Appendix 4) on 3 November 2017. A desktop exercise ('Exercise Enderby') was held between Vermillion and DoT on 23 February 2018: 1. To practice conducting a JSCC meeting between VOGA and DoT in accordance with the protocol in the IGN; 2. To assess the IGN transfer of control checklist using a transfer of Control Agency meeting for a single jurisdiction response; and 3. To explore the incident action planning process that will be used by DoT when VOGA personnel join the DoT IMT. VOGA sent a letter on 20 December 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information. The correspondence also advised the following: • In accordance with Section 10.6 of the IGN, VOGA considers that no additional consultation is required for the current revision of the document as it has not introduced new or increased environmental risk and/or any material changes in response arrangements that have the potential to impact State waters. • The revised OPEP has been reviewed to maintain alignment with the latest IGN (September 2018).	No	No issues raised in consultation to date. 2019 – DoT thanked VOGA and noted the information provided	2014 - VOGA provided a copy of OSCP and confirmed alignment with State and National response frameworks.	Ongoing engagement as required, as outlined in Section 9.5.3 - Issue revised OSCP to DoT once approved.

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
WA DBCA (previously DPaW)	Establish greater understanding of the Western Australian Government's coordinated oiled wildlife response planning. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. DPaW advised, via email on 10 February 2014, that VOGA Operations Activities were unlikely to affect ecologically sensitive receptors in general area. VOGA participated in an AMOSC-led Oiled Wildlife Plans Presentation and Discussion Session on 8 July 2014 - to agree that a common WA Oiled Wildlife Response Plan be adopted. The session was attended by DPaW representatives. VOGA emailed DPaW on 19 November 2014 to provide clarification on our available baseline data and to enquire about accessing known DPaW data. DPaW responded on 9 January 2015. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter and fact sheet on 16 December 2016 regarding the modification to the PFW process. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	2014 - DPaW sought confidence that VOGA has undertaken investigations and has access to information on baseline ecological condition of sensitive receptors within the ZPI. DPaW recommended that VOGA develops and maintains a baseline understanding of shallow water (<2m) and intertidal benthic habitat, sediment and water characteristics, turtle and seabird nesting and roosting sites within a suitable radius of any future activities (as determined in consultation with DPaW). In the absence of current baseline data for any areas affected by future incidental hydrocarbon release, DPaW would assume the baseline state of affected marine and coastal onshore and offshore areas to be pristine and would expect VOGA to return affected areas to their natural state within a period acceptable to regulators and the community.	2014 - VOGA has undertaken a gap analysis of baseline data within the worst-case ZPI (Astron 2014). A key function of the review was to link the most reliable and relevant baseline data collection with their methodological approaches so that post spill data collection is carried out with the highest likelihood of effectively informing management decisions. Additionally, VOGA has committed to further marine monitoring within the Wandoo Field in the Wandoo Field EP [WPA-7000-YH-0007]. In the absence of required data, the Operational and Scientific Monitoring Plan [WAN-2000-RD-0001.03] has identified methodologies for obtaining relevant baseline data at the time of a spill. During the development of the gap analysis, DPaW was identified as having established marine monitoring programs for sediment quality at Shark Bay, Montebello Islands and Barrow Island, as well as water quality monitoring at various locations. VOGA contacted the DPaW Environmental Management Branch to determine whether this data contains hydrocarbon analysis, as well as how this data could be accessed in the event of a spill.	Continue to keep stakeholders informed during operations.
				2014 - DPaW advised that implementation of its oiled wildlife response must be mandated by regulatory decision makers as part of whole-of-government response.	2014 - VOGA advised DPaW of the process for implementation of the Oiled Wildlife Response Measures, which are detailed in the EP, and acknowledged DPaW's valuable input to the development of these measures.	
				2014 - DPaW advised that in the event of an oil spill occurring in State waters, the DER Environmental Hazard Branch should be notified as soon as practicable in accordance with the requirements of the *Environmental Protection Act 1986*. If a site within State jurisdiction is potentially contaminated VOGA must report the area to the DER Contaminated Sites Branch in accordance with the requirements of the *Contaminated Sites Act 2003*.	2014 - Within the Wandoo Field OSCP [WAN-2000-RD-0001], VOGA has identified that DPaW will be invited to participate in the VOGA Incident Command Team during a spill to ensure that the response is reasonable and proportionate and to ensure that resources that may assist DPaW to undertake its function are supplied.	
				2014 - DPaW advised that the EP must consider the method of disposal of oily waste within State sea or land areas.	2014 - Within the Wandoo Field OSCP [WAN-2000-RD-0001] the VOGA waste management plan identifies companies and resources necessary for the offshore/shoreline temporary storage, marine transport, onshore final disposal, and auditing requirements, to ensure acceptable cradle-to-grave disposal practices are in place for all oily wastes.	
				2019 – No response to consultation to date.	N/A	

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
WA DPIRD (previously DoF)	Provide DPIRD with information on operations activities. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent a follow-up email on 25 February 2014. DoF advised it considered itself a 'relevant person' for the proposed activity. VOGA sent a letter on 11 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter and fact sheet on 25 October 2016 regarding the modification to the PFW process. VOGA sent a letter and risk assessment on 19 December 2016 responding to the questions raised by DoF on the modification to the PFW process. VOGA sent DPIRD a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	2014 - DoF recommended VOGA consult with WAFIC, Recfishwest and commercial fishers directly with regard to proposed well construction activities.	2014 - VOGA sent letters to WAFIC, Recfishwest and commercial fisheries on 4 July 2014 outlining the proposed activities. No feedback has been received to date. VOGA will engage directly with WAFIC, Recfishwest and commercial fisheries as appropriate.	Ongoing engagement as required, as outlined in Section 9.5.3
				2014 - DoF requested that VOGA collect baseline marine data to compare against any post-spill monitoring to determine the nature and extent of any impacts, and specific strategies are developed in EP and/or OSCP to mitigate the risks of spills on fish spawning areas.	2014 - VOGA has undertaken a gap analysis of baseline data within the worst-case ZPI (see DPaW response). Strategies to mitigate the impact of a hydrocarbon spill on sensitive environmental receptors, including impacts on fish and fisheries, have been detailed in the Wandoo Field OSCP [WAN-2000-RD-0001].	
				2014 - DoF requested that the risk of translocating pests and diseases via immersible equipment be minimised.	2014 - VOGA has identified and risk assessed the potential for introducing invasive marine species and developed appropriate controls. These controls include vessels obtaining quarantine clearance prior before entering Australian waters and current International Anti-fouling System Certificate for all support vessels.	
				2016 - DoF requested that affected fishers are consulted prior to the commencement of the proposed PFW modifications. DoF recommended that VOGA maintains ongoing consultation with WAFIC, the Pearl Producers Association of WA, Recfishwest, DPaW and directly with fishers (acknowledging that VOGA had already undertaken consultation with WAFIC and fishers). DoF also requested that the paper by Bakke *et al.* (2013) be considered in the PFW impact assessment and notified if mortality of individual “fish” is likely.	2016 - VOGA sent letters and the fact sheet regarding the proposed modifications to the PFW process to Recfishwest, DPaW and the Pearl Producers Association at the request of DoF. Pearl Producers Association were acknowledged as interested due to their Zone 1 fishing zone surrounding the Wandoo Permit Area (currently inactive). VOGA provided a summary copy of the PFW risk assessment to DoF and provided context of our risk assessment to the results of the Bakke *et al.* (2013) paper. It was noted that drill cuttings are not included within the scope of the Wandoo Facility Environment Plan and are therefore outside the scope of the submission. Vermilion will review this information as part of our Well Construction Environment Plan annual review. VOGA confirmed that no mortality to individual ‘fish’ was assessed as likely.	
				2019 – No response to consultation to date.	N/A	

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
AFMA	Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. AFMA confirmed via email on 29 January 2014 that it has developed new guidelines and a Fishing Consultation Directory to assist the petroleum industry. AFMA had no further comments on these specific activities as the area does not appear to overlap with any Commonwealth fisheries. AFMA would appreciate further consultation when there is any change to VOGA activities. VOGA sent a letter on 11 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. AFMA acknowledged the 19 February 2016 letter with no comments other than to ensure that VOGA continue to consult with affected fishers in the area, and requested that all future correspondence be sent to petroleum@afma.gov.au. VOGA sent a letter and fact sheet on 25 October 2016 regarding the modification to the PFW process. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	2016 - AFMA recommended engaging directly with fishers ahead of drilling. 2019 – No response to consultation to date.	2016 - Letters were issued to fishing licence holders in the vicinity of the Wandoo facility and the WA Pearl Producers Association, which distributed the letter to its members. VOGA will engage directly with fishers as appropriate ahead of drilling. N/A	Continue to keep stakeholders informed during operations.
Commercial fisheries	Notification of well construction activities.	VOGA sent letters on 4 July 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent letters on 12 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent letters on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent letters and the fact sheet on 25 July 2016 regarding the modification to the PFW process. VOGA sent letters on 5 September 2018 regarding the upcoming 2018/19 Wandoo Well Construction campaign. VOGA sent letters to individual fishers of active fisheries overlapping or in close vicinity of the planned petroleum activity (in accordance with Section 9.3.1.2) on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	No issues raised in consultation to date.	N/A	Ongoing engagement as required, as outlined in Section 9.5.3

WAFIC	Provide information on proposed operations activities. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent a follow-up email on 25 February 2014. VOGA sent a letter on 11 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. Meeting with WAFIC on 21 July 2016 regarding the modification to the PFW process. VOGA sent an email on and fact sheet on 6 September 2018 informing WAFIC of the upcoming 2018/19 Wandoo Well Construction campaign. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information. VOGA followed up with an email on 15 November 2019 advising that a number of individual licence holders were being consulted with directly regarding the well construction activity, and provided an example of the information they would receive. WAFIC replied on 15 November 2019 with a number of concerns and queries related to the stakeholder consultation approach, information provided and activity interaction with fishers and fish. WAFIC also attached the WAFIC's fee-for-service information and advised that they believe it can add significant value in information review and dissemination of information services. WAFIC advised that they can do the full commercial fishing consultation with a complete detailed report subject to other ongoing work commitments. VOGA responded to the concerns and queries with a letter on 3 January 2020. VOGA followed up with an email to WAFIC clarifying the approach to consultation with commercial fisheries on 8 January 2020. WAFIC responded on 8 January 2020 regarding the fisheries considered relevant and the fisheries within the EMBA, plus queries. VOGA responded on 9 January 2020 and clarified the approach, answered the queries and noted the comments.	No	2019 – WAFIC advised that: They insist on information bespoke for the commercial fishing sector; The fisheries identified to be "relevant potentially affected parties" to the activities described in the EP are wrong; Consultation fatigue is very real so therefore difficult to get a reply if not succinct and if not commercial fishing focussed; Identify upfront any potential impacts to commercial fishing activities and the commercial fishing resource (ie key indicator species); What happens in worse possible scenario situation, what science are you relying on for an accurate before and after assessment of commercial fishing key indicator species?; Identify active fisheries (state and commonwealth managed) with legal fishery boundaries overlapping the Wandoo site; If a fishery is not active over the site no consultation is required but you must account for the resource in the EP; What is Vermillion's policy in relation to *"No fishing from support/commercial vessels"?;* What processes does Vermillion have in place to quantitively assess any damage to fish stocks in the event of a spill event?; What science are you using to demonstrate that Vermilion has a full understanding of fish spawning practices and will avoid any activities which may potentially impact fish spawning periods; What lessons has Vermillion learned from other global spill events, especially in relation to emergency response time and (early) control of the oil loss in Australia's isolated north west oceans?; Is Vermillion's staff, and contractors and sub-contractors all aware of the difference between exclusion zones and cautionary zones? ; What is Vermillion's communication policy with all staff and vessel crew, contractors and sub-contractors regarding interacting and protecting the rights of active commercial fishers on the water?	2019 – VOGA responded that: Given the range of stakeholders with whom Vermilion must consult, we endeavour where possible to tailor information to be relevant to stakeholders. We have provided relevant information on which stakeholders can form a view as to the appropriateness of the controls that Vermilion implements as part of our activities in the Wandoo field; Vermilion has reviewed and considered the legal fishery boundaries overlapping the Wandoo site through various sources. Attached the VOGA stakeholder identification and classification information relevant to the activity. On review of this information if you still believe that the identified fisheries are incorrect, Vermilion would like to work collaboratively with WAFIC to ensure we communicate with the correct stakeholders going forward; Within Project exclusion zone area - VOGA doesn't permit fishing (commercial or recreational) from vessels. This policy is enforced and communicated to all our contractors and subcontractors and third parties. Vessels outside the project exclusion zone are not under the control of VOGA and therefore are not within the scope of our EP; Vermilion has a Wandoo Field Operational and Scientific Monitoring Plan (OSMP). This OSMP is informed by the sensitive receptors that could be impacted during a hydrocarbon spill, as identified in the EP. This OSMP has a suite of fisheries-specific Operational and Scientific Monitoring Programs to inform effectiveness of spill response and to quantify and assess impacts (and recovery) during and post spill; Vermilion is not conducting further stock assessment research for commercial fisheries species given stock assessment information is routinely produced by Australian Fisheries Management Authority (AFMA) and WA Department of Primary Industries and Regional Development (DPIRD) fishing authorities; The EP describes known spawning/aggregation periods for commercial fish species; VOGA has a comprehensive source control, emergency response and oil spill management procedures and processes in place which are documented within the Wandoo Field OSCP; VOGA staff and contractors are aware of the difference between exclusion and cautionary zones; Potential impacts associated with Project vessels interactions with other marine users (inclusive of recreation and commercial fishers) utilising Wandoo field regions have been conducted as part of project risk assessment	Ongoing engagement as required, as outlined in Section 9.5.3

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Next steps
					and considered within the EP. Majority of project vessel movements is to and from Dampier Port or waiting on standby within the Wandoo Field; this is consistent with our day-to-day operational activities at Wandoo. Given our proximity to the port and the commercial vessel traffic in our area we are unlikely to create any additional impact to fishing vessels than what currently exists in the area. As per previous campaigns, Vermilion has procedures in place to ensure Project vessels operate according to AMSA requirements and in line with consultation feedback from maritime stakeholders. WAFIC emailed on 8 January 2020 and identified some errors in fishery identification and asked questions on the stakeholder approach to fisheries. VOGA followed up with emails to WAFIC clarifying the approach to consultation with commercial fisheries (8 and 9 January 2020).	
Pearl Producers Association	Provide information on operational activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 18 August 2014 regarding the VOGA Wandoo Field Activities. VOGA sent a response email on 18, 19, 21 & 27 August 2014. VOGA sent a letter and fact sheet on 16 December 2016 regarding the modification to the PFW process. VOGA sent an email and fact sheet on 6 September 2018 informing PPA of the upcoming 2018/19 Wandoo Well Construction campaign. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	Pearl Producers Association requested on 19 August 2016 clarification on whether the VOGA operations are new or existing.	VOGA confirmed via email on 19 August 2014 that the operations and well construction activated are existing.	Continue to keep stakeholders informed during operations.
				Pearl Producers Association requested on 21 August 2014 an improved map to include the water depth contours of the operational area.	VOGA provided updated maps to Pearl Producers Association, including depth contours via email on 27 August 2014.	
				Pearl Producers Association requested clarification on 21 August 2014 whether seismic survey activity formed part of the proposed operational activities.	VOGA confirmed with Pearl Producers Association via email on 21 August 2014 that no seismic survey activity is contained within the proposed operational activities.	
				2019 – No response to date	2019 – N/A	
Recfishwest	Provide information on operational activities. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent letters on 4 July 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter and fact sheet on 19 December 2016 regarding the modification to the PFW process. VOGA sent an email and fact sheet on 6 September 2018 informing PPA of the upcoming 2018/19 Wandoo Well Construction campaign. VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	No issues raised in consultation to date.	N/A	Continue to keep stakeholders informed during operations.
Jadestone	Notification of well construction activities.	VOGA sent a letter on 1 November 2019 advising that the Well Construction EP was being reviewed to support the statutory requirement for resubmission and acceptance at the end of each period of 5 years, providing relevant activity details and contact details to request further information.	No	No issues raised in consultation to date.	N/A	Continue to keep stakeholders informed during operations.

9.5.3 Ongoing Consultation

Details of ongoing consultation required for proposed well construction activities are outlined in Table 9-3.

Should any significant change to the potential or actual environmental impacts detailed in the EP for any well construction activity be identified, VOGA will inform all relevant stakeholders in writing of the change and seek feedback via a consultative process.

Stakeholders will be able to access information on VOGA's activities via NOPSEMA's website where the full EP will be published.

VOGA has provided all stakeholders with contact details, and the company can be contacted directly regarding any aspect of our activity. Each enquiry will be carefully considered with responses provided in a timely manner.

Table 9-3: Ongoing stakeholder consultation requirements

Stakeholder	When	Ongoing stakeholder consultation requirements
Australian Hydrographic Service (AHS) – Department of Defence	When MODU on well location	MODU to email location so AHS can issue Notice to Mariners
Relevant Commercial Fisheries: WAFIC DPIRD Pearl Producers Association Mackerel Managed Fishery (Area 2) (WA) Pilbara Fish Trawl (Interim) Managed Fishery (WA) Pilbara Line Fishery (WA)	Within 1 month of each well construction program commencement	Provide start and end dates of proposed activities
Australian Marine Oil Spill Centre (AMOSC) Australian Maritime Safety Authority (AMSA) WA Department of Transport (DoT)	On acceptance of EP	Issue copy of Wandoo Field OSCP
NOPSEMA (Cth)	At least 10 days prior to commencement and within 10 days of completion	NOPSEMA will be notified of the activity commencement and cessation, using the Regulation 29 Notification Form available at https://www.nopsema.gov.au/environmental management/notification-and-reporting/
NOPTA (Cth)	48 hours prior to Commencement and upon completion	NOPTA will be notified of the activity commencement and cessation via reporting@nopta.gov.au

10 References

Adams, G.G., Klerks, P.L., Belanger, S.E., and Dantin, D. (1999). The Effect of the Oil Dispersant Omni-Clean on the Toxicity of Fuel Oil No. 2 in Two Bioassays with the Sheepshead Minnow *Cypriodon variegates*. *Chemosphere* 39: pp2141–2157

Ampolex Limited (1995). Wandoo Full Field Development Public Environment Report, November 1995.

AMSA (2012). The National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances, Protocol for the Register of Oil Spill Control Agents. Australian Maritime Safety Authority, Canberra.

AMSA and Maritime New Zealand. Oil Spill Monitoring Handbook, <http://www.amsa.gov.au/>

ANZECC/ARMCANZ (2000). National Water Quality Management Strategy: An introduction to the Australian and New Zealand guidelines for fresh and marine water quality, Australian Government Department of Sustainability, Environment, Water, Population and Communities, Viewed online <http://www.environment.gov.au/water/policy-programs/nwqms/>

APASA (2012). Oil Spill Modelling for the Wandoo Production Platform, Western Australia. Prepared for Vermillion Energy, pp.177.

APASA (2013). Wandoo Production Platform Loss of Well Control Oil Spill Modelling Study. Prepared for Vermillion Oil and Gas Australia Pty Ltd

APPEA (2008). *Code of Environmental Practice*. Australian Petroleum Production and Exploration Association, Canberra.

AS NZS ISO 31000-2009 Risk management – Principles and guidelines.

ASTM (1987). Ecological Considerations for the Use of Chemical Dispersants in Oil Spill Response – Coral Reefs. In: Annual Book of Standards, v11.04, pp909-923, 832-938, 941-961. Standard F971-86. American Society of Testing and Materials. Philadelphia

Astron Environmental Services. 2014. *OSMP Baseline Data Assessment and Gap Analysis. Prepared for Vermilion Oil and Gas Australia*. Report Reference: 18002-14-SNSR-1. November 2014.

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. National Water Quality Management Strategy Paper No. 4. Environment Australia, Canberra.

Australian Fisheries Management Authority (AFMA). (2008a). *Western Deepwater Trawl Fishery Data Summary.* Australian Fisheries Management Authority, Canberra.

Australian Fisheries Management Authority (AFMA). (2008b). *North West Slope Trawl Fishery Data Summary.* Australian Fisheries Management Authority, Canberra.

Australian Fisheries Management Authority (AFMA). (2009). *Annual Status Report Western Tuna and Billfish Fishery.* Australian Fisheries Management Authority, Canberra.

Australian Fisheries Management Authority (AFMA). (2010). *Annual Status Report Skipjack Tuna Fishery.* Australian Fisheries Management Authority, Canberra.

Baird, A.H., Blakeway, D.R., Hurley, T.J., Stoddart, J.A. (2011). Seasonality of coral reproduction in the Dampier Archipelago, northern Western Australia. *Marine Biology* 158: 275-285.

Baker, C., Potter, A., Tran, M., and Heap, A.D. (2008). Geomorphology and Sedimentology of the Northwest Marine Region of Australia. *Geoscience Australia, Record 2008/07*. Geoscience Australia, Canberra.

Baker, C.S., and Herman, L.M. (1989). Behavioural responses of summering humpback whales to vessel traffic: experimental and opportunistic observations. Final Report to the National Park Service. US Department of the Interior, Anchorage, AK.

Ballou, T.G., Dodge, R.E., Hess, S.C., Knap, A.H., and Sleeter, T.D. (1987). Effects of a Dispersed and Undispersed crude oil on Mangroves, Seagrasses and Corals, American Petroleum Institute, Washington DC

Bancroft, K.P. (2003). A standardised classification scheme for the mapping of shallow-water marine habitats in Western Australia. Marine Conservation Branch, Department of Conservation and Land Management, Report MCB-05/2003. Fremantle, Western Australia.

Bannister, A., Kemper, C.M., and Warnecke, R.M. (1996). *The Action Plan for Australian Cetaceans.* Australian Nature Conservation Agency, Canberra.

Bannister, J. (1994). Western Australian Humpback and Right Whales: An Increasing Success Story. Western Australian Museum, Perth.

Bannister, J.L., Calaby, J.H., Dawson, L.J., Ling, J.K., Mahoney, J.A., McKay, G.M., Richardson, B.J., Ride, W.D.L., and Walton, D.W. (1998). Mammalia. Australian Government Publishing Services, Canberra.

Bennelongia (2009). Ecological Character Description for Roebuck Bay. Report to the Department of Environment and Conservation. Bennelongia Pty Ltd, Jolimont.

Bennett, M., and Bansemer, C. (2004). Investigations of Grey Nurse Shark in Queensland to fulfil actions under the Recovery Plan for Grey Nurse Shark (*Carcharias taurus*) in Australia regarding impact of divers, and establishment of a photographic database to improve knowledge of migratory movements, localised site movements and estimation of bycatch. Prepared for Department of Environment and Heritage by School of Biomedical Sciences, The University of Queensland, Brisbane.

BHP Billiton (2005). Pyrenees Development Draft Environmental Impact Statement (EIS). BHP Billiton. Perth.

Bishop, S.D.H., Francis, M.P., Duffy, C., and Montogomery, J.C. (2006). Age, growth, maturity, longevity and natural mortality of the shortfin mako shark (*Isurus oxyrinchus*) in New Zealand waters. *Marine and Freshwater Research* 57: 143-154.

Bjorndal, K.A. (1985). Nutritional Ecology of Sea Turtles. *Copeia* 3: 736–751.

Black, K.P., Brand, G.W., Grynberg, H., Gwyther, D., Hammond, L.S., Mourtikas, S., Richardson, B.J., and Wardrop, J.A. (1994). Production Facilities. In: *Environmental Implications of Offshore Oil and Gas Development in Australia - The Findings of an Independent Scientific Review.*

Blakeway, D., and Radford, B.T.M. (2005). Scleractinian corals of the Dampier port and inner Mermaid Sound: species list, community composition and distributional data. In J.A. Stoddart and S.E. Stoddart (eds.) *Corals of the Dampier Harbour: Their Survival and Reproduction During the Dredging Programs of 2004*. MScience Pty Ltd, Perth.

Blumer, M. (1971). Scientific aamsaspects of the oil spill problem. Environmental Affairs 1,54-73.

Boehm P.D., Turton, A., Raval, D., Caudle, D., French, D., Rabalaise, N., Spies, R., and Johnson, J. (2001). Deepwater Program: Literature Review, Environmental Risks of Chemical Products used in Gulf of Mexico Oil and Gas Operations; Vol 1: Technical Report. OCS Study MMS 2001-011. US Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA 326pp.

Bowman Bishaw Gorham (BBG). (1996). Environmental Baseline Survey Wandoo B. Report prepared for Ampolex Ltd (Ampolex Report Number 17486).

Boyd, J.N., Scholz, D., and Hayward-Walker, A. (2001). Effects of Oil and Chemically Dispersed Oil in the Environment. International Oil Spill Conference, pp 1213-1216.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C. Hucke-Gaete, R. Jenner, K.C.S., Jenner, M.-N.M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best. P.B., Borosa, P., Brownell, Jr., A.R.L., Childerhouse, S., Findlay, K.P., Gerodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B. Ljungblad, D.K., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerbeek, K., and Warneke, R.M. (2007). Past and present distribution, densities and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and northern Indian Ocean. *Mammal Review* 37: 116-175.

Brewer, D., Lyne, V., Skewes, T., and Rothlisberg, P. (2007). *Trophic systems of the North West Marine Region.* Report to the Department of the Environment and Water Resources. CSIRO Marine and Atmospheric Research, Australia.

Bureau of Meteorology (BOM). (2010). Climate Statistics for Australian Locations. A WWW publication accessed in April, 2010 at <http://www.bom.gov.au>

Bureau of Meteorology (BOM). (2012). *Climatology of Tropical Cyclones in Western Australia*. Accessed 13 April 2012. <http://www.bom.gov.au/cyclone/climatology/wa.shtml>

Burns, K.A., Codi, S., Pratt, C., and Duke, N.C. (1999). Weathering of hydrocarbons in mangrove sediments: testing the effects of using dispersants to treat oil spills, Organic Geochemistry, Vol. 30, pp.1273-1286 Australia.

Butcher, R., and Hale, J. (2010) Ecological Character Description for The Dales Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

CALM (2005). Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area. Department of Conservation and Land Management, Perth, Western Australia.

CALM and MPRA (2005). Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Management Plan No. 52. Department of Conservation and Land Management and Marine Parks and Reserves Authority.

Campana, S.E., Marks, L., and Joyce, W. (2005). The biology and fishery of shortfin mako sharks (*Isurus oxyrinchus*) in Atlantic Canadian waters. *Fisheries Research* 73: 341-352.

Carr, A., and Stancyk, S. (1975). Observations on the ecology and survival outlook of the hawksbill turtle. *Biological Conservation* 8: 161-172.

Carr, B., and Livesey, N. (1996). *Pilbara Mangrove Study*. Prepared for the Heritage Council of Western Australia. Murdoch University, Perth.

Cassata, L., and Collins, L.B. (2008). Coral reef communities, habitats and substrates in and near sanctuary zones of Ningaloo Marine Park. Journal of Coastal Research, Vol. 241:39–151

Cavanagh, R.D., Kyne, P.M., Fowler, S.L., Musick, J.A. and Bennett, M.B. (eds). (2003). The conservation status of Australian chondrichthyans: report of the IUCN Shark Specialist Group Australia and Oceania and Oceania Regional Red List Workshop. School of Biomedical Sciences, The University of Queensland, Brisbane.

Chatto, R. (1995). Sea turtles killed by flotsam in northern Australia. *Marine Turtle Newsletter* 69: 17-18.

Chatto, R. (1998). A preliminary overview of the locations of marine turtle nesting in the Northern Territory. In R. Kennett, A. Webb, G. Duff, M. Guinea and G. Hill (eds). *Marine turtle conservation and management in northern Australia*. Northern Territory University, Darwin.

Chatto, R., and Baker, B. (2008). *The distribution and status of marine turtle nesting in the Northern Territory-Technical Report 77/2008*. Parks and Wildlife Service, Department of Natural Resources, Environment, The Arts and Sport. Northern Territory Government.

Chevron Australia (2005). Draft Environmental Impact Statement/Environmental Review and Management Program for the Proposed Gorgon Development. Chevron Australia Pty Ltd, Perth.

Chevron Australia (2008). Gorgon Gas Development Revised and Expanded Proposal Public Environmental Review Operated by Chevron Australia in joint venture with Gorgon Project. EPBC Referral 2008/4178 Assessment No. 1727. Chevron Australia Pty Ltd, Perth, Western Australia, September 2008.

Chevron Australia (2009). Gorgon Gas Development and Jansz Feed Gas Pipeline Long Term Marine Turtle Management Plan. Chevron Australia Pty Ltd, Perth.

Chevron Australia (2010). Gorgon Gas Development and Jansz Feed Gas Pipeline Costal and Marine Baseline State and Environmental Impact Report. Chevron Australia Pty Ltd, Perth.

Chittleborough, R.G. (1953). Aerial Observations on the Humpback Whale, Megaptera novaeangliae (Borrowski). Australian Journal of Marine and Freshwater Research 4. pp 219-266.

Chittleborough, R.G. (1965). Dynamics of Two Populations of the Humpback Whale, Megaptera novaeangliae (Borrowski). Australian Journal of Marine and Freshwater Research 16. pp 13-128.

Cintron, G., Lugo, A.E., Marinez, R., Cintron, B.B., and Encarnacion, L. (1981). Impact of oil in the tropical marine environment. Technical Publication, Division of Marine Research, Department of Natural Resources, Puerto Rico.

Clark, J.R., Bragin, G.E., Febbo, R.J., and Letinski, D.J. (2001). Toxicity of physically and chemically dispersed oils under continuous and environmentally realistic exposure conditions: Applicability to dispersant use decisions in spill response planning. *Proceedings of the 2001 International Oil Spill Conference*. Pp. 1249-1255, Tampa, Florida. American Petroleum Institute, Washington, D.C.

Coelho, G., Clark, J., and Aurand, D. (2013). Toxicity testing of dispersed oil requires adherence to standardized protocols to assess potential real world effects. Environmental Pollution (2013), http://dx.doi.org/10.1016/j.envpol.2013.02.004

Commonwealth of Australia (2002). Ningaloo Marine Park (Commonwealth Waters) Management Plan. Environment Australia, Canberra.

Commonwealth Scientific and Industrial Research Organisation (CSIRO). (2006). Ecosystem characterisation of Australia's North West Shelf. North West Shelf Joint Environmental Management Study. Technical Report No.12. Accessed 18th July 2012. <http://www.cmar.csiro.au>

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 Study Technical Report No. 6*. CSIRO Marine and Atmospheric Research, Australia.

Connell, D.W., and Miller, G.J. (1981). Petroleum hydrocarbons in aquatic ecosystems – behaviour and effects of sublethal concentrations. CRC Report: Critical Reviews in Environmental Controls

Corexit 9527 and 9500, water accommodated fraction (WAF) of crude oil and dispersant enhanced WAF (DEWAF) to *Hydra viridissima* (green hydra). *Water Research* 34:343–348

Costello, M.J., and Read, P. (1994). Toxicity of sewage sludge to marine organisms: a review. Marine Environmental Research 37:23–46

Coutou, E.I. Castritis-Catharios and M. Moraitou-Apostolopoulo. (2001). Surfactant-based oil dispersant toxicity to developing nauplii of Artemia: effects on ATPase enzymatic system. *Chemosphere* 42:959-964.

D'Adamo, N., Fandry, C., Buchan, S., and Domingues, C. (2009). Northern sources of the Leeuwin Current and the "Holloway Current" of the North West Shelf. *Journal of the Royal Society of Western Australia* 92: 53-66.

Davis, T.L.O., Jenkins, G.P., and Young, J.W. (1990). Diel patterns of vertical distribution in larvae of southern bluefin *Thunnus maccoyii* and other tuna in the East Indian Ocean. *Marine Ecology Progress Series* 59: 63-74.

de Lestang, S., Caputi, N., How, J., Melville-Smith, R., Thomson, A., and Stephenson, P. (2012). Stock Assessment for the West Coast Rock Lobster Fishery. Fisheries Research Report No. 217. Department of Fisheries, Western Australia. 200pp

Den Hartog, C. (1984). Seagrasses of the World. North Holland Publishing Company, Amsterdam.

Department of Conservation and Land Management (CALM). (2005a). *Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 – 2015.* Management Plan Number 52. Department of Environment and Conservation, Perth.

Department of Conservation and Land Management (CALM). (2005b). Indicative Management Plan for the Proposed Dampier Archipelago marine Park and Cape Preston Marine Management Area. Department of Environment and Conservation, Perth.

Department of Environment (DotE) (2013) Sawfish http://www.environment.gov.au/topics/marine/marine-species/sharks/sawfish. Viewed 25th July 2013

Department of Environment and Conservation (DEC). (2006). *Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves, 2007–2015*. Management Plan No. 55. Prepared by Department of Environment and Conservation for the Marine Parks and Reserves Authority

Department of Environment and Conservation (DEC). (2007a). *Management Plan for the Montebello/Barrow Islands marine Conservation Reserves. 2007-2017.* Management Plan No. 55. Department of Environment and Conservation, Perth.

Department of Environment and Conservation (DEC). (2007b). *Rowley Shoals Marine Park management Plan. 2007-2017.* Management Plan No. 56. Department of Environment and Conservation, Perth.

Department of Environment and Conservation (DEC). (2008). Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve

Department of Environment and Conservation (DEC). (2009). *Marine Turtle Recovery Plan for Western Australia 2009-2016*. Wildlife Management Program No. 45, Department of Environment and Conservation, Perth.

Department of Environment and Conservation (DEC). (2010a). *Proposed Camden Sound Marine Park indicative management plan.* Department of Environment and Conservation, Perth.

Department of Environment and Conservation (DEC). (2010b). Jurien Bay Marine Park.

Department of Environment and Conservation (DEC). (2011). *Proposed Eighty Mile Beach Marine Park indicative management plan.* Department of Environment and Conservation, Perth.

Department of Environment and Conservation (DEC). (2012). *Kimberley Wilderness Parks*. Viewed 20 April 2012, <http://www.dec.wa.gov.au/content/view/6171/1618/>.

Department of Environment and Heritage (DEH). (2005a). *Humpback Whale Recovery Plan 2005 - 2010*. Department of Environment and Heritage. Canberra.

Department of Environment and Heritage (DEH). (2005b). *Blue, Fin and Sei Whale Recovery Plan 2005 – 2010*. Department of Environment and Heritage. Canberra.

Department of Environment and Heritage (DEH). (2005c). *Whale Shark (Rhincodon typus) Recovery Plan Issues Paper.* Department of Environment and Heritage, Canberra. Viewed 22 June 2011. <http://www.deh.gov.au/biodiversity/threatened/publications/recovery/whale-shark/index.html>

Department of Environment, Water, Heritage and Arts (DEWHA). (April 2010). EPBC Act – Protected Matters Search Tool. <http://www.environment.gov.au/erin/ert/epbc/index.html>

Department of Environment, Water, Heritage and the Arts (DEWHA). (2008). *The North-West Marine Bioregional Plan: Bioregional Profile*. Department of the Environment, Water, Heritage and the Arts, Canberra.

Department of Fisheries (DoF). (2009). *Prawn Aquaculture in Western Australia: Final ESD Risk Assessment Report for Prawn Aquaculture*. Fisheries Management Paper No. 230. Department of Fisheries, Perth.

Department of Fisheries (DoF). (2011). State of the Fisheries and Aquatic Resources Report 2010/2011. Department of Fisheries, Perth.

Department of Fisheries (DoF). (2012). *What is Pearling in Western Australia?* Viewed 23 April 2012. <http://fish.wa.gov.au/docs/pub/WhatPearling/index.php?0309>

Department of Mines and Petroleum (DMP). (2004). Petroleum Guidelines, Drilling Fluids Management.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2008). Shark Bay World Heritage Area, viewed 2 October 2013 http://www.environment.gov.au/heritage/places/world/shark-bay/information.html

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2011b). Assessment of the Western Australian Shark Bay Crab (Interim) Managed Fishery

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2011c). Whale Shark (*Rhincodon typus*), Sharks in Australian Waters, Australian Government, Canberra, Viewed 20 November 2012. http://www.environment.gov.au/coasts/species/sharks/whaleshark/index.html

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013a). Macronectes giganteus – Southern Giant Petrel. Viewed 23 July 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1060

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013b). Anous tenuirostris melanops – Australian Lesser Noddy. Viewed 24 July 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26000

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013c). Pterodroma mollis – Soft-plumaged Petrel. Viewed 24 July 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1036

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013d). *Sternula nereis nereis* - Australian Fairy Tern. Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82950

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013e). Thalassarche cauta cauta – Shy Albatross, Tasmanian Shy Albatross. Viewed 24th July 2013, <http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82345>

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013f). Carcharodon carcharias-Great White Shark. Viewed 24th July 2013, <http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82345>

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013g). *Tursiops aduncus* (Arafura/Timor Sea populations) — Spotted Bottlenose Dolphin (Arafura/Timor Sea populations). Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=78900

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013h). Balaenoptera borealis — Sei Whale. Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=34

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013i). Eubalaena australis — Southern Right Whale. Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=40

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013j). Balaenoptera physalus — Fin Whale. Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=37

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013k). Neophoca cinerea — Australian Sea-lion. Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=22

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013l). Orcaella heinsohni — Australian Snubfin Dolphin. Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=81322

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013m). Sousa chinensis — Indo-Pacific Humpback Dolphin. Viewed 24 July, 2013. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=50

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013n). Assessment of the Western Australian Shark Bay Prawn Managed Fishery.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2013o). Assessment of the Western Australian Abrolhos Island and Mid West Trawl Managed Fishery.

Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC). (2011a). Mermaid Reef Marine National Nature Reserve. Accessed 20 April 2012. <http://www.environment.gov.au/coasts/mpa/mermaid/index.html>

Department of the Environment (DotE). (2014). Commonwealth Marine Reserves viewed 5th February 2014 http://www.environment.gov.au/topics/marine/marine-reserves

Duke, N.C., and Burns, K.A. (1999). Fate and effects of oil and dispersed oil on mangrove ecosystems in Australia. Final project report to the Australian Petroleum Production and Exploration Association (APPEA).

Duke, N.C., Burns, K.A., and Dalhaus, O. (1998a). Effects of oils and dispersed-oils on mangrove seedlings in planthouse experiments: a preliminary assessment of results two months after oil treatments. Australian Petroleum Production and Exploration Association Limited Journal 38:631–636.

Duke, N.C., Ellison, J.C., and Burns, K.A. (1998b). Surveys of oil spill incidents affecting mangrove habitat in Australia: a preliminary assessment of incidents, impacts on mangroves, and recovery of deforested areas. Australian Petroleum Production and Exploration Association Limited Journal 38:646–654.

Ecotox (2012). Ecotox Services of Australia, Toxicity Assessment of a Crude Oil from the Wandoo Platform 2012, Test Report, July 2012.

Edgar, G., and Barrett, N. (1995). Preliminary Report to the Long Term Impact Assessment Group: Program 7 Impact on and Recovery on Subtidal Reefs, Department of Primary Industry and Fisheries Tasmania.

Environmental Protection Authority (EPA). (2001). Guidance for the assessment of environmental factors, guidance statement for protection of tropical arid zone mangroves along the Pilbara coastline, No. 1. Environmental Protection Authority, Perth.

Environmental Protection Authority (EPA). (2011). EPA’s Toxicity Testing of Dispersants, United States Environmental Protection Agency, USA, Viewed Online (29th November 2012) <http://www.epa.gov/bpspill/dispersants-testing.html#phase2>.

Epstein, N., Bak, R.P.M., and Rinkevich, B. (2000). Toxicity of third generation dispersants and dispersed Egyptian crude oil on Red Sea coral larvae. Marine Pollution Bulletin 40:497–503.

Etkin (2003). Determination of Persistence in Petroleum Based Oils. Report prepared for US Environmental Protection Agency Oil Program. September 2003.

Fandry, C., Revill, A., Wenziker, K., McAlpine, K., Apte, S., Masini, R., and Hillman, K. (2006). Contaminants on Australia’s North West Shelf: sources, impacts, pathways and effects. *NWSJEMS Technical Report No. 13*. CSIRO Marine and Atmospheric Research, Australia.

Fingas, M.F. (2000). *A Review of Literature Related to Oil Spill Dispersants Especially Relevant to Alaska.* Report prepared for the Prince William Sound Regional Citizens’ Advisory Council. Prince William Sound Regional Citizens’ Advisory Council, Anchorage, Alaska

Fingas, M.F. (2008). *A Review of Literature Related to Oil Spill Dispersants Especially Relevant to Alaska 2002-2008*.Prepared for Prince William Sound Regional Citizens Advisory Council Anchorage Alaska, Environment Canada,

Fletcher, W.J., and Santoro, K. (eds). (2011). State of the Fisheries and Aquatic Resources Report 2010/11. Department of Fisheries, Perth, Western Australia. 359pp.

Food and Agriculture Organisation (FAO). (1983). Scombrids of the World – An Annotated and Illustrated Catalogue of Tunas, Mackerels, Bonitos and Related Species Known to Date. FAO Fisheries Synopsis No. 125, Vol. 2.

Forrest, B. M., Gardner, J. P., & Taylor, M. D. 2009. Internal borders for managing invasive marine species. Journal of Applied Ecology, 46(1), 46-54.

Francis, M.P., Natanson, L.J., and Campana, S.E. (2008). The biology and ecology of the porbeagle shark, Lamna nasus. P. 105-113. In M.D. Camhi, E.K. Pikitch and E.A. Babcock (eds.). *Sharks of the Open Ocean: Biology, Fisheries and Conservation*. Blackwell Publishing, Oxford.

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 22nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, June 1999, Alberta, Canada, PP. 243-270.

French-McCay, D.P. (2002). Development and application of an oil toxicity and exposure model, OilToxEx. *Journal of Environmental Toxicology and Chemistry* 21: PP.2080-2094.

French-McCay, D.P. (2003). Development and Application of Damage Assessment Modelling: Example Assessment for the North Cape Oil Spill. *Marine Pollution Bulletin* 47(9-12) PP. 341-359.

French-McCay, D.P. (2004). Oil spill impact modelling: development and validation. Environmental Toxicology and Chemistry 23(10):2441-2456.

Friligos, N. (1985). Turnover time of waters in a deep basin in the Aegean Sea. Estuarine, Coastal and Shelf Science, 21: 879-894.

Gales, N., McCauley, R.D., Lanyon, J., and Holley, D. (2004). Change in abundance of dugongs in Shark Bay, Ningaloo and Exmouth Gulf, Western Australia: evidence for large-scale migration. *Wildlife Research* 31: 283-290.

Goodbody Gringley, G., Wetzel, D.L., Gillon, D., Pulster, E., Miller, A., Ritchie, K.B. (2013). Toxocity of Deepwater Horizon Source Oil and the Chemical Dispersant Corexit 9500 to Coral Larvae Plos one

Guinea, M. (2007). Marine Snakes: Species Profile for the North-west Planning Area, Report for the National Oceans Office, Hobart.

Gulec, I., Leonard, B., and Holdaway, D.A. (1997). Oil and Dispersed Oil Toxicity to Amphipod sand Snails. *Spill Science and Technology Bulletin* 4:1-6.

Gulf Coast Research Laboratory (2013). Research Needs to Assess Oil Related Impacts on Whale Sharks in the Northern Gulf of Mexico The University of Southern Mississippi http://www.usm.edu/gcrl/whaleshark/oil.impact.php

Hale, J. and Butcher, R. (2009). Ecological Character Description of the Eighty-mile Beach Ramsar Site, Report to the Department of Environment and Conservation, Perth, Western Australia.

Hale, J. and Butcher, R. (2010) Ecological Character Description for Hosnies Spring Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Hale, J. and Butcher, R. (2013) Ashmore Reef Commonwealth Marine Reserve Ramsar Site Ecological Character Description. A report to the Department of the Environment, Canberra

Harrison, P.L. (1999). Oil pollutants inhibit fertilisation and larval settlement in the scleractinian reef coral Acropora tenuis from the Great Barrier Reef, Australia. In: Sources, Fates and Consequences of Pollutants in the Great Barrier Reef and Torres Strait: Conference Abstracts. Great Barrier Reef Marine Park Authority, Townsville

Harrison, P.L., Babcock, R.C., Bull, G.D., Oliver, J.K., Wallace, C.C., and Willis, B.L. (1984). Mass spawning in tropical reef corals. Science 223:1186-1189.

HB 203: 2006. Environmental risk management – Principles and processes. Standards Australia/Standards New Zealand

Heatwole, H. (1999). Seasnakes In: Australian History Series. Page (s) 148. Sydney, NSW: UNSW Press.

Hemmer, M.J., Barron, M.G., and Greene R.M. (2011). Comparative toxicity of eight oil dispersants, Louisiana sweet crude oil (LSC) and chemically dispersed LSC to two aquatic test species. Environmental Toxicology and Chemistry 30, 2244-2252

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). Environmental Implications of Shore Oil and Gas Development in Australia – Drilling Activities. The Findings of an independent Scientific Review on Behalf of the APPEA and Energy Research and Development Corporation.

Holmberg, J., Norman, B., and Arzoumanian, Z. (2009). Estimating population size, structure, and residency time for whale sharks *Rhincodon typus* through collaborative photo-identification. *Endangered Species Research* 7: 39-53.
<http://www.environment.gov.au/coasts/mpa/mermaid/index.html>
<http://www.environment.gov.au/coasts/mpa/ningaloo/index.html>

Huisman, J.M. (2004). Marine benthic flora of the Dampier Archipelago, Western Australia. *Records of the Western Australian Museum*. Supplement No. 66: 61-68.

Huisman, J.M., and Borowitzka, M.A. (2003). Marine benthic flora of the Dampier Archipelago, Western Australia. In F.E. Wells, D.I. Walker and D.S. Jones (eds.) *The Marine Flora and Fauna of Dampier, Western Australia*. Western Australian Museum, Perth.

IFC (2015). Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development.

IMO (2007). Prevention of Pollution by Sewage from Ships, Annex IV of MARPOL http://www.imo.org/

Integrated Fisheries Allocation Advisory Committee (2013). West Coast Demersal Scalefish Allocation Report. Fisheries Management Papter No. 249. Prepared by the Integrated Fisheries Allocation Advisory Committee for the Minister for Fisheries. Department of Fisheries, WA, July 2013.

Intertek Geotech (2012). *An Assessment of Dispersion Efficacy on a Crude Oil: Professional Opinion*, Prepared for Vermillion Gas and Gas Australia Pty Ltd.

IPIECA (2008). Oil Spill preparedness and response: report series summary, IPIECA Report Series 1990-2008, United Kingdom

ITOPF (2011). Clean-up of Oil from Shorelines. Technical information paper

ITOPF (2013). The international tanker owners pollution federation limited Containment and Recovery http://www.itopf.com/spill-response/clean-up-and-response/containment-and-recovery/

IUCN (2011). The IUCN Red List of Threatened Species: Manta birostris. Accessed 5 Feb 2014. Last updated 1 November 2011. http://www.iucnredlist.org/details/198921/0

Jackson, J.B.C., Cubit, J.D., Keller, B.D., Batista, V., Burns, K., Caffey, H.M., Caldwell, R.L., Garrity, S.D., Getter, C.D., Gonzales, C., Guzman, H.M., Kaufman, K.W., Knap, A.H., Levings, S.C., Marshall, M.J., Steger, R., Thompson, R.C., and Weil, E. (1989). Ecological effects of a major oil spill on Panamanian coastal marine communities. Science, 243: 37–44.

Jenner, K.C.S., and Jenner, M-N. (1988). Proposed Humpback Whale Migratory Paths. Unpublished data to Woodside Energy Ltd.

Jenner, K.C.S., Jenner, M., Burton, C., Sturrock, V., Salgado Kent, C., Morrice, M., Attard, C., Moller, L., and Double, M.C. (2008). *Mark recapture analysis of Pygmy Blue Whales from the Perth Canyon, Western Australia 2000-2005*. Curtin University, Perth. Prepared for the International Whaling Commission.

Jenner, K.C.S., Jenner, M-N.M., and McCabe, K.A. (2001). Geographical and temporal movements of humpback whales in Western Australian waters. *APPEA Journal* 38: 749-765.

Jones H.E. (1986). Marine Resources Map of Western Australia: Part 2- The Influence of Oil on Marine Resources and Associated Activities with Emphasis on Those found in Western Australia. Report No 74, Fisheries Department of Western Australia, Perth.

Jones, D.S. (2004). Report on the results of the Western Australia Museum/Woodside Energy Ltd. Partnership to explore the Marine Biodiversity of the Dampier Archipelago, Western Australia 1998-2002. Records of the Western Australian Museum, Supplement 66:1-401.

Kagi, R.I., Fisher, S.J., and Alexander, R. (1988). Behaviour of Petroleum in Northern Australian Waters. In Proceedings North West Shelf Symposium, Perth Western Australia, 1988. Petroleum Exploration Society of Australia.

Keesing, J.K., Irvine, T.R., Alderslade, P., Clapin, G., Fromont, J., Hosie, A.M., Huisman, J.M., Phillips, J.C., Naughton, K.M., Marsh, L.M., Slack-Smith, S.M., Thomson, D.P., and Watson, J.E. (2011). Marine benthic flora and fauna of Gourdon Bay and the Dampier Peninsula in the Kimberley region of north-western Australia. *Journal of the Royal Society of Western Australia* 94: 285-301.

Kinhill (1997). East Spar First Post-commissioning Survey Report. A report to Apache Energy by Kinhill Pty Ltd. October 1997. Report EA-00-RI-9981/B.

Klimley, A.P., and Anderson, S.D. (1996). Residency Patterns of White Sharks at the South Farallon Islands, California. In A.P. Klimley and D.G. Ainley (eds.) *Great White Sharks: The biology of* Carcharodon carcharias. Academic Press Inc., California.

Koops, W. (1985). “The Oil Spill Slide Rule to Predict the Fate of an Oil Spill.” in: Proceedings of the 1985 International Oil Spill Conference (Prevention, Behaviour, Control, Cleanup), February 25-28, 1985, Los Angeles, CA. Washington, DC: American Petroleum Institute, Publication 4385.647.

Kucklick, J.H., and Aurand, D. (1997). Historical dispersant and in- situ burning opportunities in the United States. Pp 205-210 in proceedings of the 1997 International Oil Spill Conference, Fort Lauderdale, Florida. American Petroleum Institute, Washington DC.

Laegdsgaard, P., and Johnson, C.R. (1995). Mangrove habitats as nurseries: unique assemblages of juvenile fish in suptropical mangroves in eastern Australia. *Marine Ecology Progress Series* 126: 67-81.

Lambert, G., Peakall, D.B, Philogene B.J.R., and Engelhardt F.R. (1982). Effect of oil and dispersant mixtures on basal metabolic rate of ducks. Bulletin of Environmental Contamination and Toxicology 29:520-524

Lance, B.K., Irons, D.B., Kendall, C.J., and McDonald, L.L. (2001). An evaluation of marine population trends following the ‘Exxon Valdez’ oil spill, Prince William Sound, Alaska. Marine Pollution Bulletin, 42(4): 298–309

Last, P.R., and Stevens, J.D. (2009). *Sharks and Rays of Australia*. Second Edition. CSIRO Publishing, Collingwood.

Lee, R. F. (1980). Processes affecting the fate of oil in the sea. In Marine Environmental Pollution. 1: Hydrocarbons, ed. R. A. Geyer, pp. 337-351. Elsevier, Amsterdam.

Lee, K., Nedwed, T., Prince, R.C., Palandro, D. (2013). Lab test on the biodegradation of chemically dispersed oil should consider rapid dilution that occurs at sea. Marine Pollution Bulletin 73 (2013)314-318

Limpus, C. (2009). *A biological review of Australian marine turtle species*. Environmental Protection Agency, Queensland.

Limpus, C.J., Miller, J.D., Parmenter, C.J., Reimer, D., McLachlan, N., and Webb, R. (1992). Migration of green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles to and from eastern Australian rookeries. *Wildlife Research* 19, 347-358.

Lohmann, K.J., Witherington, B.E., Lohman, C.M.F., and Salmon, M. (1997). Orientation, navigation and natal beach homing in sea turtles. In P.L. Lutz and J.A. Musick (eds) *The Biology of Sea Turtles*. CRC Press, Boca Raton.

Long, E.R., MacDonald, D.D., Smith, S.L. and Calder, F.D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19: 81-97.

Lunel, T., and Lewis, A. (1999). Optimisation of Oil Spill Dispersant Use. Proceedings, 1999 International Oil Spill Conference. American Petroleum Institute, Washington DC, pp 187-193.

Marsh, H., Penrose, H., Eros, C., and Hugues, J. (2002). Dugong: Status Reports and Action Plans for Countries and Territories. United Nations Environment Programme Early Warning and Assessment Series. Viewed 25 July 2012. <http://www.unep.org/dewa/Docs/DUGONG.pdf>

Marsh, H., Penrose, H., Eros, C., and Hugues, J. (2002). *Dugong: Status Reports and Action Plans for Countries and Territories.* United Nations Environment Programme Early Warning and Assessment Series. Viewed 20 April 2012. <http://www.unep.org/dewa/Docs/DUGONG.pdf>

Mau, R., and Balcazar, N. (2007). Progress Report: Establishing Turtle Nesting Activity for Serrurier Island Nature Reserve, Locker Island Nature Reserve and Locker Point to the Ashburton River, North Western Australia. Department of Environment and Conservation, Western Australia.

McAuliffe, C.D. (1986). Organism exposure to volatile hydrocarbons from untreated and chemically dispersed oils in field and laboratory: in Proc. Ninth Arctic Marine Oil Spill Program Tech. Sem., pp. 497-526.

McAuliffe, C.D. (1987). Organism exposure to volatile hydrocarbons from untreated and chemically dispersed oils in field and laboratory: in Proc. Ninth Arctic Marine Oil Spill Program Tech. Sem., pp. 497-526.

McCauley, R., Bannister, J.L., Burton, C., Jenner, C., Rennie, S., and Kent, C.S. (2004). *Western Australia exercise area blue whale project*. Final Summary Report. Milestone 6. Prepared by Curtin University for the Australian Defence Force.

McCauley, R.D. (1994). Seismic Surveys. The environmental implications of offshore oil and gas development in Australia – In: The Environmental Implications of Offshore Oil and Gas Development in Australia – the Findings of an Independent Scientific Review.

McCauley, R.D. (1998). Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia. Report to Shell Australia.

McCauley, R.D., and Duncan, A.J. (2001). Marine Acoustic Effects Study, Blue Whale Feeding Aggregations Otway Basin, Bass Strait Victoria. Unpublished Report to Ecos Consulting, Australia.

McCauley, R.D., Fewtrell, J., and Popper, A.N. (2003). High intensity anthropogenic sound damages fish ears. J. Acoust. Soc. Am. 113 (1): 638-642.

Meekan, M.G., Bradshaw, C.J.A., Press, M., McLean, C., Richards, A., Quasnichka, S., and Taylor, J.G. (2006). Population size and structure of whale sharks *Rhincodon typus* at Ningaloo Reef, Western Australia. *Marine Ecology Progress Series* 319: 275-285.

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. Marine Biology. Vol 139, pg 373–381.

Mitchell, F.M., and Holdaway, D.A. (2000). The acute and chronic toxicity of the dispersants.

Mollet, H.F., Cliff, G., Pratt, Jr, H.L. and Stevens, J.D. (2000). Reproductive Biology of the female shortfin mako, *Isurus oxyrinchus* Rafinesque, 1820, with comments on the embryonic development of lamnoids. *Fishery Bulletin* 98: 299-318.

Nagelkerken, I., Blaber, S.J.M., Bouillon, S., Green, P., Haywood, M., Kirton, L.G., Meynecke, J-O., Pawlik, J., Penrose, H.M., Sasekumar, A., and Somerfield, P.J. (2008). The habitat function of mangroves for terrestrial and marine fauna: A review. *Aquatic Botany* 89: 155-185.

NAP (2005). Oil Spill Dispersants: Efficacy and Effects, Committee on Understanding Oil Spill Dispersants: Efficacy and Effects, National Research Council, Washington DC.

NAS (2005). *Understanding oil Spill Dispersants: Efficacy and Effects,* National Research Council of the National Academies, Washington DC.

National Oceanic and Atmospheric Administration (NOAA). (1977). Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments.

National Oceanic and Atmospheric Administration (NOAA). (2012). Impacts of Oil on Marine Mammals and Sea Turtles, NOAA Fisheries Services.

National Oceanic and Atmospheric Administration (NOAA). (2014). Oil Spills in Mangroves: Planning and Response Considerations. Office of Response and Restoration, NOAA Ocean Service.

Negri, A.P., and Heyward, A.J. (2000). Inhibition of fertilization and larval metamorphosis of the coral *Acropora millepora* (Ehrenberg, 1834) by petroleum products. Marine Pollution Bulletin 41:420-427.

Nicholls, N. (1992). Recent performance of a method for forecasting Australian seasonal tropical cyclone activity. *Australian Meteorological Magazine* 40: 105-110.

NOAA (2014). NOAA Coral Reef Conservation Program 23 January 2014 http://coralreef.noaa.gov/aboutcrcp/news/featuredstories/may10/oilspill_coral/welcome.html

NRC (1985). Oil in the Sea: Inputs, Fates and Effects. National Academic Press, Washington, DC

Ober, H.K. (2010). Effects of Oil Spills on Marine and Coastal Wildlife, Florida.

Orth, R.J., Harwell, M.C. and Inglis, G.J. (2006). Ecology of seagrass seeds and dispersal strategies. In A.W.D. Larkum, R.J. Orth and C.M. Duarte (eds.) *Seagrasses: Biology, Ecology and Conservation*. Springer, Dordrecht.

Patterson, H, Larcombe, J, Nicol, S and Curtotti, R (2019). Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. Avaialble from: https://apo.org.au/sites/default/files/resource-files/2018/09/apo-nid194846-1242241.pdf

Parra, G.J. (2006). Resource partitioning in sympatric delphinids: Space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins. *Journal of Animal Ecology* 75:862-874.

Parra, G.J., Preen, A.R., Corkeron, P.J., Azuma C., and Marsh, H. (2002). Distribution of Irrawaddy dolphins, *Orcaella brevirostris*, in Australian waters. *Raffles Bulletin of Zoology* 10:141-154.

Peakall, D.B., Wells, P.G., and Mackay, D. (1987). A hazard assessment of chemically dispersed oil spills and seabirds. Marine Environmental Research 22:91-106.

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 F.E. Wells, D.I. Walker and D.S. Jones (eds.) *The Marine Flora and Fauna of Dampier, Western Australia*. Western Australian Museum, Perth.

Peckol, P., Levings, S.C., and Garrity, S.D. (1990). Kelp response following the World Prodigy oil spill. Marine Pollution Bulletin 21:473-476.

Pedretti, Y.M., and Paling, E.I. (2000). *WA Mangrove assessment project 1999-2000*. Marine and Freshwater Research Laboratory, Perth.

Pendoley, K. (1997). Sea turtles and management of marine seismic programs in Western Australia. *Petroleum Exploration Society of Australia Journal* 23: 8-16.

Pendoley, K. (2005). Sea turtles and the Environmental Management of Industrial Activities in North West Western Australia. PhD thesis, Murdoch University, Perth.

Plotkin, P. (2003). Adult migrations and habitat use. In P.L. Lutz, J.A. Musick and J. Wyneken (eds.) *The Biology of Sea Turtles Volume II*. CRC Press, Boca Raton.

Queensland Government (2011). *Queensland Coastal Contingency Action Plan*, Transport and Main Roads, May 2011, compiled by Maritime Safety Queensland.

Radniecki, T.S., Schneider, M.C., and Semprini, L. (2013). The influence of Corexit 9500A and weathering on Alaska North Slope crude oil toxicity to the ammonia oxidizing bacterium, *Nitrosomonas europaea*. Marine Pollution Bulletin Vol. 68(1-2):64-70.

Rainer, S.F. (1991). High species diversity in demersal polychaetes of the North West Shelf of Australia. *Ophelia Suppl.*, 5: 497-505.

Ralph, P.J., and Burchett, M.D. (1998). Impact of petrochemicals on the photosynthesis of *Halophila ovalis* using chlorophyll fluorescence. Marine Pollution Bulletin 36(6), 429-436.

Ren, L., Huang, X-D., McConkey, B.J., Dixon, D.G. and Greenberg, B.M. (1994). Photoinduced toxicity of three polycyclic aromatic hydrocarbons (Fluoranthene, Pyrene and Napthalene) to the duckweed Lemna gibba. Ecotoxicology and Environmental Safety 28:160–170.

Richardson, W.J., Greene Jnr, C.R., Malme, C.I., and Thomson, D.H. (1995). Marine Mammals and Noise. Academic Press, California.

Robertson, A.I., and Duke, N.C. (1987). Mangroves as nursery sites: comparisons of the abundance and species composition of fish and crustaceans in mangroves and other nearshore habitat in tropical Australia. *Marine Biology* 96: 193-205.

Rogers, D.I., Hassell, C.J., Boyle, A., Gosbell, K., Minton, C., Rogers, K.G., and Clarke, R.H. (2011). Shorebirds of the Kimberley coast – populations, key sites, trends and threats. *Journal of the Royal Society of Western Australia* 94: 377-391.

Ross, J.P. (1998). *Crocodiles: Status Survey and Conservation Action Plan*. Second Edition. IUCN/SSC Crocodile Specialist Group. IUCN, Gland.

Ross, S.L. (2002). Assessment of the Use of Dispersants on Oil Spills in California Marine Waters, S.L. Ross Environmental Research Ltd, Ottawa.

Rosser, N.L., and Gilmour, J.P. (2008). New insights into patterns of coral spawning on Western Australian reefs. *Coral Reefs* 27: 345-349.

RPS (2009). INPEX Environmental Impact Assessment Studies — Supplementary Report: Marine Turtle Studies 2007–2008. Prepared by RPS Environment and Planning Pty Ltd for INPEX Browse Ltd, Perth.

RPS (2010). *Wheatstone Project EIS/ERMP: Technical Appendix — Marine Turtles*. Prepared by RPS Environment and Planning Pty Ltd for Chevron Australia, Perth.

RPS (2012). OSCP Environmental Sensitivities Summary. Wandoo B Production Facility. Unpublished report prepared for Vermilion Oil & Gas Australia.

Scholz, D., Michael, J., Shigenaka, G., and Hoff, R. (1992). Biological resources. In: An introduction to coastal Habitats and biological resources for oil spill response. Report HMRAD, 92-4, pp(4)-1-6, noaa Hazardous Materials Response and Assessment Division, Seattle.

Schuler, P.A., and Baca, B. Net Environmental Benefit Analysis (NEBA) of Dispersed Oil Versus Non-Dispersed Oil on Coastal Ecosystems & Wildlife Utilizing Data Derived from the 20-Year Tropics Study, Florida.

Semeniuk, V. (1993). The Pilbara coast: a riverine coastal plain in a tropical arid setting, northwestern Australia. *Sedimentary Geology* 83: 235-256.

Sepulveda, C.A., Kohin, S., Chan, C., Vetter, R., and Graham, J.B. (2004). Movement patterns, depth preferences, and stomach temperatures of free-swimming juvenile mako sharks, *Isurus oxyrinchus*, in the Southern California Bight. *Marine Biology* 145: 191-199.

Sheppard, J.K., Marsh, H., Jones, Eyeh, R., and Lawler, I.R. (2010). Dugong habitat use in relation to seagrass nutrients, tides and diel cycles. *Marine Mammal Science* 26: 855-879.

Shingenaka, G., Yender, R.A., Mearns, A., and Hunter, C.L. (2010). Oil Spills in Coral Reefs: Planning and Response Considerations, US Department of Commerce.

Simpson, C.L., Cary, J.L., and Masini, R.J. (1993). Destruction of corals and other reef animals by coral spawn slicks on Ningaloo Reef, Western Australia. *Coral Reefs* 12: 185-191.

SIMTARS (1992). Environmental Testing of Wandoo Crude. Unpublished report by Safety in Mines Testing and Research Station, Department of Resource Industries, Brisbane.

Sinclair Knight Merz (SKM). (1996). East Spar Gas Field Long Term Environmental Monitoring Program. Pre-production survey. Report prepared by Sinclair Knight Merz for WMC Resources, Perth.

Skalski, JR. 1995. *Statistical considerations in the design and analysis of environmental damage assessment studies*. Journal of Environmental Management, vol. 43 pp 67-85.

Spies, R.B. (1987). The biological effects of Petroleum Hydrocarbons in the Sea: Assessments from the Field and Microcosms. Long-Term Environmental Effects of Offshore Oil and Gas Development. Boesch and Rabalais, eds Elsevier Applied Science, New York, NY. Pp. 411-467

Spotila, J.R. (2004). Sea Turtles: A Complete Guide to their Biology, Behavior, and Conservation. The John Hopkins University Press, Baltimore.

Steedman. (1991). Preliminary Environmental Design Criteria, Wandoo Location. Unpublished report to Ampolex Ltd by Steedman Science and Engineering, Perth.

Steedman. (1992). Prediction of Oil Spill Trajectories for the Wandoo-1 Location, Unpublished report to Ampolex Ltd by Steedman Science and Engineering, Perth.

Stevens, J.D., Bradford, R.W., and West, G.J. (2010). Satellite tagging of blue sharks (*Prionace glauca*) and other pelagic sharks of eastern Australia: depth behaviour, temperature experience and movements. *Marine Biology* 157: 575-591.

Stoddart, J.A., and Gilmour, J. (2005). Patterns of reproduction of in-shore corals of the Dampier Harbour, Western Australia, and comparisons with other reefs. In J.A. Stoddart and S.E. Stoddart (eds.) *Corals of the Dampier Harbour: Their Survival and Reproduction During the Dredging Programs of 2004*. MScience Pty Ltd, Perth.

Stoddart, J.A., and Gilmour, J.P. (2005b). Patterns of reproduction of in-shore corals of the Dampier Harbour, Western Australia, and comparisons with other reefs. Corals of the Dampier Harbour: Their Survival and Reproduction during the Dredging Page 218 301012-01121: Rev 1: 14-Mar-11.

Swan, J.M., Neff, J.M., and Young, P.C. (Eds). Australian Petroleum Exploration Association (APEA), Sydney. Pp. 209-407.

Swan, J.M., Neff, J.M., and Young, P.C. (eds). Australian Petroleum Production and Exploration Association (APPEA), Sydney.

Teal, J.M., and Howarth, R.W. (1984). Oil spill studies: a review of ecological effects. Environmental Management, Vol .8, pp. 27-44.

United Nations Educational, Scientific and Cultural Organisation (UNESCO). (2011). *The Operational Guidelines for the Implementation of the World Heritage Convention.* UNESCO World Heritage Centre, Paris.

USEPA, EPA Response to BP Spill in the Gulf of Mexico <http://www.epa.gov/bpspill/dispersants-qanda.html#q011>

VOGA. Wandoo B 2011 Water Shut-off Campaign Well Intervention SIMOPS Plan VOG-5000-RD-0013.

VOGA. Wandoo Drilling SIMOPS Plan, VOG-7000-PD-0003.

VOGA. Wandoo Emergency Response Plan, VOG-2000-RD-0017.

VOGA. Wandoo Field Source Control Contingency Plan, WNB-3000-PD-0007

VOGA. Wandoo Field Well Construction Oil Spill Contingency Plan, WAN-2000-RD-0002.

VOGA. Wandoo Oil Spill Contingency Plan, WAN-200-RD-0001.

VOGA. Wandoo Risk Management Manual, VOG-2000-MN-0001.

VOGA. Well Construction Emergency Response Manual, VOG-5000-YH-0001.

Volkman, J.K., Miller, G.J., Revill, A.T., and Connell, D.W. (1994). Oil Spills. Pages 509-695 In: J.M. Swan, J.M. Neff, and P.C. Young, eds., Environmental Implications of Offshore Oil and Gas Development In Australia Findings of an Independent Scientific Review. Australian Petroleum Production and Exploration Association, Canberra, Australia.

Volkman, J.K., Miller, G.J., Revill, A.T., and Connell, D.W. (1994). Part 6. Oil spills. In: Swan, J.M., Neff, J.M., Young, P.C. (Eds.), Environmental Implications of Offshore Oil and Gas Development in Australia Ð Findings of an Independent Scientific Review. Australian Petroleum Production and Exploration Association, Sidney, pp. 509-696.

Walker, D.I., and Prince, R.I.T. (1987). Distribution and biogeography of seagrass species on the northwest coast of Australia. *Aquatic Botany* 29: 19-32.

Wardrup, J.A., (1987). The effects of oils and dispersants on mangroves: a review and bibliography. Occasional paper no. 2. Environmental Studies, University of Adelaide, South Australia, (70 pp).

Watson, W.T.A., Joseph, L.N., and Watson, J.E.M. (2009). A rapid assessment of the impacts of the Montara oil leak on birds, cetaceans and marine Reptiles, prepared on behalf of the Department of the Environment, Water, heritage and the Arts, Queensland.

Webb, G.J.W., Messel, H., and Magnusson, W. (1977). The nesting of *Crocodylus porosus* in Arnhem Land, Northern Australia. *Copeia* 2: 238-249.

Wells, F.E., Walker, D.I., and Jones, D.S. (2003). The marine flora and fauna of Dampier, Western Australia. Western Australian Museum, Perth.

Whiting, S.D., Long. J.L., Hadden, K., and Lauder, A. (2007). Insights into size, seasonality and biology of a nesting population of the Olive Ridley turtle in northern Australia. *Wildlife Research* 34: 200-210.

Wilson, K., and Ralph, P. (2008). Effects of Oil and Dispersed oil on Temperate Seagrass: Scaling of Pollution Impacts, Plant Functional Biology and Climate Change Cluster, Sydney.

Wilson, S.G., Polovina, J.J., Stewart, B.S., and Meekan, M.G. (2006). The movement of whale sharks (*Rhincodon typus*) tagged at Ningaloo Reef, Western Australia. *Marine Biology* 148: 1157-1166.

Witzell, W.N. (1983). Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). *FAO Fisheries Synopsis* 137: 1-78.

Woodside Energy. (2006). Pluto LNG Project Public Environmental Review. Woodside Energy Limited, Perth, Western Australia.

WorleyParsons. (2011). Dampier Marine Services Facility. Assessment on Proponent Information. Dampier Port Authority. Dampier, Western Australia.

Zieman, J., Orth, R., Phillips, R., Thorhaug, A. & Thayer, G. (1984). The effects of oil spills on seagrass ecosystems. Published by Butterworth Publishers.

APPENDICES

Appendix 1. VOGA Health, Safety and Environment (HSE) Policy

Health, Safety and Environment (HSE) Policy

Vermilion is committed to ensuring we conduct our activities in a manner that will protect the health and safety of its employees, contractors and the public. Our HSE vision is to fully integrate Health, Safety and Environment into our business, where our culture is recognized as a model by industry and stakeholders, resulting in a healthy workplace free of incidents.

Vermilion will maintain health, safety and environmental practices and procedures that comply with or exceed regulatory requirements and industry standards. Vermilion's HSE actions will reinforce our corporate Core Values of Excellence, Trust, Respect, and Responsibility. Vermilion Energy will:

- Maintain a strong, integrated Health, Safety and Environmental Management System to identify and manage risks;
- Accept responsibility and accountability for providing leadership, visible commitment and direction to meet our HSE performance targets;
- Continuously evaluate and improve policies and operating practices;
- Integrate HSE into business objectives;
- Provide every employee and contractor with a safe and healthy workplace;
- Make a positive contribution to the protection of the environment and seek improvements in the efficient use of natural resources;
- Respond promptly, responsibly and effectively to emergencies;
- Focus on continual improvement of HSE performance;
- Ensure open and timely HSE communication with all stakeholders;
- Ensure the resources necessary to support this policy are provided.

Hazard awareness, incident prevention and environmental awareness comprise an integral part of any job. It is a joint effort that requires continuous support of everyone who works at Vermilion Energy. The protection of health, safety and the environment must be a key part of the planning and execution of every task. All those engaged in work for Vermilion Energy shall be aware of this policy and its contents, and shall commit themselves to its implementation.

Anthony Marino
President and CEO

Michael Kaluza
Chief Operating Officer

Vermilion Energy

Appendix 2. Oil Spill Characteristics and Trajectory Modelling

1 OVERVIEW

1.1 Modelling parameters

Table 1-1 Modelling parameters

Modelling parameters	RPS 2019 (Report Reference: MAQ0825J)
Type	Wandoo crude spill (Loss of well control)
Details	Surface release over 43 days
Simulation length	73 days
Total Modeled release Volume	25,555 m^3
Minimum tracked surface spill thickness	1 gm^{-2} (1 μm) 10 gm^{-2} (10 μm)
Stochastic Modelling (SITMAP)	100 randomly selected single trajectory simulations per season (summer, transitional and winter), with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times.
Thresholds	Refer Section 1.2
Dispersants	Remodelled the 100 simulations per season under identical conditions, though with surface dispersant applied. Refer Section 1.3.

1.2 Sea-surface, Shoreline and In-Water Thresholds

The thresholds described below for surface, shoreline, and in-water (entrained and dissolved) oil have been adopted according to low, moderate and high, based on increasing concentrations of oiling:

Low thresholds are unlikely to affect species but would be visible and detectable by instrumentation and may trigger socioeconomic impacts, such as temporary closures of areas such as fishing grounds as a precautionary measure.

Moderate thresholds represent moderate concentrations of oil exposure/contact which are anticipated to result in behavioural changes and sub-lethal effects to biota (effects that may result in changes in reproduction or growth) and are unlikely to result in lethal effects (representing potential death of individuals) although lethality may occur if ingestion occurs.

High thresholds represent high concentrations of oil that are expected to result in sub-lethal and lethal effects to at least some species (representing potential death of individuals).

Reporting threshold values (based on the scientific literature) represent potential effects ranging from possible social and economic effects, degradation of water quality as well as possible effects on the behaviour, survival and recruitment success on biota. The changes in the state of the oil over time, in addition to a wide range of sensitivities and in turn potential effects on marine life, does not make it possible to strictly assign single specific effect thresholds. Instead, the analysis presented herein is presented for ranges of low, moderate and high threshold levels, with separate analysis for oil floating at the sea surface, stranded on shoreline, dissolved in the water column and suspended in the water column.

Moderate levels were defined based on available evidence that indicated the potential for low-level sub-lethal effects on some biota, or else evidence of reduced survival rates of sensitive species. This level can be considered a lower ecological threshold. The higher threshold was defined on the assumption that there would be more potential for reduced survivorship of less sensitive species.

1.2.1 Sea-surface Exposure Thresholds

As a conservative approach, the same reporting thresholds for fresh and weathered oil exposure on the sea surface were applied in this study, which were 1-10 g/m2 (low), 10-25 g/m2 (moderate) and above 25 g/m2 (high) (Table -2). As the effects of fresh oil are better understood than for weathered oil, appropriate effects thresholds for fresh oil are more readily identifiable. Exposure pathways of species to weathered oil (i.e. smothering and potential ingestion for some species) are less likely to result in adverse effects.

Table 1-2 Oil exposure thresholds on the sea surface.

Potential level of exposure	Trigger value (g/m^2)
Low	1- 10
Moderate	10* - 25
High	> 25

* 10 g/m^2 also used to define the threshold for actionable sea surface oil.

The lowest threshold to better assess the potential for sea surface exposure, was 1 g/m2, which equates approximately to an average thickness of 1 µm, referred to as visible oil. Oil of this thickness is described as rainbow sheen in appearance, according to the Bonn Agreement Oil Appearance Code (Bonn Agreement 2009) (see Table 1-3). This threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. Table 1-3 provides a description of the appearance in relation to exposure zone thresholds used to classify the zones of sea surface exposure.

Ecological impact has been estimated to occur at 10 g/m2 (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance of oil at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009). Concentrations above 10 g/m2 is also considered the lower actionable threshold, where oil may be thick enough for containment and recovery as well as dispersant treatment (AMSA, 2015).

Scholten et al. (1996) and Koops et al. (2004) indicated that oil concentrations on the sea surface of 25 g/m2 (or greater), would be harmful for all birds that have landed in an oil film due to potential contamination of their feathers, with secondary effects such as loss of temperature regulation and ingestion of oil through preening. The appearance of oil at this thickness is also described as metallic sheen (Bonn Agreement, 2009). Note that the higher threshold applied in this study falls below the thickness that would begin to present as patches of true oil colour.

Figure 1-1 shows examples of the differences between oil colour and corresponding thickness on the sea surface. Hydrocarbons in the marine environment may appear differently due the ambient environmental conditions (wind and wave action).

Table 1-3 The Bonn Agreement Oil Appearance Code.

Code	Description/Appearance	Layer Thickness Interval (g/m^2 or µm)	Litres per km^2
1	Sheen (silvery/grey)	0.04 – 0.30	40 – 300
2	Rainbow	0.30 – 5.0	300 – 5,000
3	Metallic	5.0 – 50	5,000 – 50,000
4	Discontinuous True Oil Colour	50 – 200	50,000 – 200,000
5	Continuous True Oil Colour	≥ 200	≥ 200,000

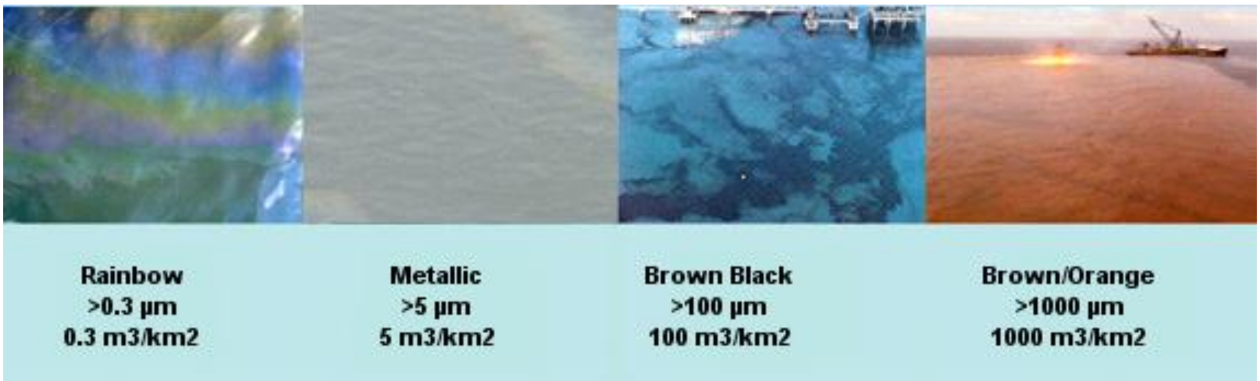


Figure 1-1 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil Spill Solutions.org, 2015).

The generic oil colour categories used in this report are meant as a guide only. For more accurate description of oil appearance on the sea surface a detailed analysis of an oil should be undertaken.

The specific oil type will determine appearance (i.e. colour) and behaviour on the sea surface. Lighter oils such as condensates, have true oil colours that are pale or transparent. As such, these oil types may not increase beyond a rainbow or metallic sheen, despite their thickness increasing beyond 25 g/m2 (~25 um). Moreover, the physical properties and appearance of oil types will change due to weathering on the sea surface. For example, oils with high paraffinic wax content will form waxy sheets that break up into flakes or nodules after the more volatile components have evaporated. Take up of water by the oil (emulsification) will also significantly change the appearance and thickness of floating oil. Stable water-in-oil emulsions will have a higher combined mass and thickness and will present as thick, semi-solid, aerated layers that tend to be coloured strongly red/brown, orange or yellow, rather than the true oil colour.

It should be noted that in the case of solidified or emulsified oils, mass per area estimates cannot be directly referenced to the Bonn Agreement visibility scale that refers only to oil present as films or slicks of oil alone.

1.2.2 Shoreline Contact Threshold

The thresholds for shoreline contact were 10-100 g/m2 (low), 100-1,000 g/m2 (moderate) and above 1000 g/m2 (high).

The lower threshold (10 g/m^2) was applied as the reporting limit for oil on shore. This threshold may trigger socio-economic impact, such as triggering temporary closures of beaches to recreation or fishing, or closure of commercial fisheries and might trigger attempts for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). In previous risk assessment studies, French-McCay et al. (2005a; 2005b) used a threshold of 10 g/m2, equating to approximately two teaspoons of oil per square meter of shoreline, as a low impact threshold when assessing the potential for shoreline contact.

French et al. (1996) and French-McCay (2009) define a shoreline oil threshold of 100 g/m2, or above, would potentially harm shorebirds and wildlife (furbearing aquatic mammals and marine reptiles on or along the shore) based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay, 2003; French-McCay et al., 2004, French-McCay et al., 2011; 2012; NOAA, 2013). Additionally, a shoreline concentration of 100 g/m2, or above, is the minimum limit that the oil can be effectively cleaned according the AMSA (2015) guideline. This threshold equates to approximately ½ a cup of oil per square meter of shoreline contacted. The appearance is described as a thin oil coat.

The higher threshold of 1,000 g/m2, and above, was adopted to inform locations that might receive oil accumulation levels that could have a higher potential for ecological effect. Observations by Lin and Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m2 of oil during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing oil impacts on mangroves (Grant et al., 1993; Suprayogi and Murray, 1999). This concentration equates to approximately 1 litre or 4 ¼ cups of fresh oil per square meter of shoreline contacted. The appearance is described as an oil cover.

Table 1-4 Thresholds for oil accumulation on shorelines.

Potential level of exposure	Trigger value (g/m^2)
Low	10 - 100
Moderate	100* - 1,000
High	> 1,000

* 100 g/m^2 also used to define the threshold for actionable shoreline oil.

1.2.3 Dissolved and Entrained Hydrocarbon Thresholds

Oil is a mixture of thousands of hydrocarbons of varying physical, chemical, and toxicological characteristics, and therefore, demonstrate varying fates and impacts on organisms. As such, for in-water exposure, the SIMAP model provides separate outputs for dissolved and entrained hydrocarbons from oil droplets. The consequences of exposure to dissolved and entrained components will differ because they have different modes and magnitudes of effect.

Entrained hydrocarbon concentrations were calculated based on oil droplets that are suspended in the water column, though not dissolved. The composition of this oil would vary with the state of weathering (oil age) and may contain soluble hydrocarbons when the oil is fresh. Calculations for dissolved hydrocarbons specifically calculates oil components which are dissolved in water, which are known to be the primary source of toxicity exerted by oil.

1.2.3.1 Dissolved Hydrocarbons

Laboratory studies have shown that dissolved hydrocarbons exert most of the toxic effects of oil on aquatic biota (Carls et al., 2008; Nordtug et al., 2011; Redman, 2015). The mode of action is a narcotic effect, which is positively related to the concentration of soluble hydrocarbons in the body tissues of organisms (French-McCay, 2002). Dissolved hydrocarbons are taken up by organisms directly from the water column by absorption through external surfaces and gills, as well as through the digestive tract. Thus, soluble hydrocarbons are termed “bioavailable”.

Hydrocarbon compounds vary in water-solubility and the toxicity exerted by individual compounds is inversely related to solubility, however bioavailability will be modified by the volatility of individual compounds (Nirmalakhandan & Speece, 1988; Blum & Speece, 1990; McCarty, 1986; McCarty et al., 1992a, 1992b; Mackay et al., 1992; McCarty & Mackay, 1993; Verhaar et al., 1992, 1999; Swartz et al., 1995; French-McCay, 2002; McGrath et al., 2009). Of the soluble compounds, the greatest contributor to toxicity for water-column and benthic organisms are the lower-molecular-weight aromatic compounds, which are both volatile and soluble in water. Although they are not the most water-soluble hydrocarbons within most oil types, the polynuclear aromatic hydrocarbons (PAHs) containing 2-3 aromatic ring structures typically exert the largest narcotic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant accumulation to occur (Anderson et al., 1974, 1987; Neff & Anderson, 1981; Malins & Hodgins, 1981; McAuliffe, 1987; NRC, 2003). The monoaromatic hydrocarbons (MAHs), including the BTEX compounds (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes (straight chain hydrocarbons) also contribute to toxicity, but these compounds are highly volatile, so that their contribution will be low when oil is exposed to evaporation and higher when oil is discharged at depth where volatilisation does not occur (French-McCay, 2002).

French-McCay (2002) reviewed available toxicity data, where marine biota was exposed to dissolved hydrocarbons prepared from oil mixtures, finding that 95% of species and life stages exhibited 50% population mortality (LC50) between 6 and 400 ppb total PAH concentration after 96 hrs exposure, with an average of 50 ppb. Hence, concentrations lower than 6 ppb total PAH value should be protective of 97.5% of species and life stages even with exposure periods of days (at least 96 hours). Early life-history stages of fish appear to be more sensitive than older fish stages and invertebrates.

Exceedances of 10, 50 or 400 ppb over a 1 hour timestep (see Table) was applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high), based on NOPSEMA (2019).

1.2.3.2 Entrained Hydrocarbons

Entrained hydrocarbons consist of oil droplets that are suspended in the water column and insoluble. As such, insoluble compounds in oil cannot be absorbed from the water column by aquatic organisms, hence are not bioavailable through absorption of compounds from the water. Exposure to these compounds would require routes of uptake other than absorption of soluble compounds. The route of exposure of organisms to whole oil alone include direct contact with tissues of organisms and uptake of oil by direct consumption, with potential for biomagnification through the food chain (NRC, 2005).

The 10 ppb threshold represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC (2000) water quality guidelines. Due to the requirement for relatively long exposure times (> 24 hours) for these concentrations to be significant, they are likely to be more meaningful for juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes, or when entrained hydrocarbons adhere to organisms or trapped against a shoreline for periods of several days or more.

This exposure zone is not considered to be of significant biological impact and is therefore outside the adverse exposure zone. This exposure zone represents the area contacted by the spill. This area does not define the area of influence as it is considered that the environment will not be affected by the entrained hydrocarbon at this level.

Thresholds of 10 ppb and 100 ppb were applied over a 1 hour time exposure (Table), to cover the range of thresholds outlined in the ANZECC/ARMCANZ (2000) water quality guidelines, the incremental change for greater potential effect and is per NOPSEMA (2019).

A complicating factor that should be considered when assessing the consequence of dissolved and entrained oil distributions is that there will be some areas where both physically entrained oil droplets and dissolved hydrocarbons co-exist. Higher concentrations of each will tend to occur close to the source where sea conditions can force mixing of relatively unweathered oil into the water column, resulting in more rapid dissolution of soluble compounds.

Table 1-5 Dissolved and entrained hydrocarbon exposure values assessed over a 1-hour time step, as per NOPSEMA (2019).

Threshold level	Dissolved hydrocarbon concentration (ppb)	Entrained hydrocarbon concentrations (ppb)
Low	10	10
Moderate	50	NA
High	400	100

1.3 Dispersant Application

The application of surface dispersant was modelled within a 40 km by 40 km zone and a 500 m radius exclusion zone around Wandoo A, Wandoo B (study release location), a potential relief well within a 3 km of Wandoo B and Stag Platform.

The dispersant effectiveness was set at 50% based on laboratory testing. It was assumed that that the dispersant will be effective on fresh, weathered and emulsified oil with a minimum thickness of 10 µm and a viscosity of up to 12,500 cP. The surface dispersant application was assumed continuous for 10 hours during daylight hours only, starting from 48 hours after the initial release until the end of the spill duration. Winds were capped at 35 knots to ensure safe operating conditions for planes, but also to allow for sufficient mixing of the chemical dispersants and oil at water surface (API et al. 2001; NOAA 2010). A dispersant to oil ratio of 1:20 was applied. Table summarises the parameters.

Table 1-6 Aerial dispersant application parameters.

Parameter	Input
Maximum Volume (m^3/d)	After 48 hours: 30 After 72 hours: 77
Dispersant to oil ratio	1:20 (applied on oil > 10 g/m^2)
Dispersant effectiveness (%)	50
Maximum viscosity threshold (cP)	12,500
Minimum Operational Wind Speeds (knots)	2
Maximum Operational Wind Speeds (knots)	35
Operational hours	10 (during daylight only)

1.4 Hydrocarbon Characteristics

Wandoo Crude (API 19.4) was used for this oil spill modelling study. It has a density of 937.7 g/cm3, a dynamic viscosity of 161 cP and a low pour point of -24°C, which ensures that this crude will remain in a liquid state over the annual temperature range observed on the North West Shelf. It is also low in wax content, typical of a biodegraded oil and categorised as a Group IV (or persistent) oil according to both oil classifications for AMSA (2015) and the International Tanker Owner Pollution Federation (ITOPF, 2012).

Table 1-7 Physical properties for Wandoo Crude.

Properties	Wandoo Crude
Density (kg/m^3)	0.937 (at 16 °C)
API	19.4
Dynamic viscosity (cP)	161 (at 25 °C)
Pour point (°C)	-24
Hydrocarbon property category	Group IV
Hydrocarbon property classification	Persistent

Figure 1-2 displays the predicted weathering and fates for a 24 hour surface release (594 m3 as the average daily release rate) of Wandoo Crude, under three constant wind speeds. Under low wind-speeds (5 knots), the crude will remain on the surface longer, spread quicker, and in turn increase the evaporative process. Conversely, sustained stronger winds (>10 knots) will generate breaking waves at the surface, causing a large amount of crude to be entrained into the water column and in turn reducing the amount available to evaporate.

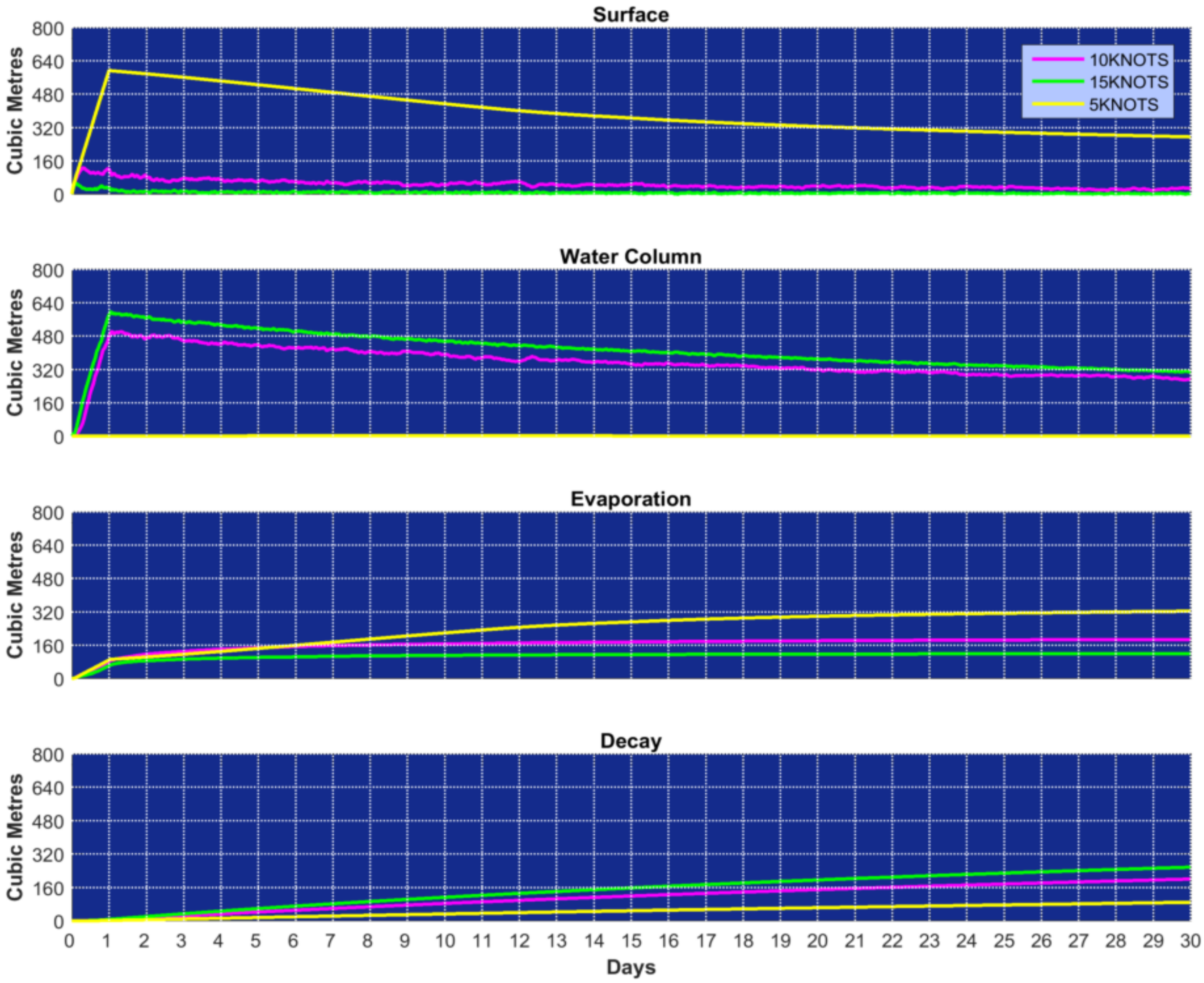


Figure 1-2 Weathering and fates of Wandoo Crude under three static winds conditions (5, 10 and 15 knots). The results are based on a 594 m3 (average daily release rate) surface release over 24 hours and tracked for 30 days.

2 SEA SURFACE EXPOSURE

Table 2-1 summarises the maximum distances from the release location to oil exposure zones on the sea surface for each season, for the unmitigated (no dispersant application) and mitigated cases (dispersant application).

For the unmitigated case, the maximum distance from the release location to the low (1–10 g/m2), moderate (10–25 g/m2) and high (> 25 g/m2) exposure thresholds was 2,213 km west-northwest, 902 km west and 369 km west-southwest, respectively, which had all occurred for spills commencing during the transitional months. In comparison, for the mitigated case the maximum distance was 2,091 km west-northwest (transitional), 685 km north (summer) and 358 km west-southwest (transitional), for each threshold, respectively.

Figures 2-1 to 2.30 present the zones of sea surface exposure in summer, transitional and winter months, for the unmitigated case.The figures show the probability of sea-surface contact (reporting threshold of 10 g/m2) at day 1, 2, 5, 10, 20, 30, 40, 50, 60, and 70 without the application of dispersant for each season.

Table 2-2 to Table 2-4 summarise the potential sea surface exposure to individual receptors for each season for both the unmitigated and mitigated case. For spills commencing during summer conditions, the following receptors had recorded surface oil exposure greater than 90% for the unmitigated and mitigated cases: Montebello AMP, Northwest Shelf and Pilbara (Offshore) IMCRA, Ancient coastline at 125 m depth contour Key Ecological Feature (KEF), Continental Slope Demersal Fish Communities KEF, Glomar Shoals and WA State Waters (Table 2-2).

The following receptors had recorded surface oil exposure greater than 90% for the unmitigated and mitigated cases, for spills commencing during the transitional months: Montebello AMP, Northwest Shelf and Pilbara (offshore) IMCRAs, Ancient coastline at 125 m depth contour, Continental Slope Demersal Fish Communities and Glomar Shoals KEFs (Table 2-3).

Winter conditions resulted in a broader surface oil exposure to receptors at, or above the low threshold and the following receptors recorded probabilities greater than 90%: Gascoyne AMP and Montebello AMP, Northwest Shelf IMCRA, Pilbara (offshore) IMCRA, Ancient coastline at 125 m depth contour KEF, Continental Slope Demersal Fish Communities KEF, Exmouth Plateau KEF, Montebello Islands Marine Park (MP), Tryal Rock and WA State Waters (Table 2-4), for both the unmitigated and mitigated cases.

The use of surface dispersant did demonstrate a notable reduction of the sea surface exposure at, or above the moderate threshold, hence resulting in a lesser number of environmental receptors potentially exposed to surface hydrocarbons.

Table 2-1 Maximum distance and direction from the release location to oil exposure thresholds on the sea surface, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during all seasonal conditions.

Season	Distance and direction travelled	Zones of potential sea surface exposure					
		Unmitigated			Mitigated		
		Low	Moderate	High	Low	Moderate	High
Summer	Maximum distance (km) from the release location	1,721	687	308	1,651	685	192
	Direction	WNW	N	SW	WNW	N	W
Transitional	Maximum distance (km) from the release location	2,213	902	369	2,091	415	358
	Direction	WNW	W	WSW	WNW	WSW	WSW
Winter	Maximum distance (km) from the release location	2,080	771	350	2,089	631	343
	Direction	WNW	W	WSW	WNW	W	WSW

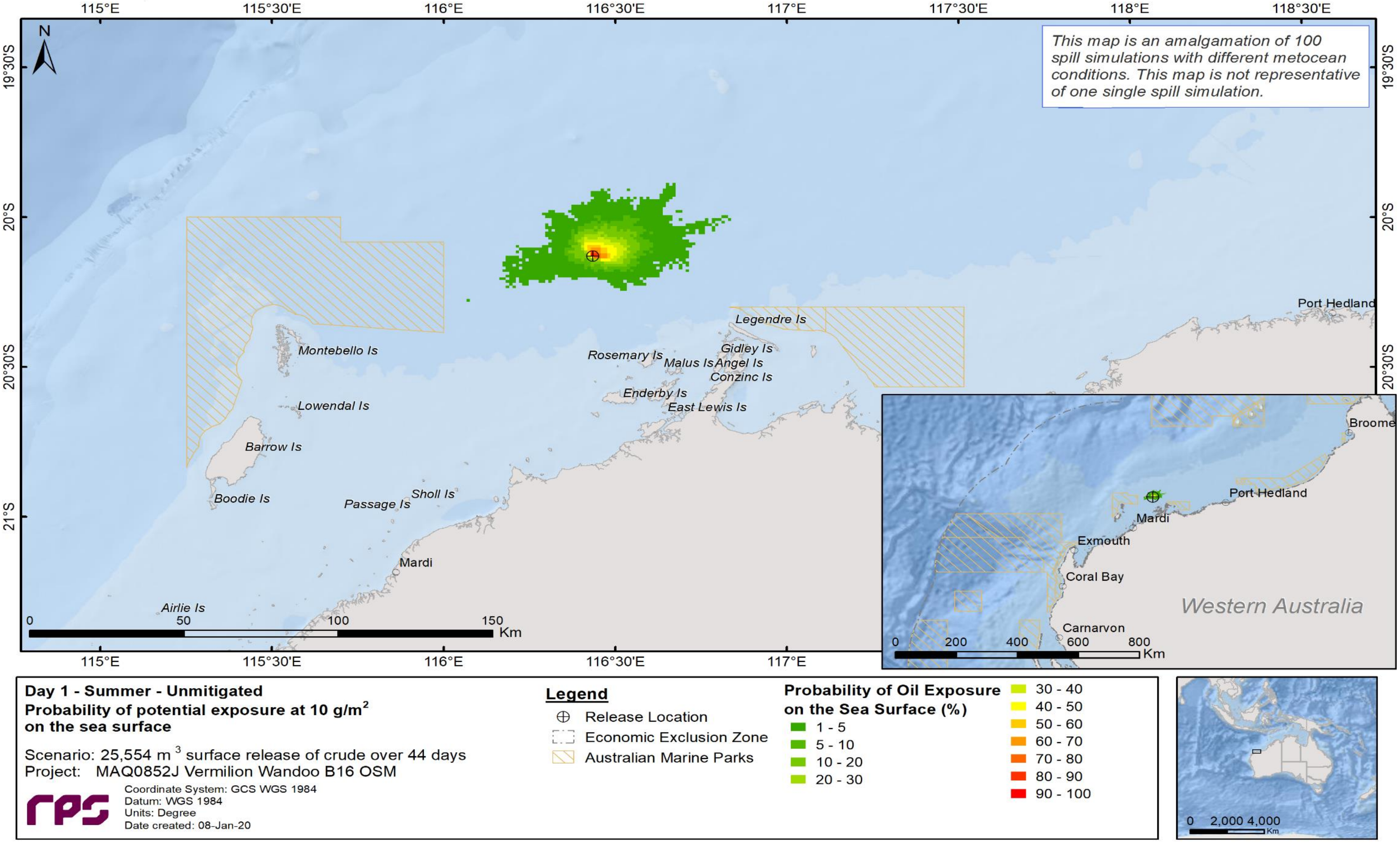


Figure 2-1 Probability of sea-surface exposure (above 10 g/m2) at day 1 during summer conditions.

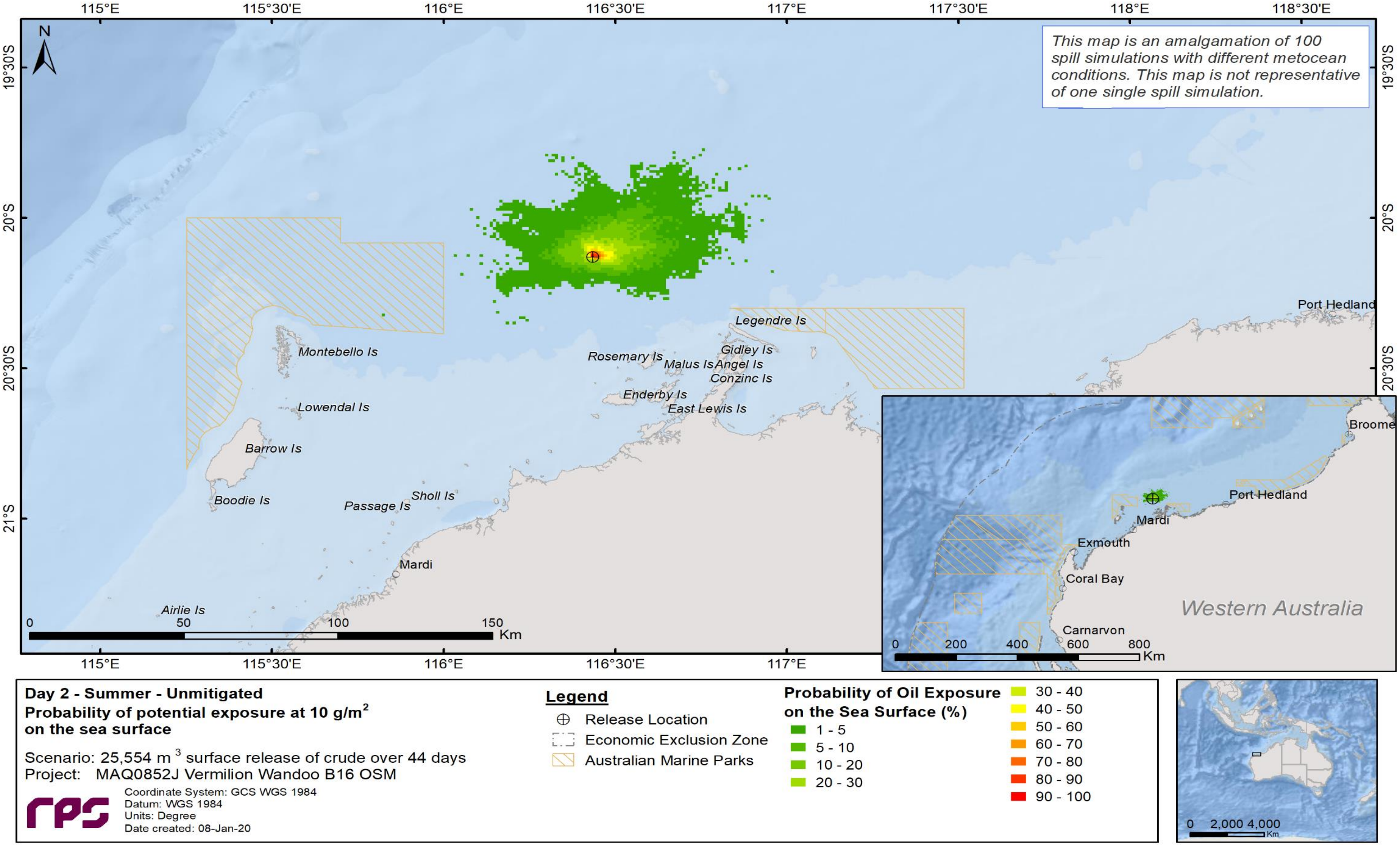


Figure 2-2 Probability of sea-surface exposure (above 10 g/m2) at day 2 during summer conditions

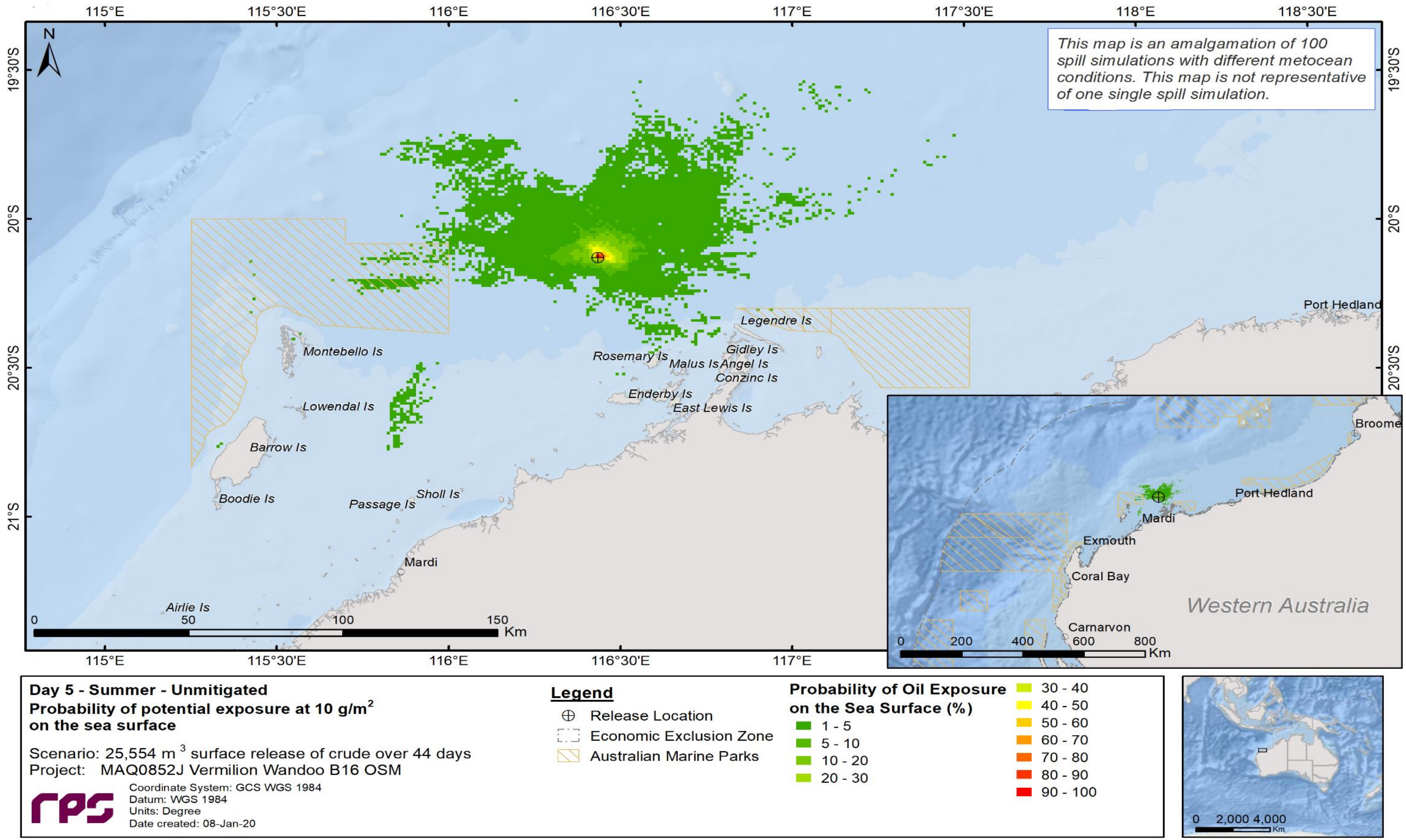


Figure 2-3 Probability of sea-surface exposure (above 10 g/m2) at day 5 during summer conditions.

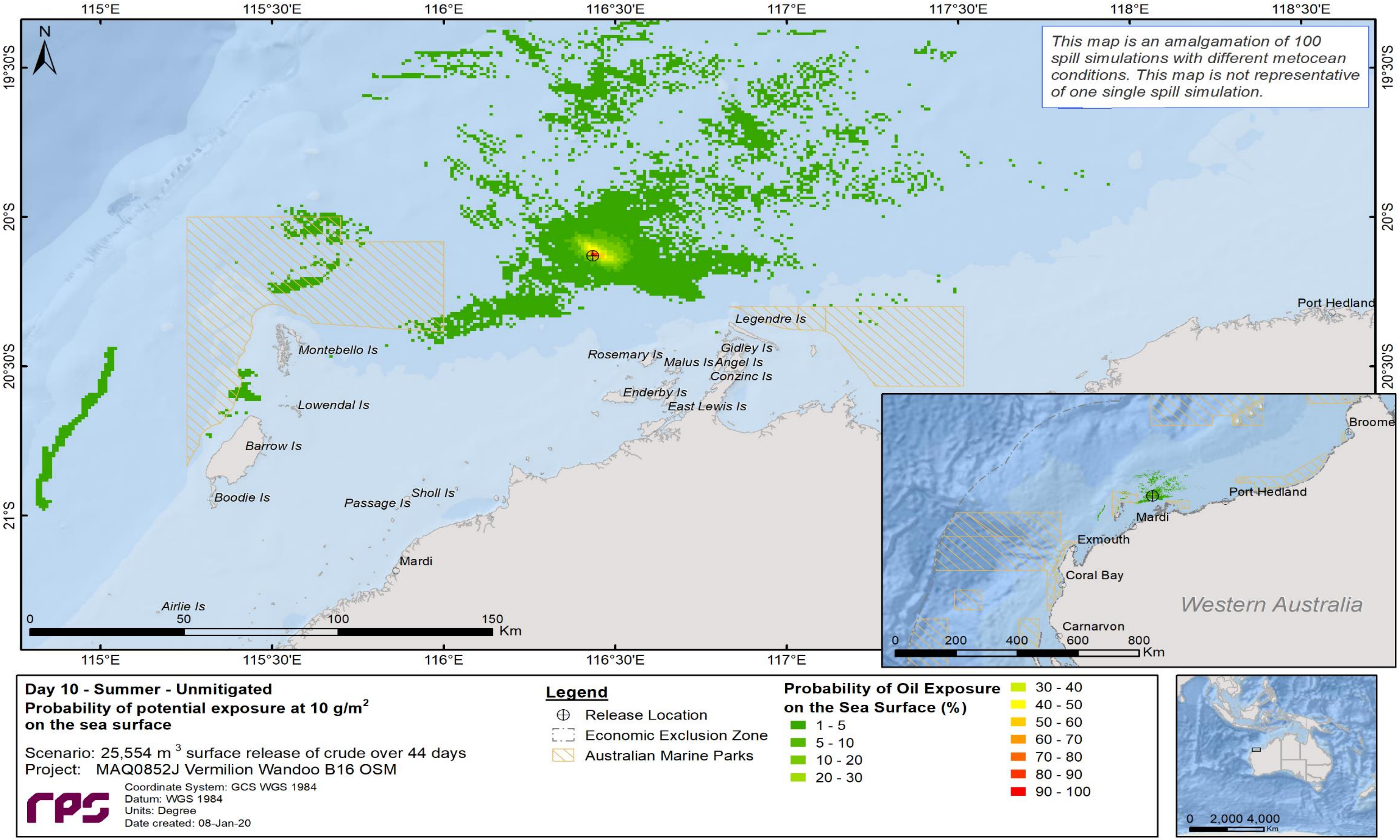


Figure 2-4 Probability of sea-surface exposure (above 10 g/m2) at day 10 during summer conditions

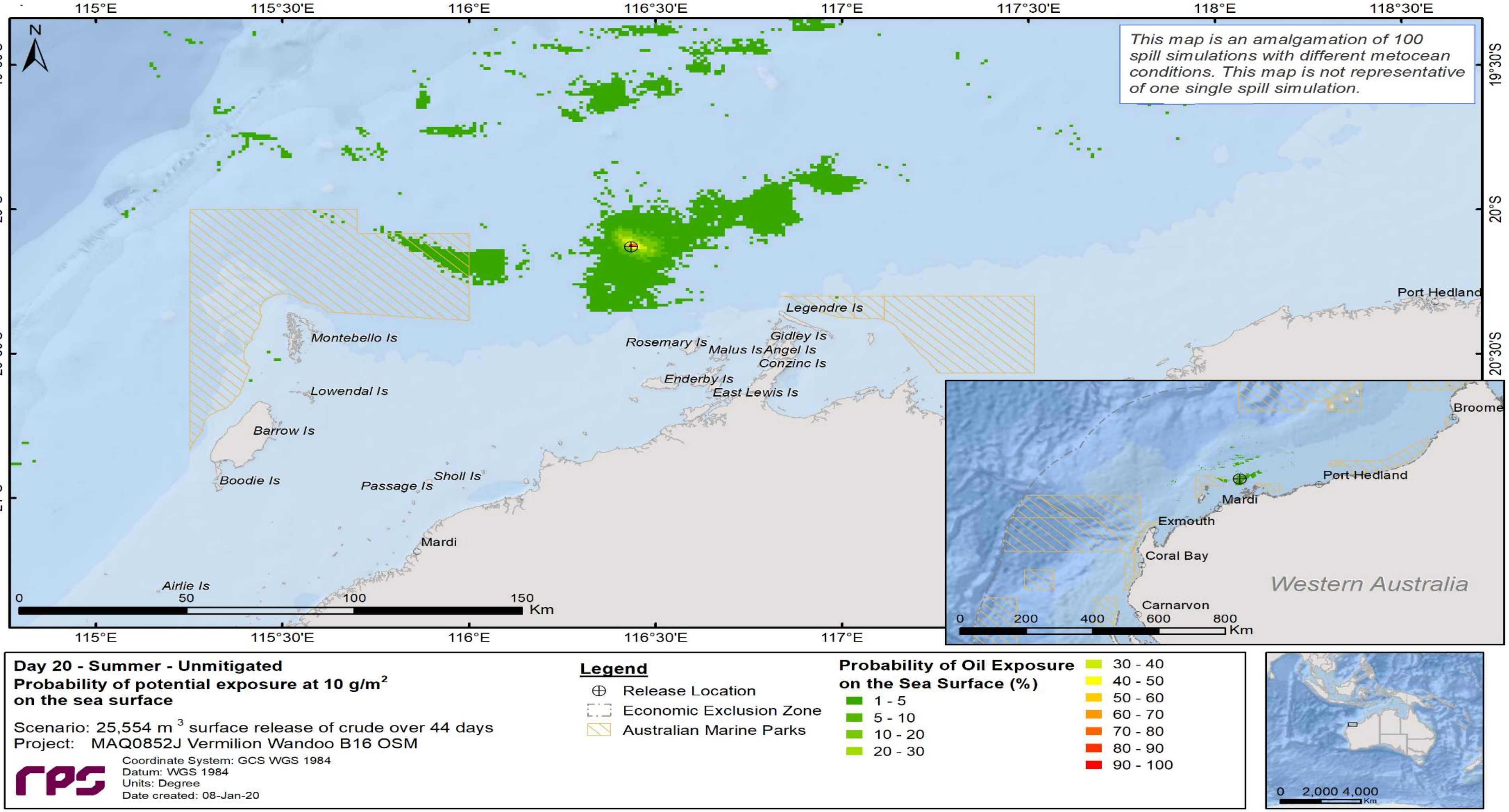


Figure 2-5 Probability of sea-surface exposure (above 10 g/m2) at day 20 during summer conditions

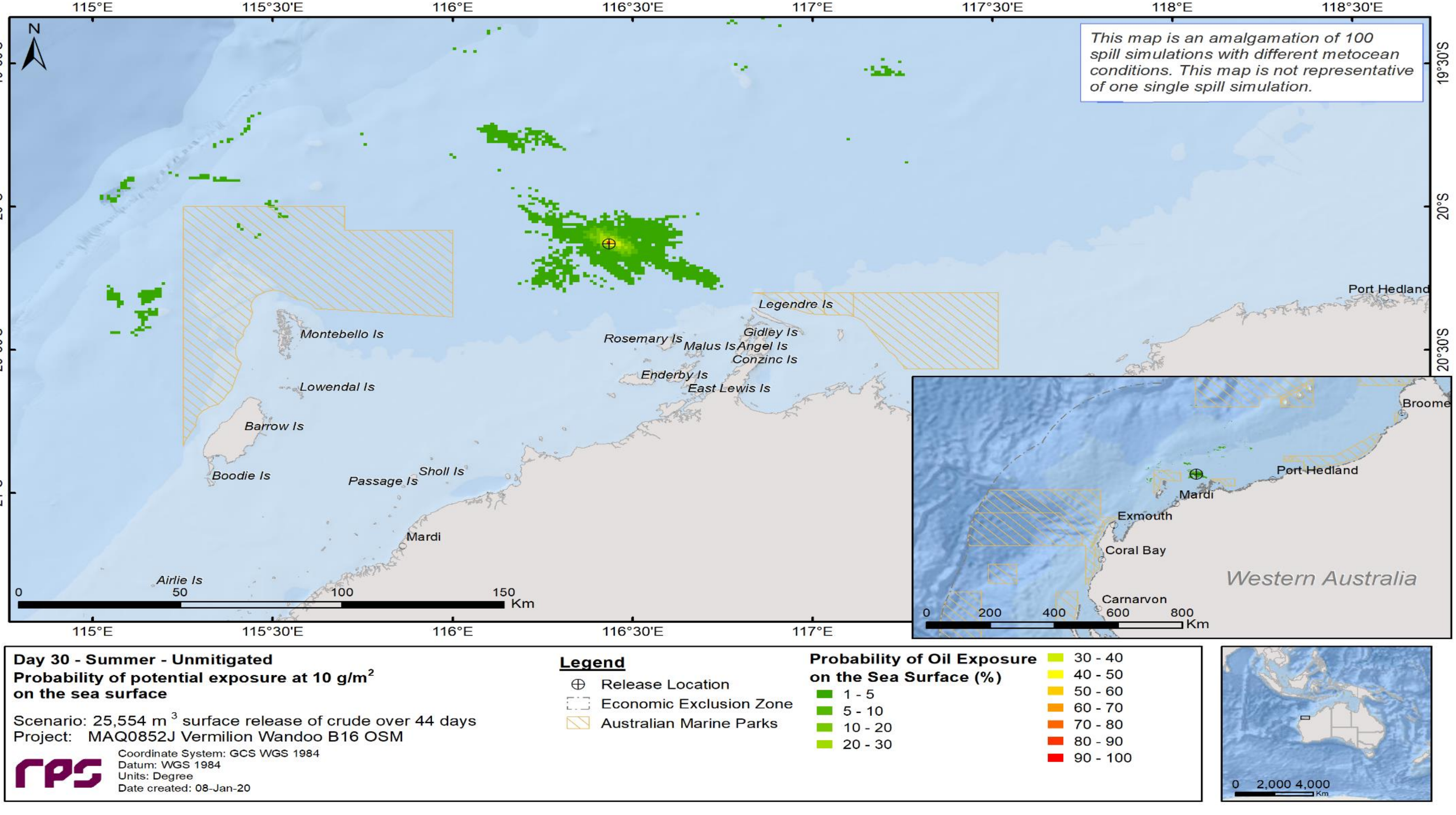


Figure 2-6 Probability of sea-surface exposure (above 10 g/m2) at day 30 during summer conditions

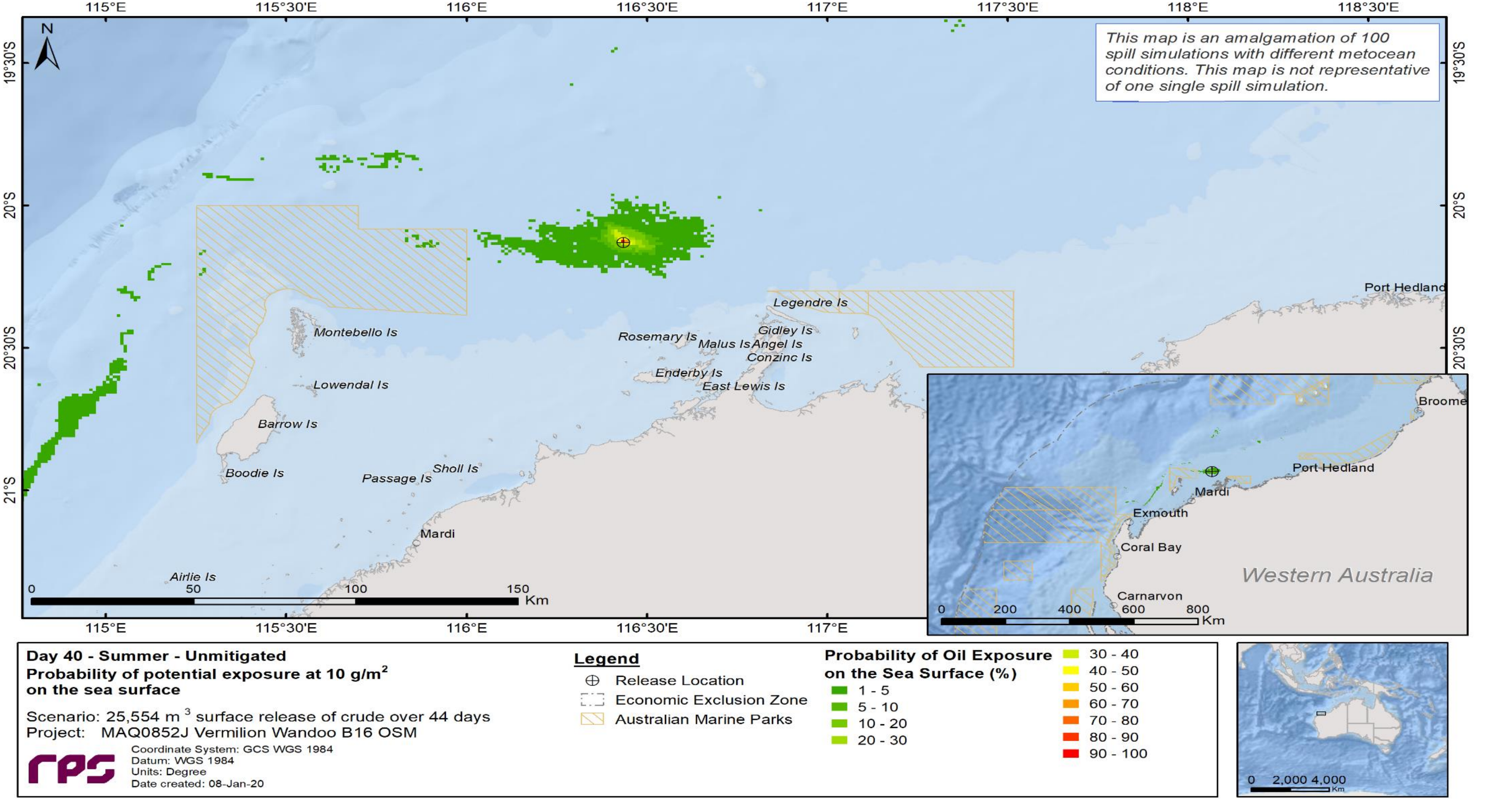


Figure 2-7 Probability of sea-surface exposure (above 10 g/m2) at day 40 during summer conditions

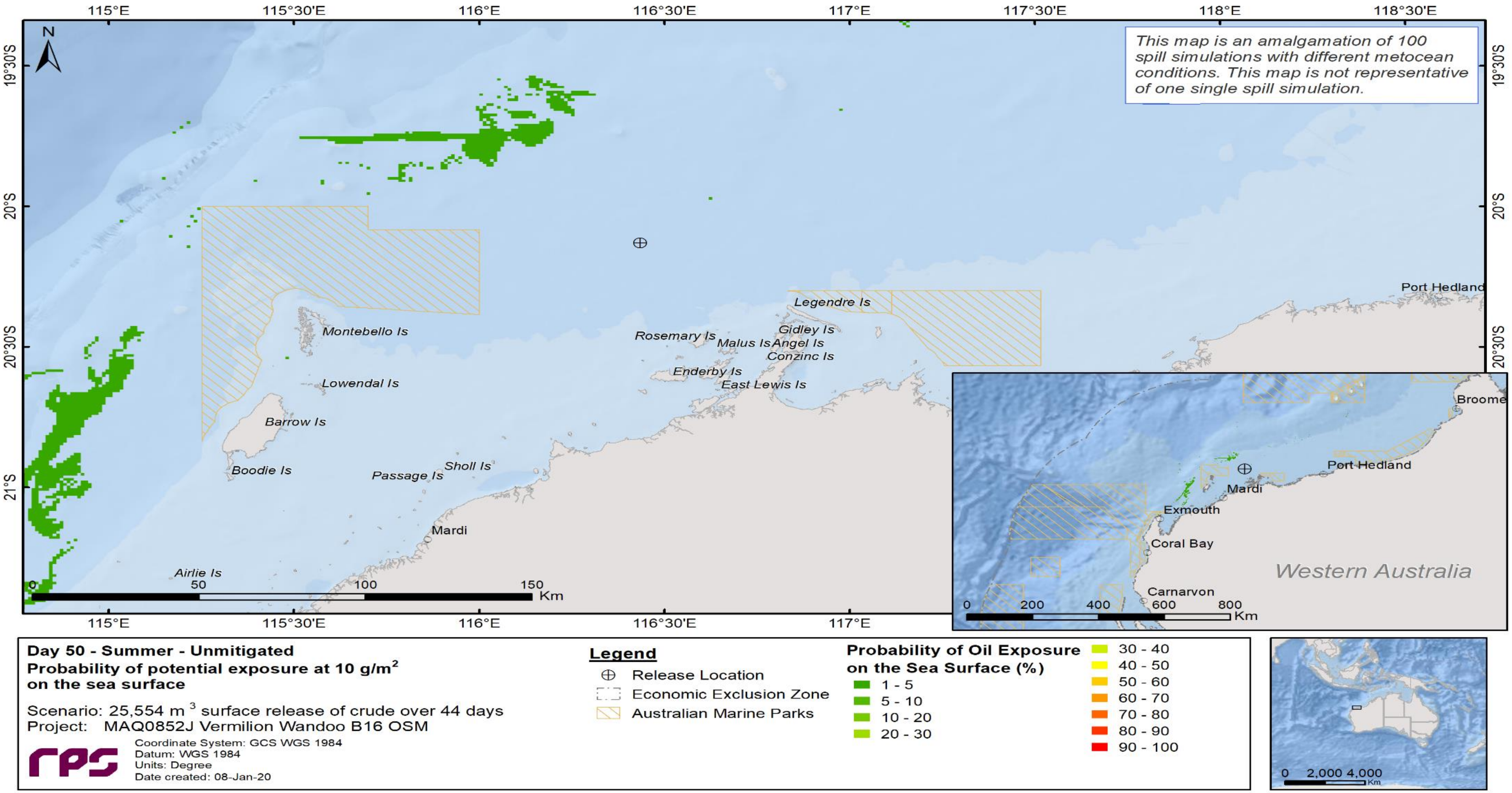
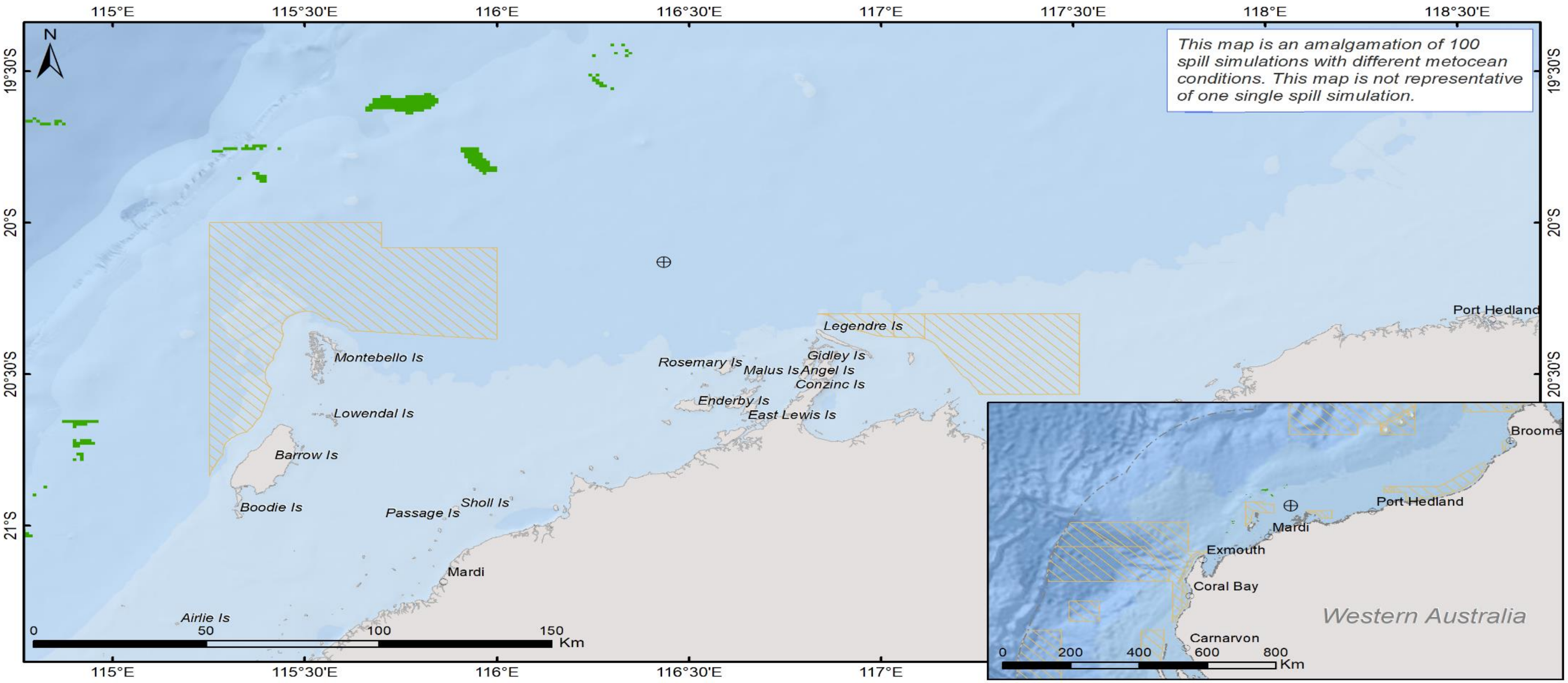


Figure 2-8 Probability of sea-surface exposure (above 10 g/m2) at day 50 during summer conditions



Day 60 - Summer - Unmitigated
Probability of potential exposure at 10 g/m^2 on the sea surface

Scenario: 25,554 m^3 surface release of crude over 44 days
Project: MAQ0852J Vermilion Wandoo B16 OSM

rps

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Date created: 08-Jan-20

Legend
- Release Location
- Economic Exclusion Zone
- Australian Marine Parks

Probability of Oil Exposure on the Sea Surface (%)
- 1 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100

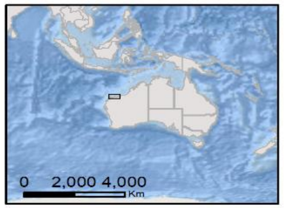


Figure 2-9 Probability of sea-surface exposure (above 10 g/m2) at day 60 during summer conditions

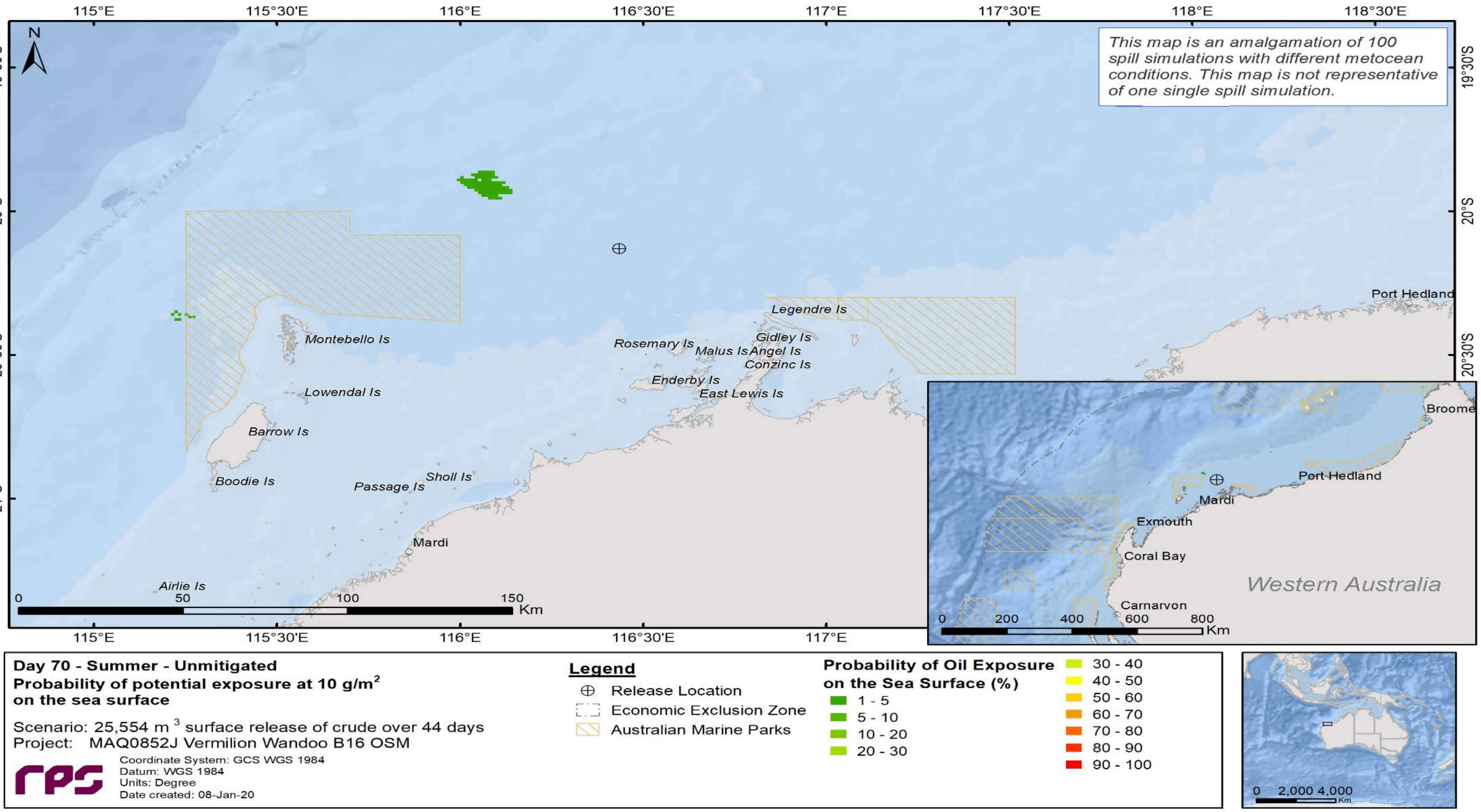


Figure 2-10 Probability of sea-surface exposure (above 10 g/m2) at day 70 during summer conditions

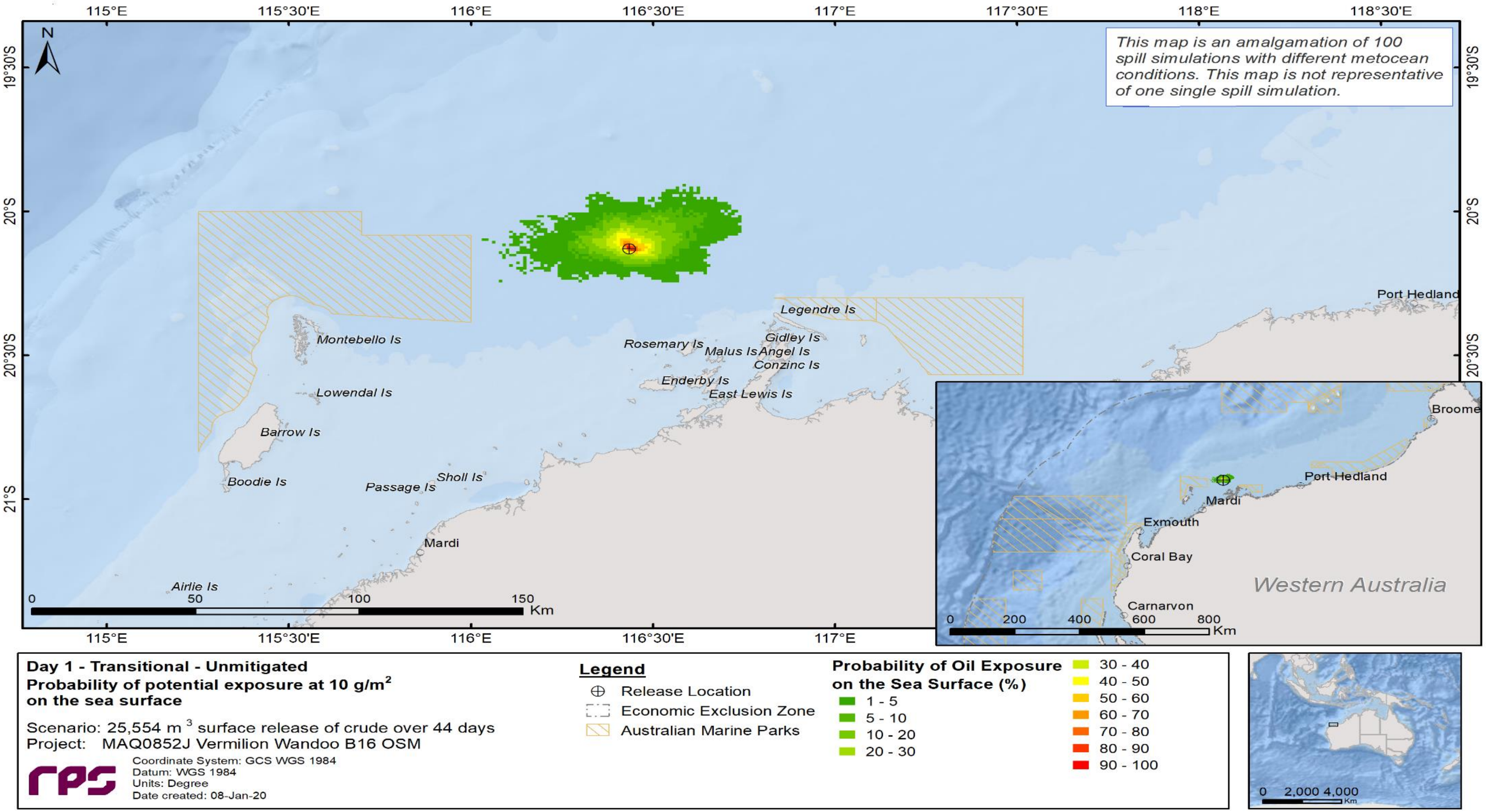


Figure 2-11 Probability of sea-surface exposure (above 10 g/m2) at day 1 during transitional conditions

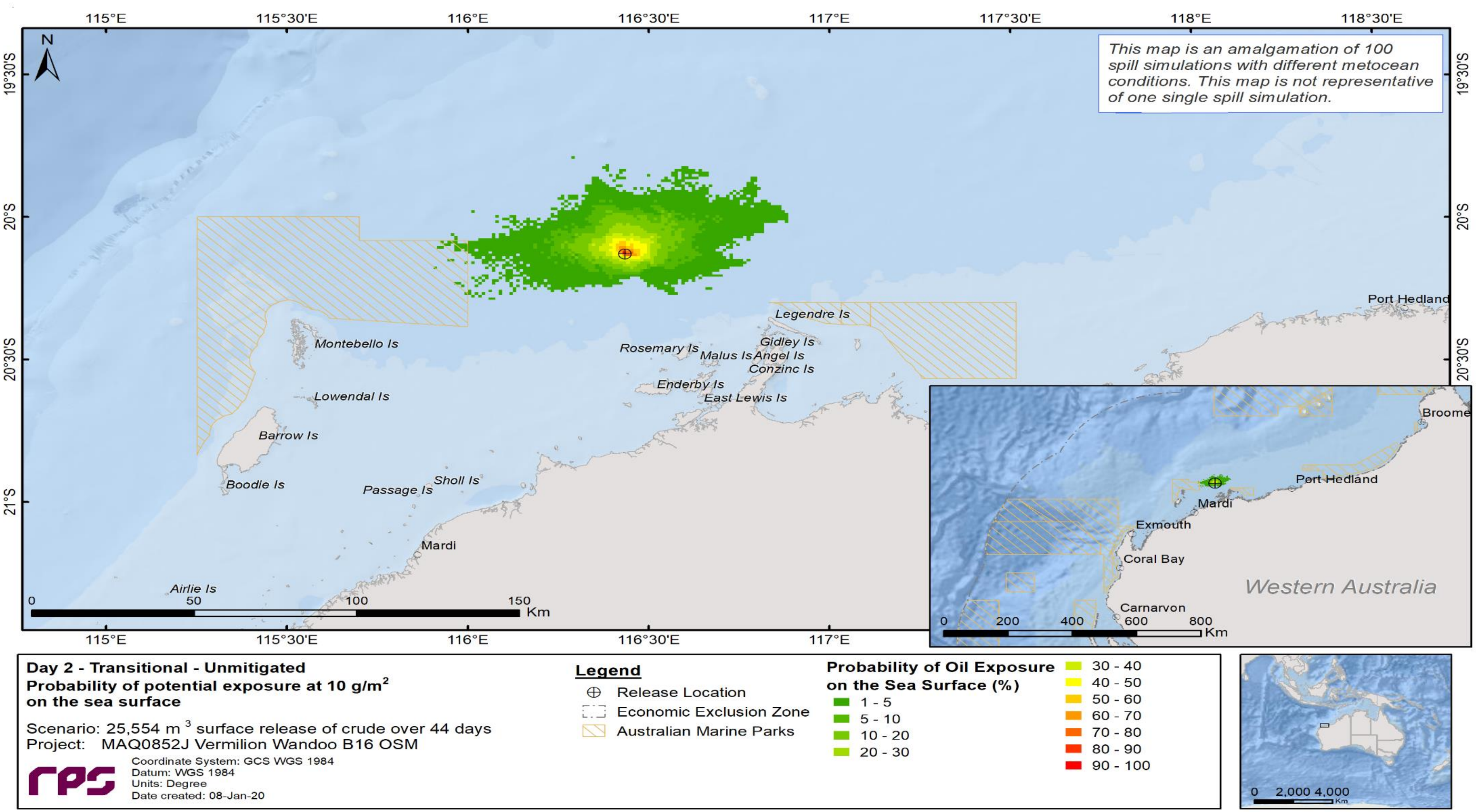


Figure 2-12 Probability of sea-surface exposure (above 10 g/m2) at day 2 during transitional conditions

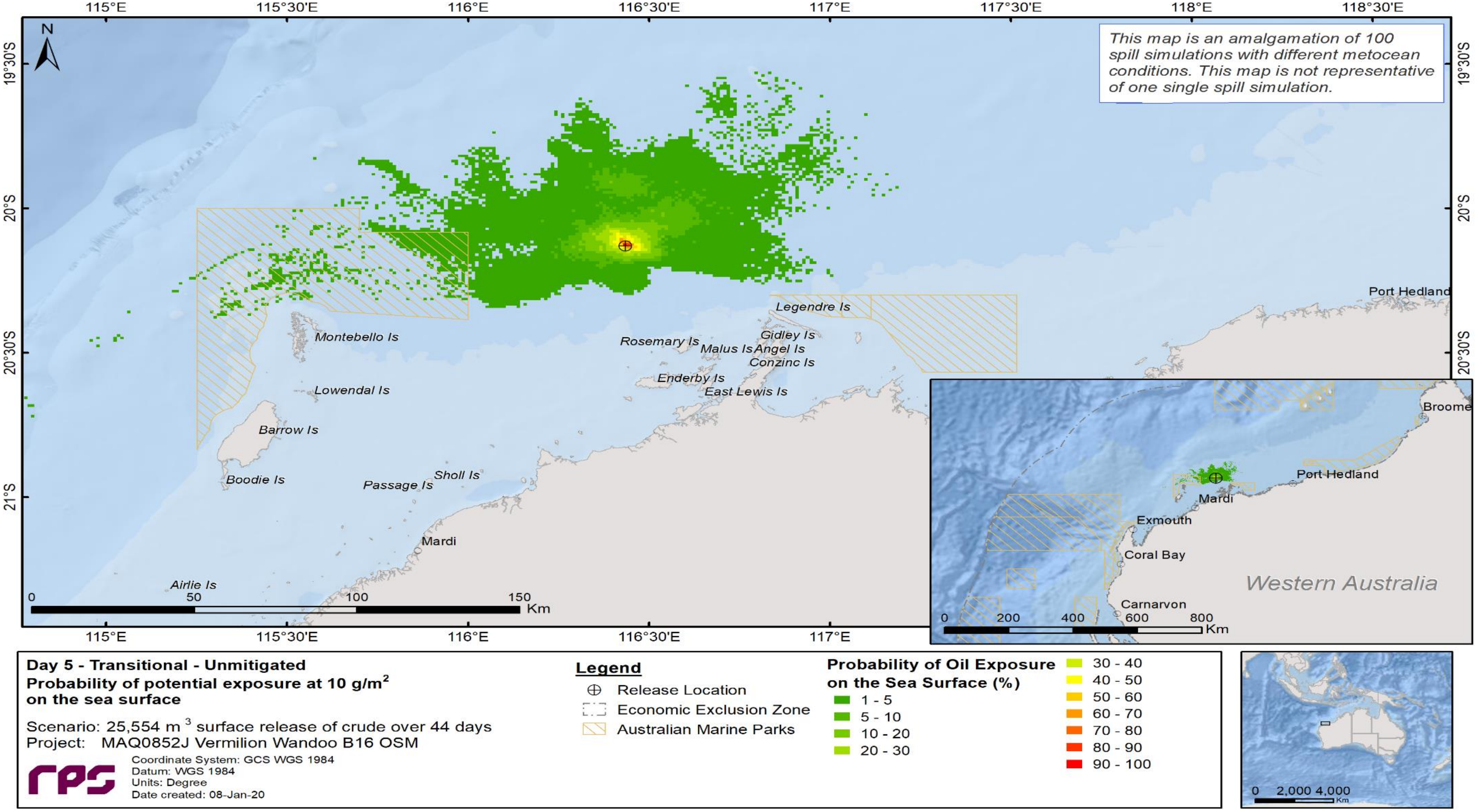


Figure 2-13 Probability of sea-surface exposure (above 10 g/m2) at day 5 during transitional conditions

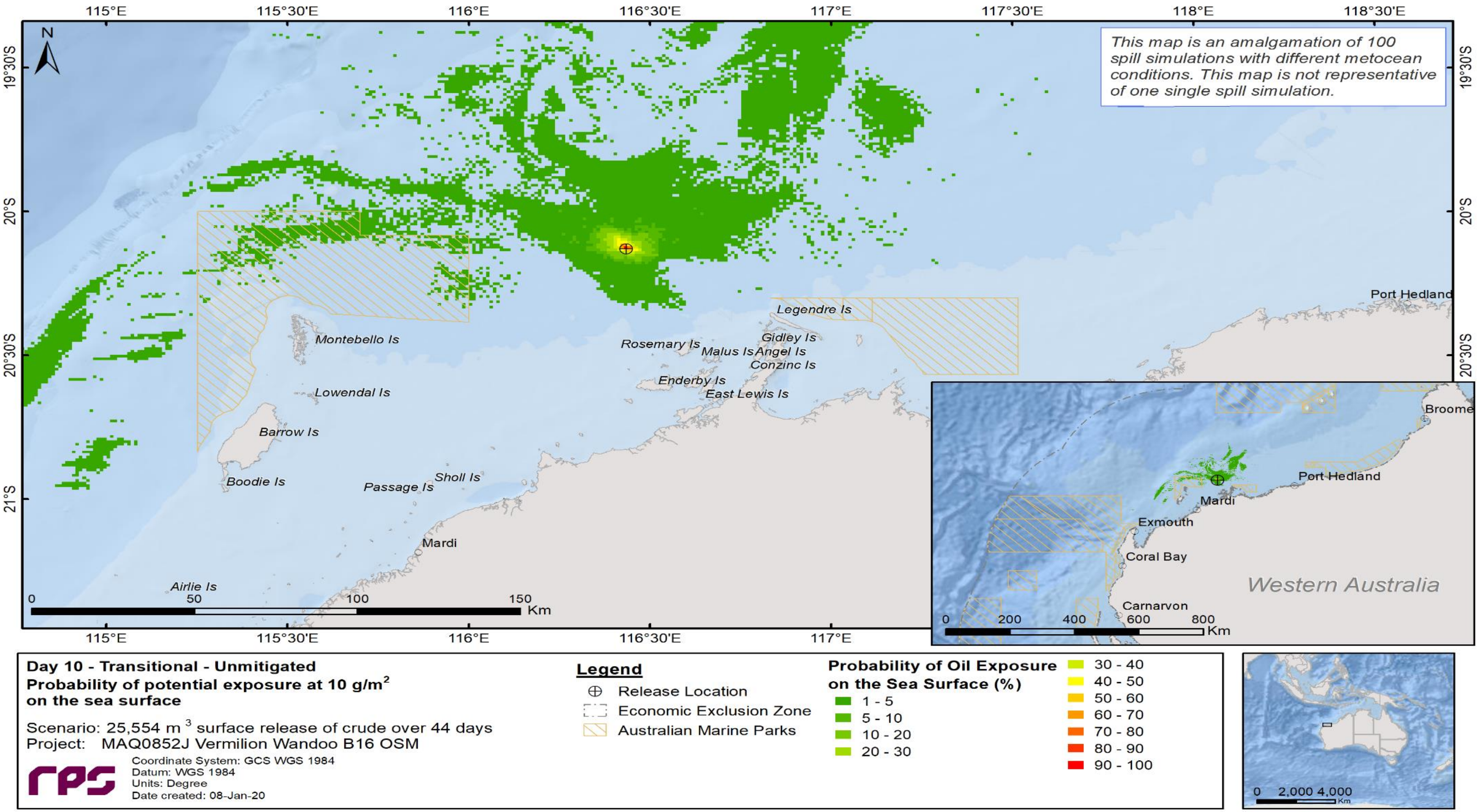


Figure 2-14 Probability of sea-surface exposure (above 10 g/m2) at day 10 during transitional conditions

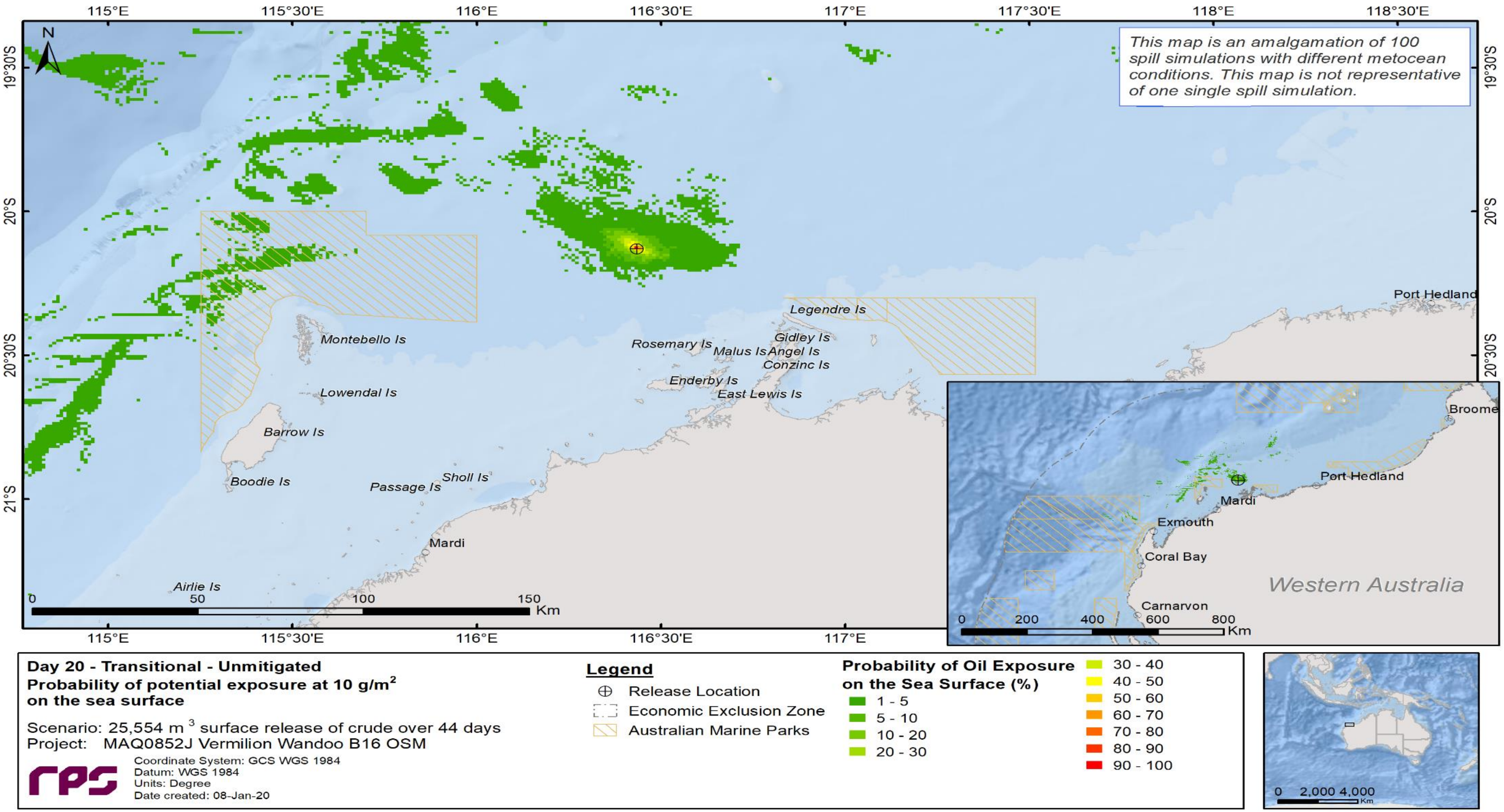


Figure 2-15 Probability of sea-surface exposure (above 10 g/m2) at day 20 during transitional conditions

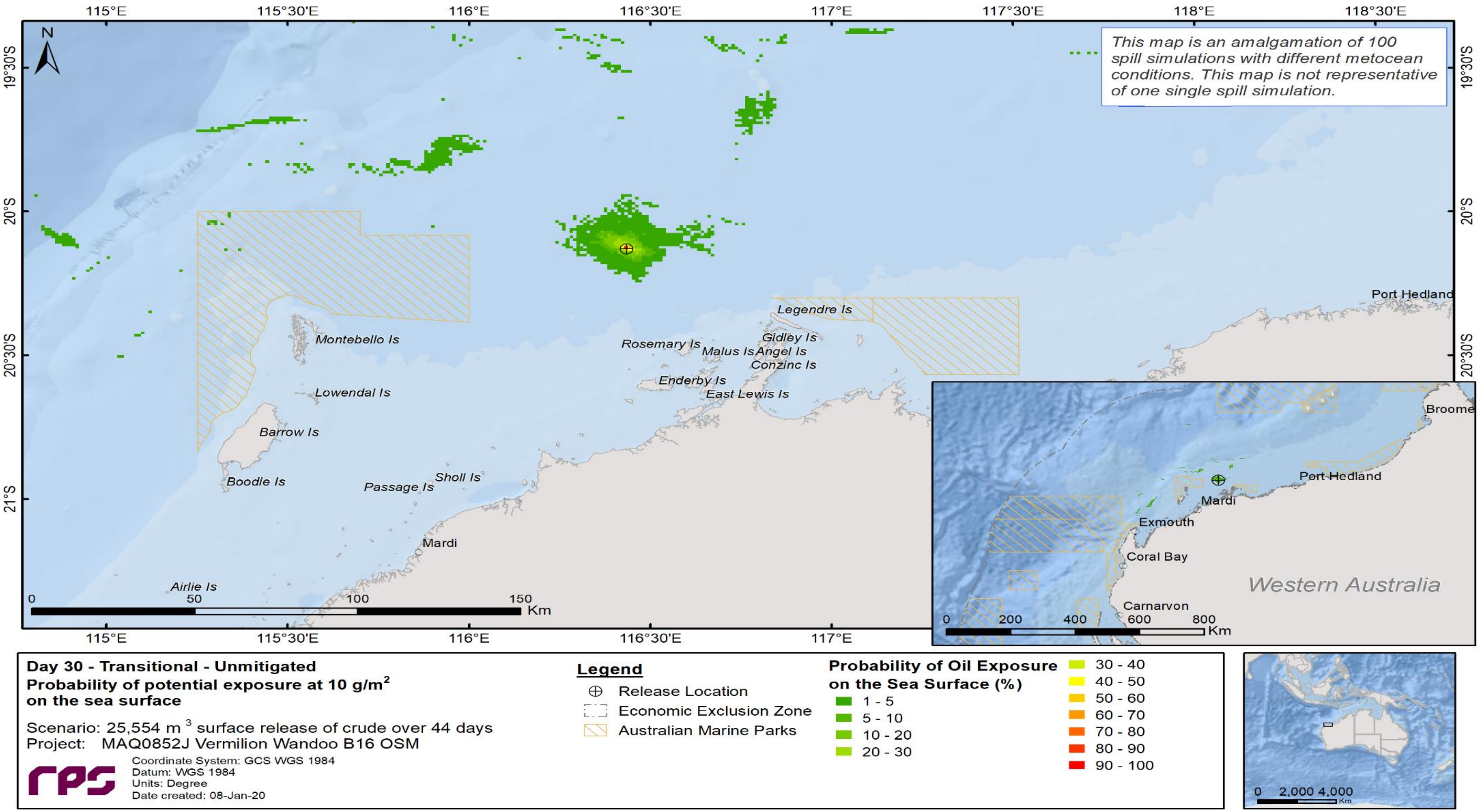


Figure 2-16 Probability of sea-surface exposure (above 10 g/m2) at day 30 during transitional conditions

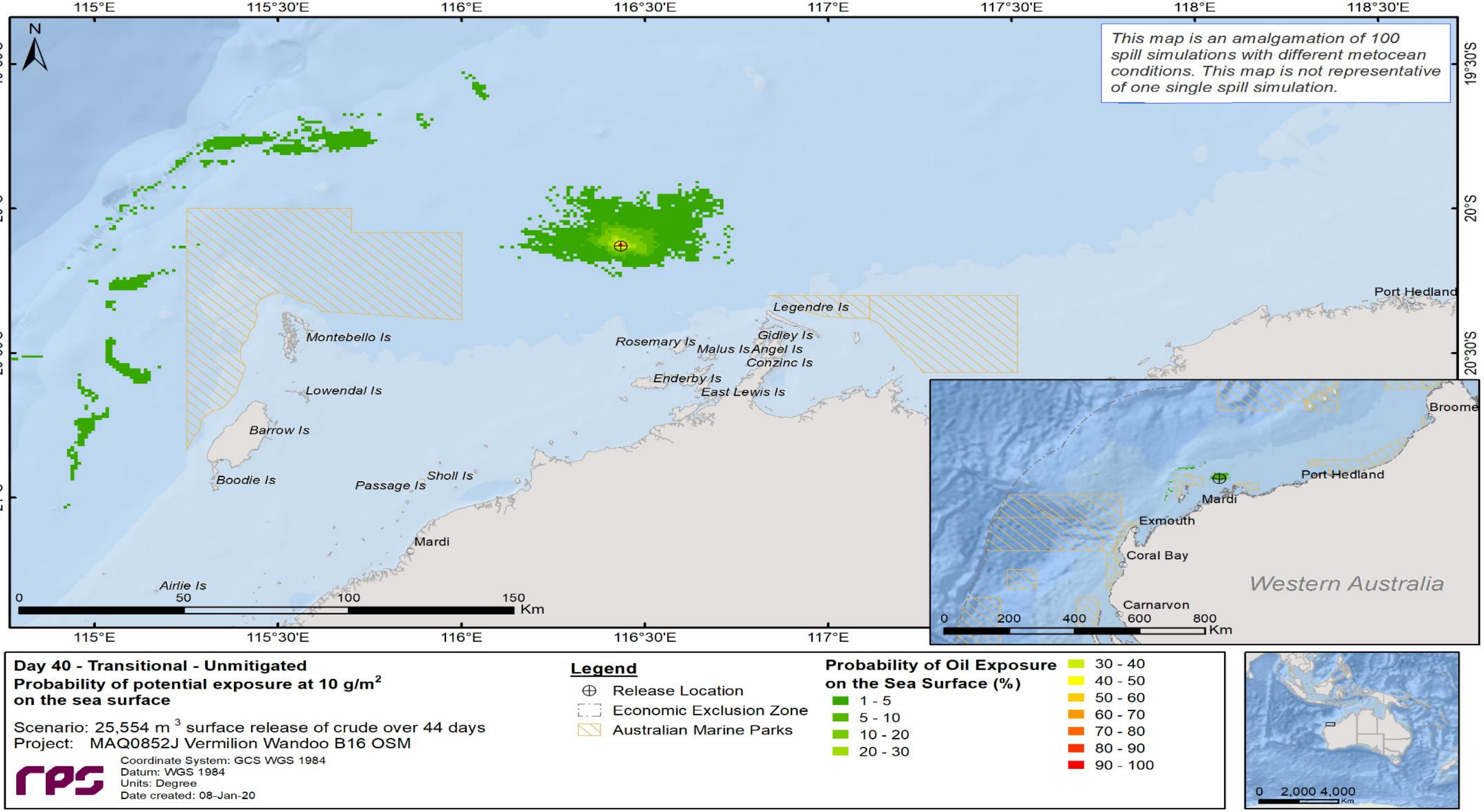


Figure 2-17 Probability of sea-surface exposure (above 10 g/m2) at day 40 during transitional conditions

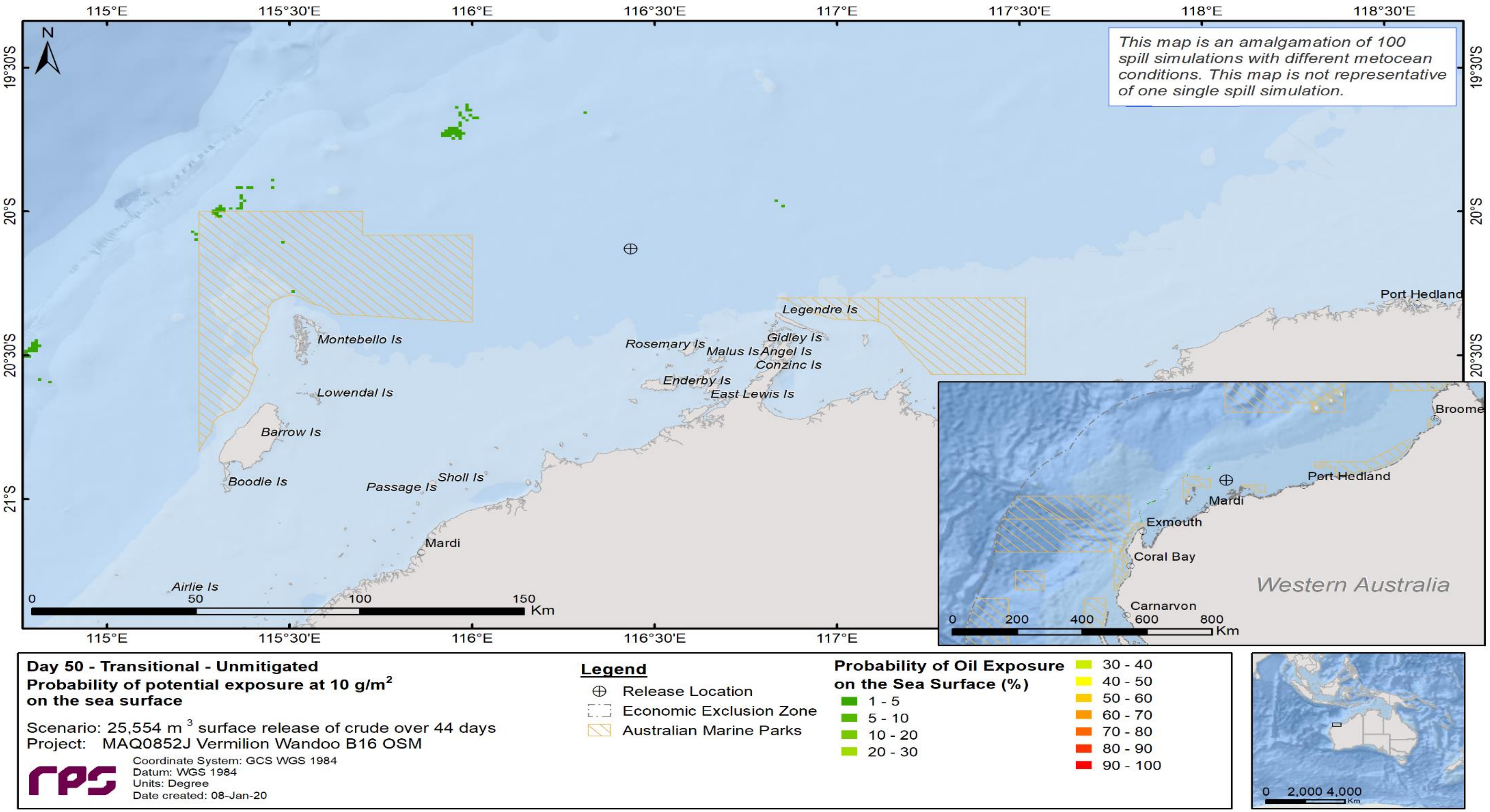


Figure 2-18 Probability of sea-surface exposure (above 10 g/m2) at day 50 during transitional conditions

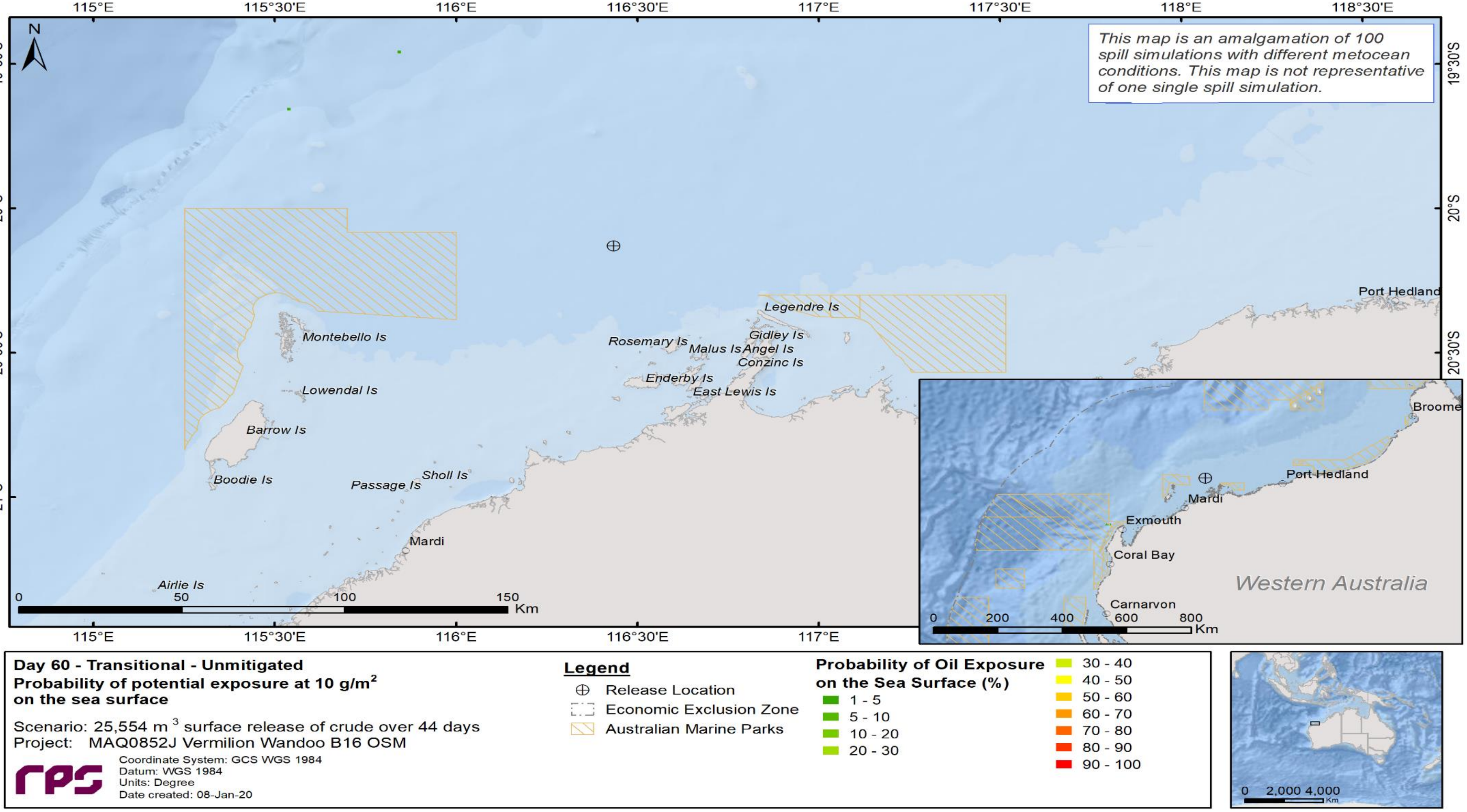


Figure 2-19 Probability of sea-surface exposure (above 10 g/m2) at day 60 during transitional conditions

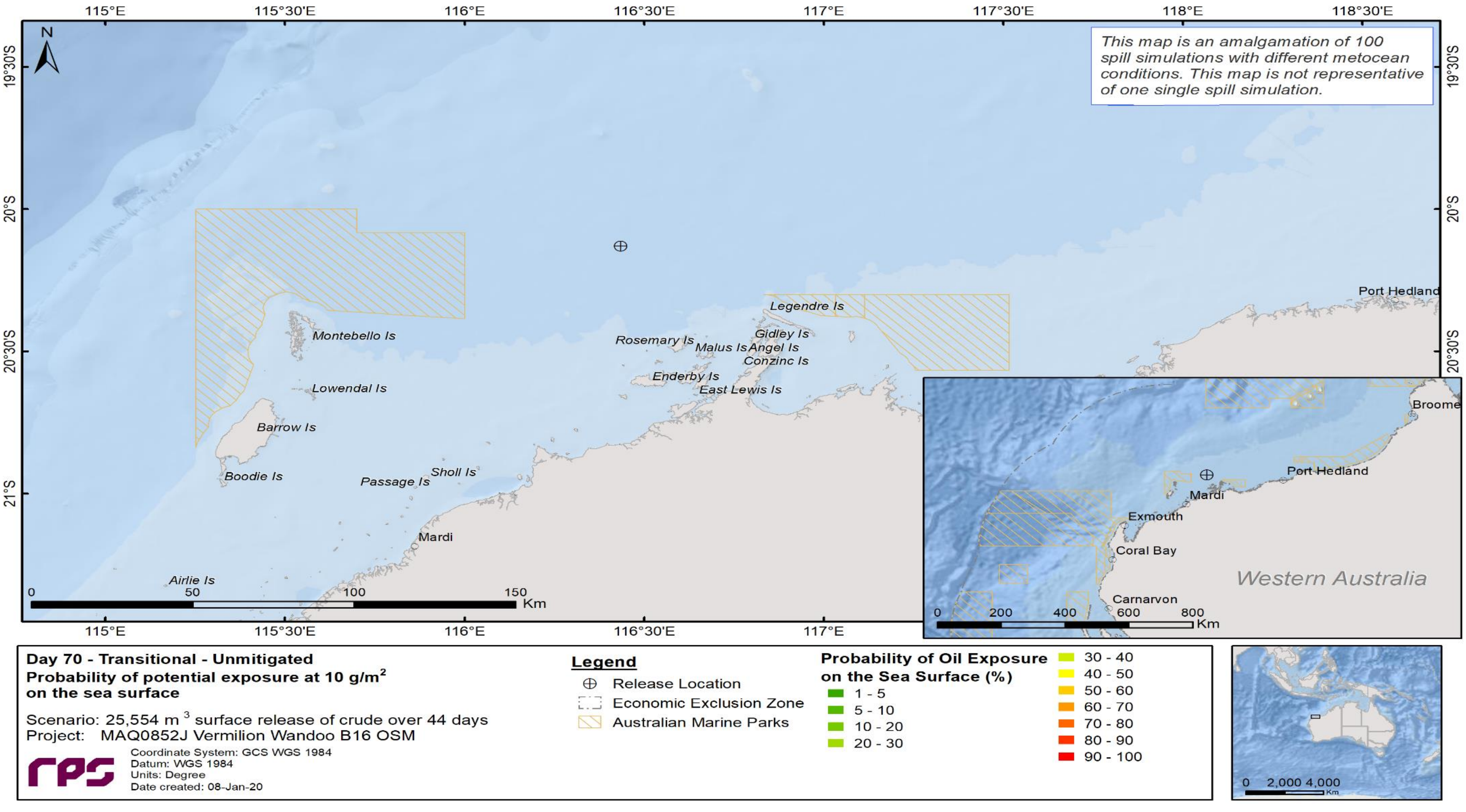


Figure 2-20 Probability of sea-surface exposure (above 10 g/m2) at day 70 during transitional conditions

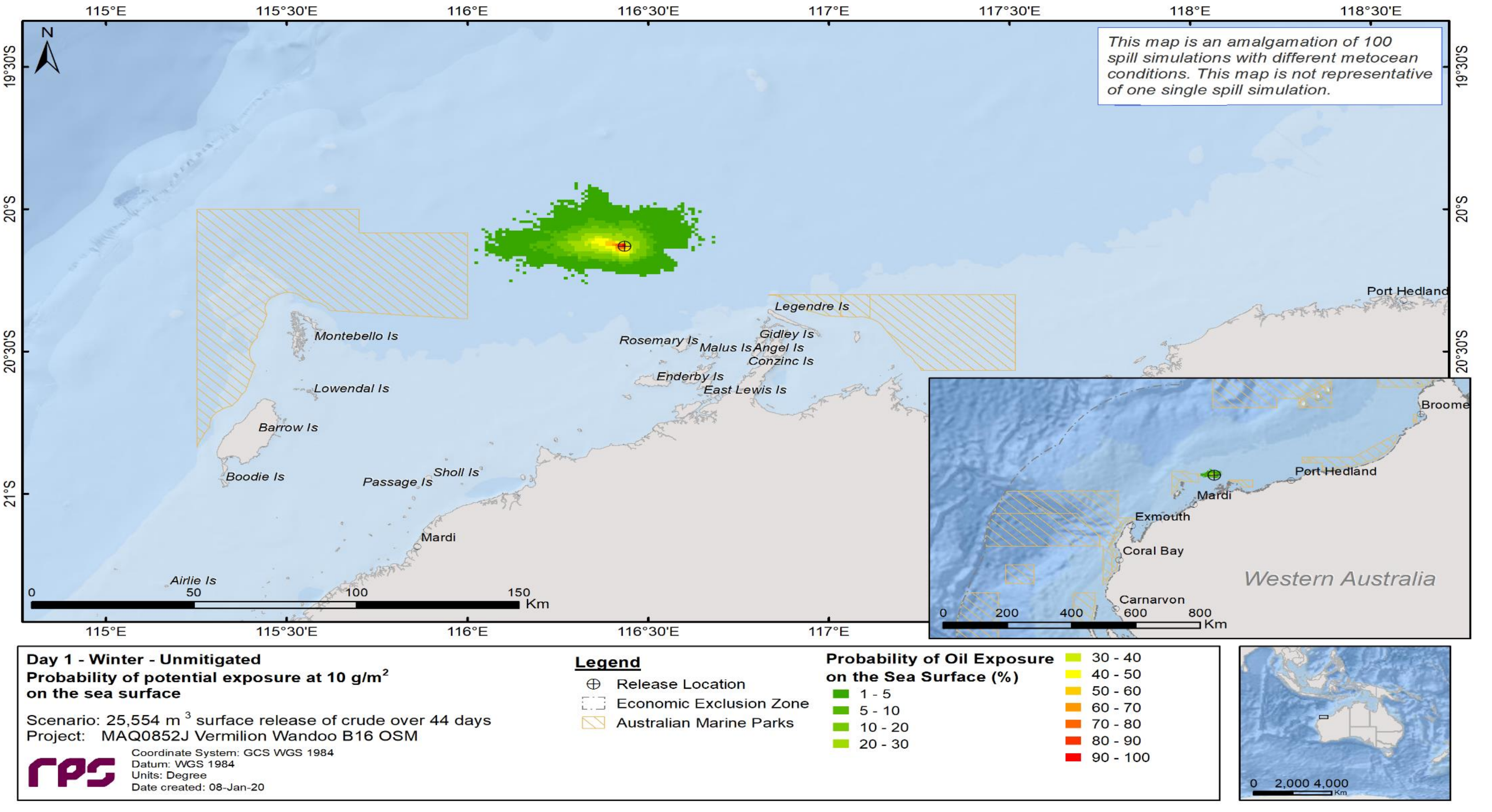


Figure 2-21 Probability of sea-surface exposure (above 10 g/m2) at day 1 during winter conditions

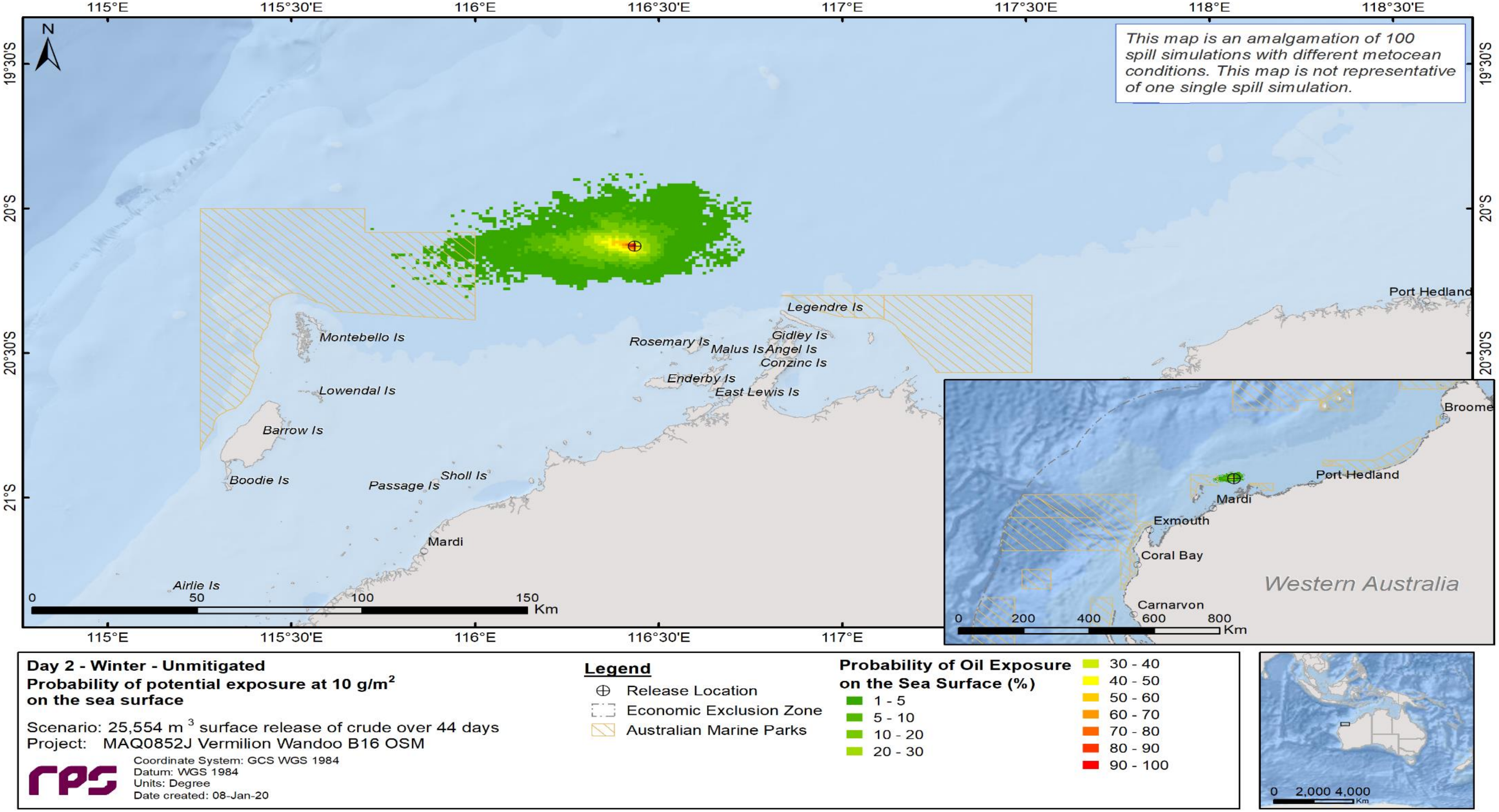


Figure 2-22 Probability of sea-surface exposure (above 10 g/m2) at day 2 during winter conditions

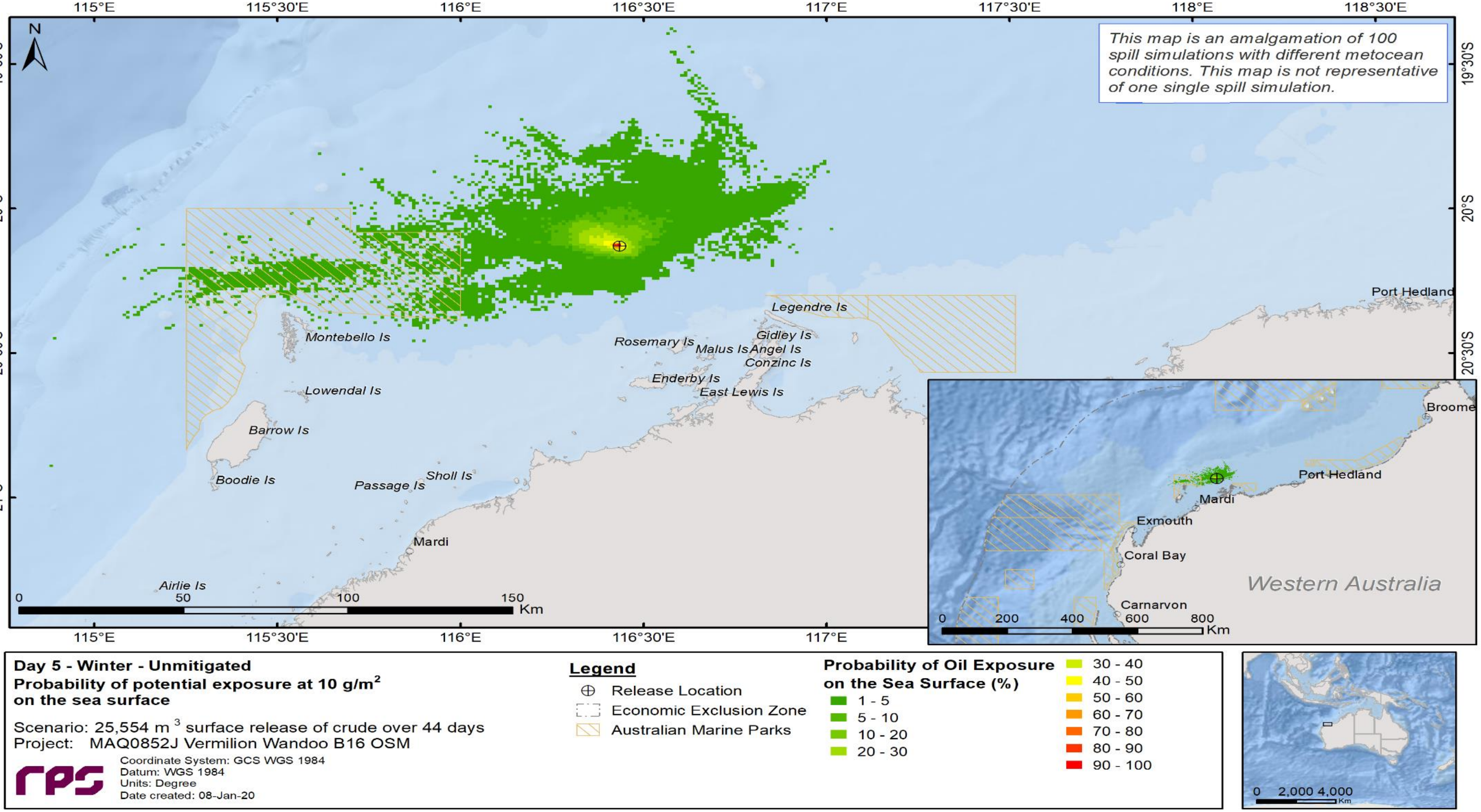


Figure 2-23 Probability of sea-surface exposure (above 10 g/m2) at day 5 during winter conditions

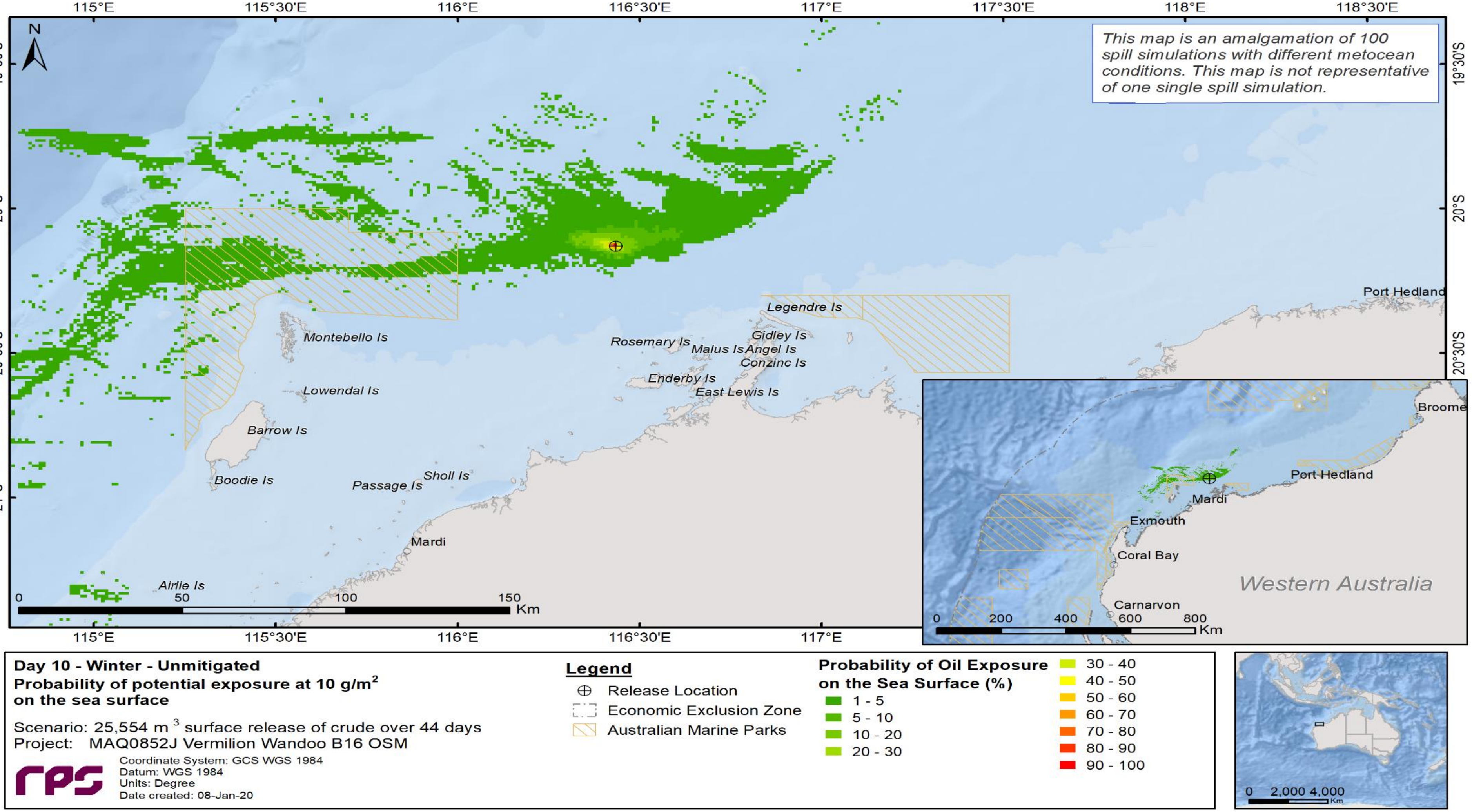


Figure 2-24 Probability of sea-surface exposure (above 10 g/m2) at day 10 during winter conditions

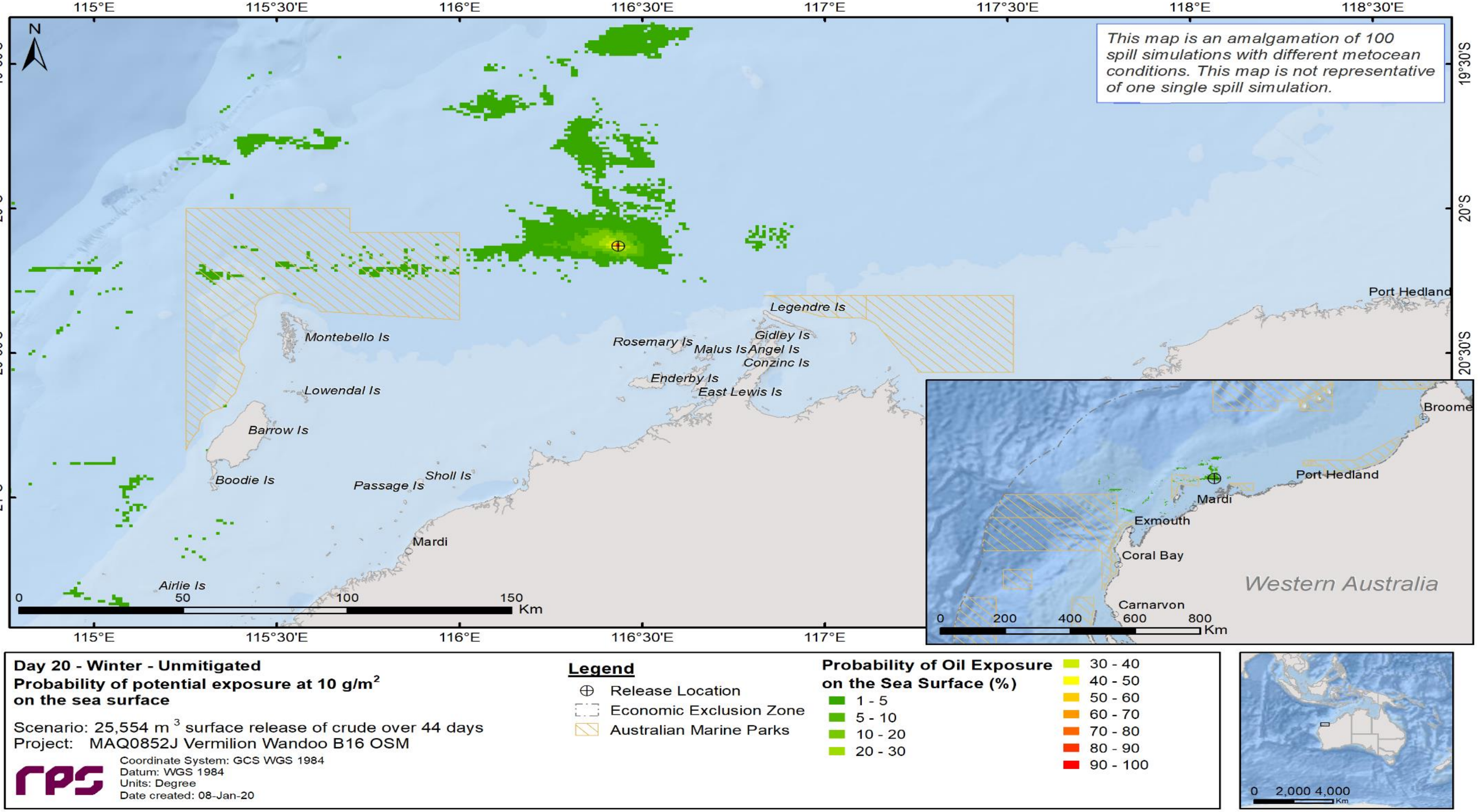


Figure 2-25 Probability of sea-surface exposure (above 10 g/m2) at day 20 during winter conditions

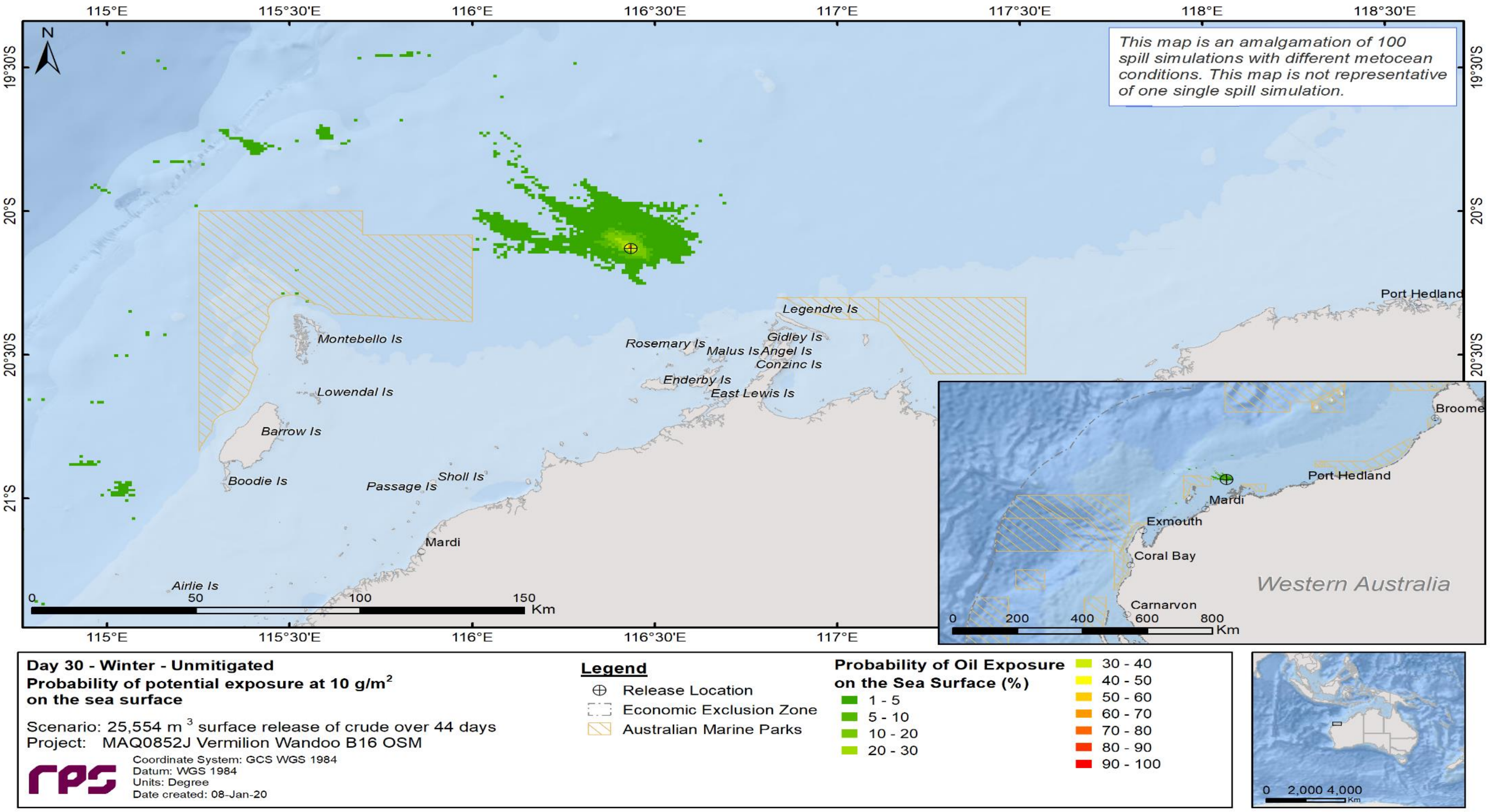


Figure 2-26 Probability of sea-surface exposure (above 10 g/m2) at day 30 during winter conditions

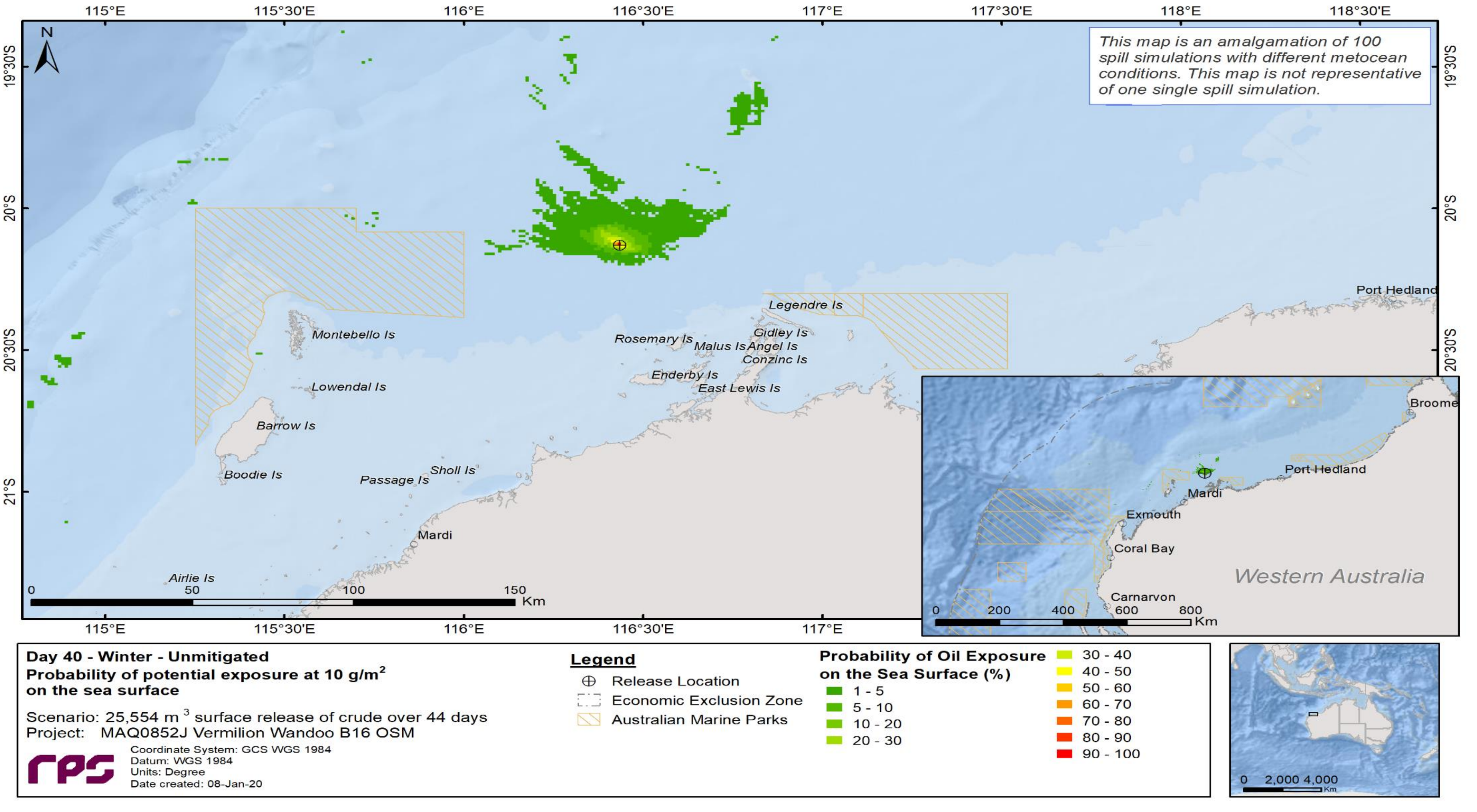


Figure 2-27 Probability of sea-surface exposure (above 10 g/m2) at day 40 during winter conditions

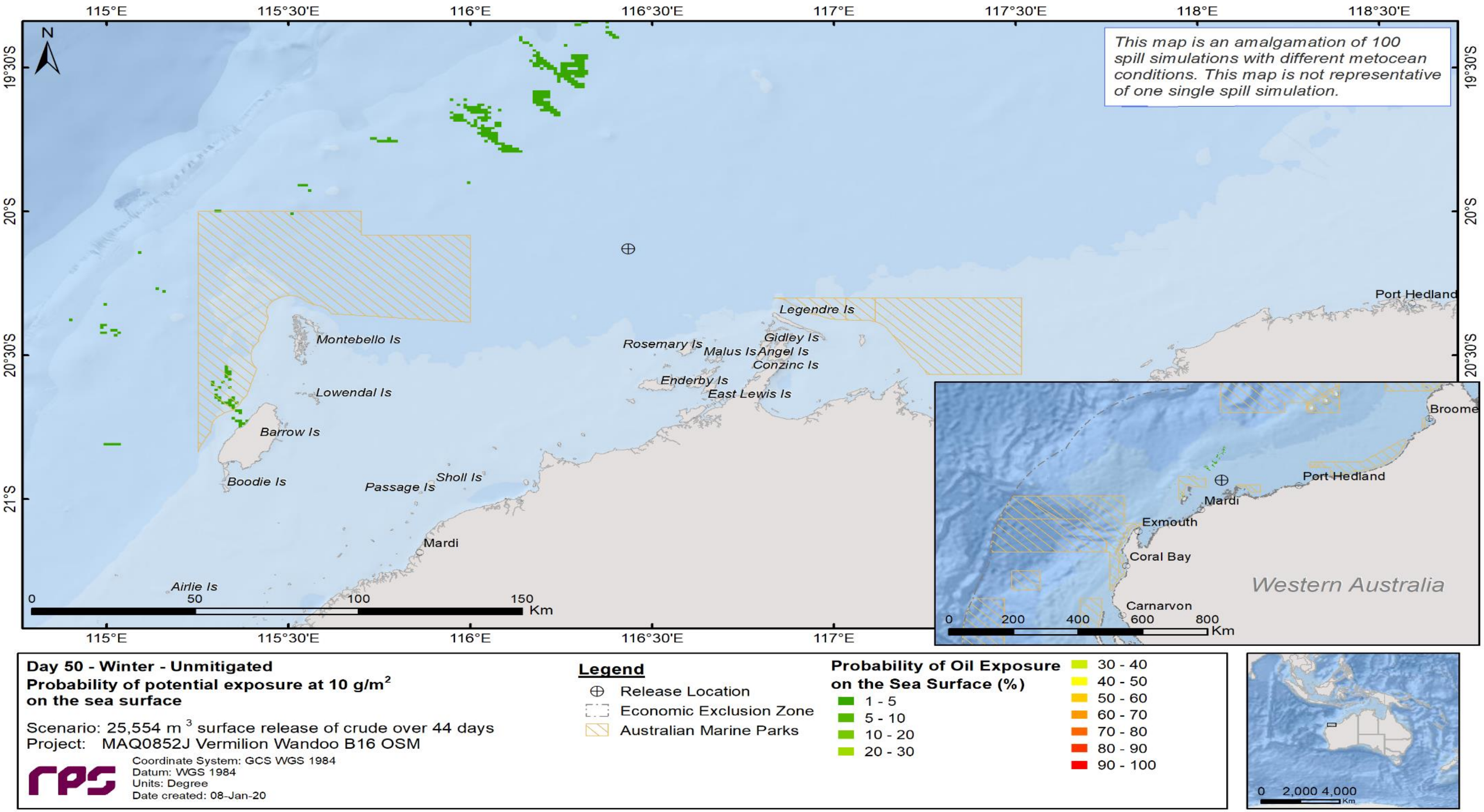


Figure 2-28 Probability of sea-surface exposure (above 10 g/m2) at day 50 during winter conditions

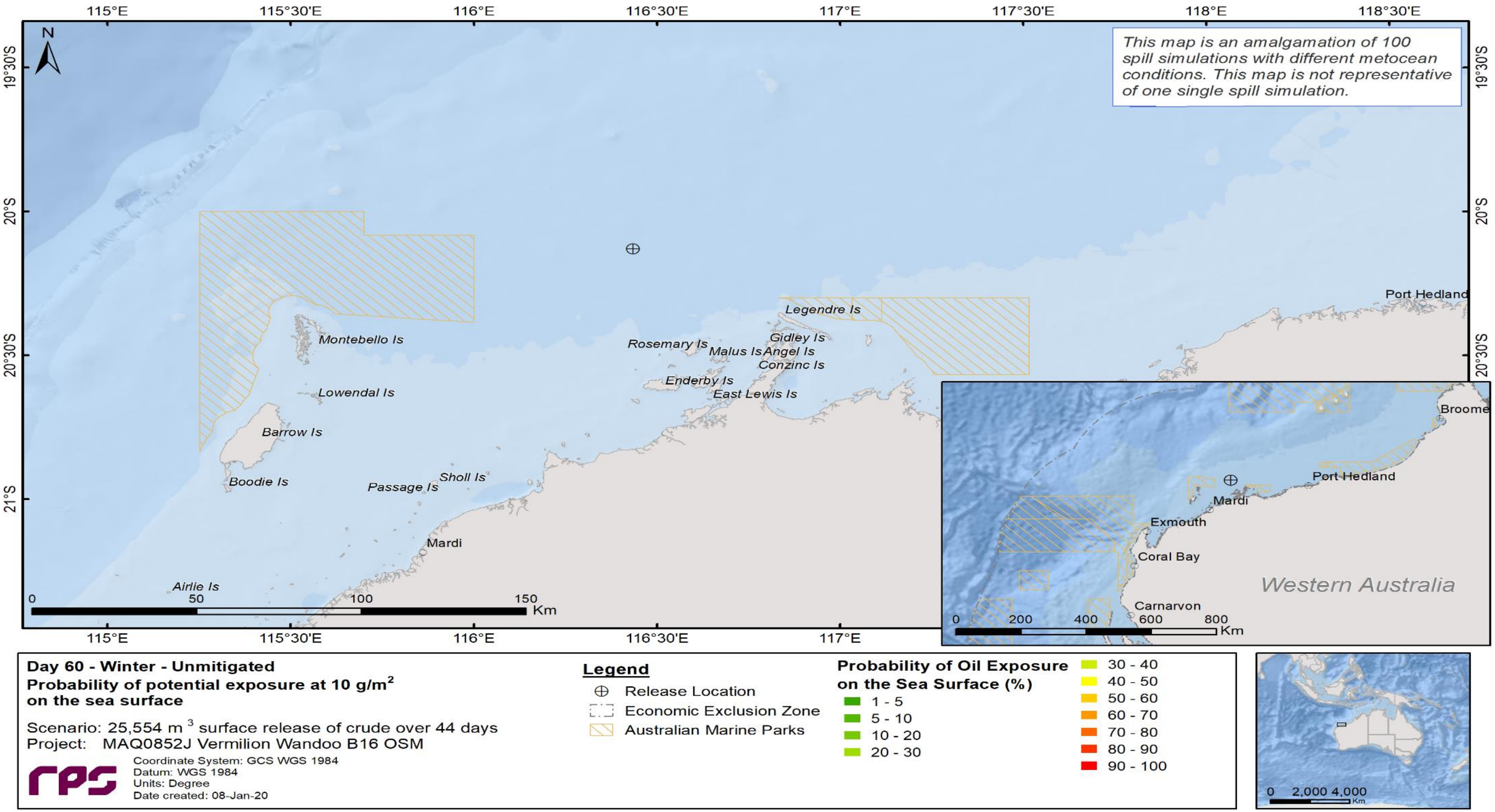


Figure 2-29 Probability of sea-surface exposure (above 10 g/m2) at day 60 during winter conditions

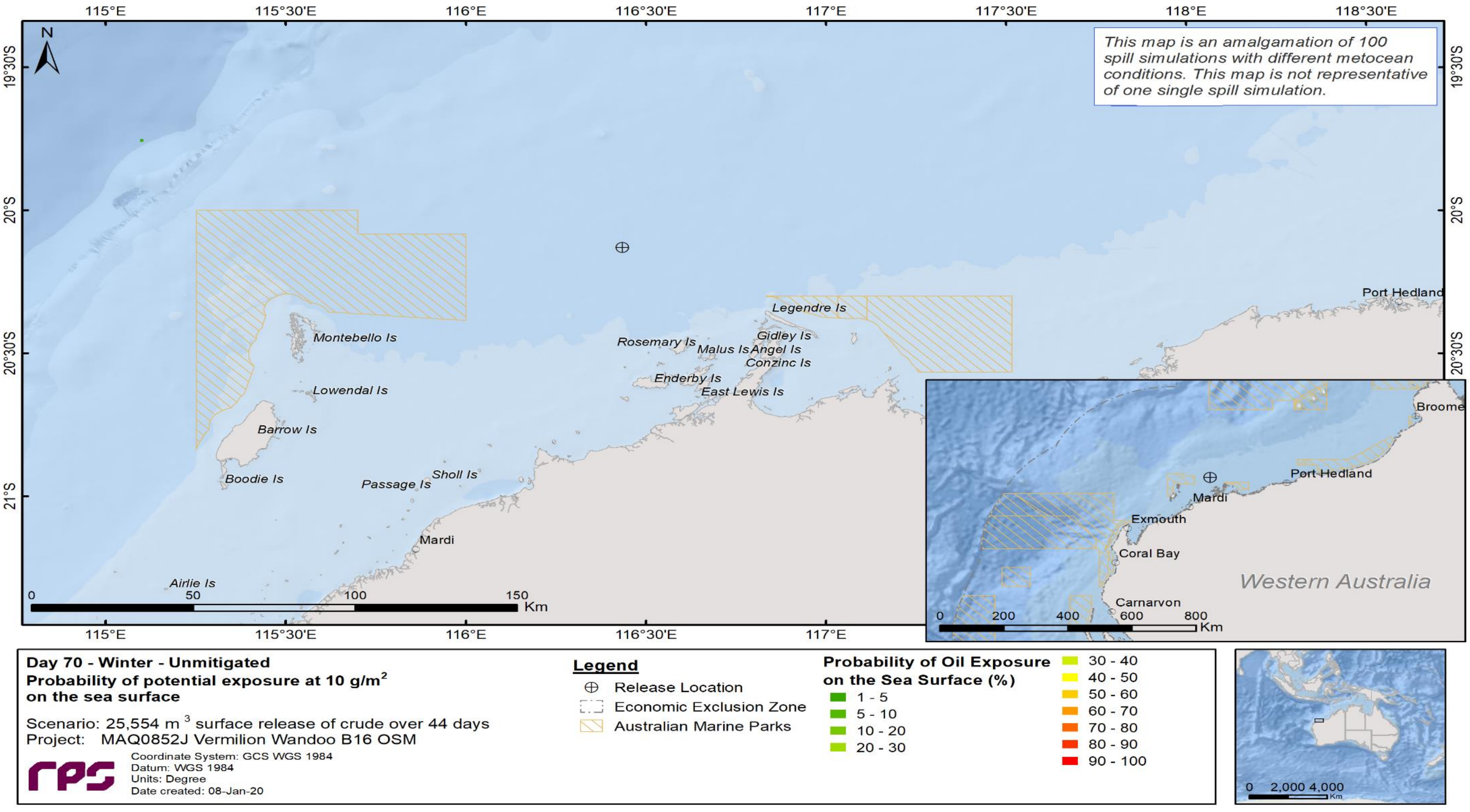


Figure 2-30 Probability of sea-surface exposure (above 10 g/m2) at day 70 during winter conditions

Table 2-2 Summary of the potential sea surface exposure to individual receptors, for both, the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during summer conditions. The results were calculated from 100 spill trajectories per case.

		Unmitigated						Mitigated					
Receptor		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
AMP	Abrolhos	3	-	-	44.58	-	-	2	-	-	45.63	-	-
	Argo-Rowley Terrace	87	2	-	16.54	29.88	-	80	2	-	16.42	29.92	-
	Carnarvon Canyon	8	-	-	35.33	-	-	5	-	-	37.38	-	-
	Dampier	49	2	-	3.75	9.08	-	39	1	-	3.75	10.04	-
	Eighty Mile Beach	52	-	-	16.67	-	-	45	-	-	15.46	-	-
	Gascoyne	58	8	-	12.79	41.88	-	52	2	-	13.38	61.21	-
	Kimberley	36	-	-	41.00	-	-	33	-	-	40.79	-	-
	Mermaid Reef	39	-	-	30.50	-	-	33	-	-	30.71	-	-
	Montebello	94	33	5	1.63	2.58	6.13	92	16	2	1.63	2.75	6.50
	Ningaloo	32	4	1	9.04	42.17	53.17	34	-	-	9.00	-	-
	Roebuck	21	-	-	44.75	-	-	19	-	-	39.79	-	-
	Shark Bay	1	-	-	27.13	-	-	1	-	-	26.96	-	-
EEZ	Indonesian Exclusive Economic Zone	27	-	-	39.71	-	-	24	-	-	39.75	-	-
IBRA	Cape Range	52	6	1	3.92	4.29	6.75	44	3	-	3.67	5.71	-
	Chichester	5	-	-	9.33	-	-	2	-	-	8.75	-	-
	Pindanland	36	-	-	20.38	-	-	35	-	-	20.38	-	-
	Roebourne	56	4	1	3.17	6.00	6.04	52	2	1	3.04	5.83	6.04

Receptor		Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
IMCRA	Canning	42	2	-	27.17	55.08	-	41	1	-	26.63	69.50	-
	Eighty Mile Beach	38	-	-	21.13	-	-	36	-	-	20.96	-	-
	Kimberley	5	-	-	70.33	-	-	4	-	-	70.29	-	-
	Ningaloo	39	6	1	9.17	18.54	52.88	32	-	-	9.04	-	-
	Northwest Shelf	100	100	77	0.17	0.17	0.29	100	100	68	0.17	0.17	0.25
	Oceanic Shoals	3	-	-	70.63	-	-	1	-	-	70.46	-	-
	Pilbarra (nearshore)	65	6	1	1.88	4.08	5.96	62	5	1	1.88	3.29	6.04
	Pilbarra (offshore)	100	100	100	0.04	0.04	0.04	100	100	100	0.04	0.04	0.04
	Zuytdorp	10	-	-	26.79	-	-	3	-	-	26.75	-	-
IPA	Nyangumarta Warrarn	23	-	-	23.29	-	-	19	-	-	23.88	-	-
KEF	Ancient coastline at 125 m depth contour	100	78	15	3.25	4.75	9.67	100	43	4	3.29	5.50	7.46
	Canyons linking the Argo Abyssal Plain with the Scott Plateau	20	-	-	36.58	-	-	14	-	-	36.33	-	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	50	6	-	8.21	41.21	-	42	-	-	8.29	-	-
	Commonwealth waters adjacent to Ningaloo Reef	32	4	1	9.04	42.17	53.17	34	-	-	9.00	-	-
	Continental Slope Demersal Fish Communities	96	38	4	6.88	7.13	13.08	96	16	-	6.58	7.21	-
	Exmouth Plateau	75	5	-	13.25	44.54	-	72	2	-	13.50	61.21	-
	Glomar Shoals	98	38	-	2.17	2.54	-	98	22	-	2.33	2.96	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	63	1	-	23.13	35.29	-	62	-	-	23.54	-	-
	Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	9	-	-	59.71	-	-	7	-	-	59.83	-	-
	Wallaby Saddle	2	-	-	61.75	-	-	1	-	-	45.63	-	-
	Western demersal slope and associated fish communities	1	-	-	31.79	-	-	1	-	-	31.50	-	-
MMA	Barrow Island	59	9	1	4.13	6.04	6.75	40	5	1	3.96	6.08	10.50
	Muiron Islands	24	3	-	8.83	16.00	-	17	-	-	8.75	-	-
MP	Barrow Island	26	1	-	4.29	6.08	-	22	1	-	5.04	5.92	-
	Eighty Mile Beach	33	-	-	19.92	-	-	30	-	-	19.29	-	-
	Montebello Islands	62	12	1	2.88	4.29	11.67	51	2	1	2.83	5.71	11.58
	Ningaloo	32	4	1	9.17	42.42	52.88	26	-	-	9.21	-	-
	Rowley Shoals	60	1	-	23.46	35.29	-	56	-	-	23.96	-	-
NR	Great Sandy Island	10	-	-	5.33	-	-	9	-	-	5.50	-	-
	Scott Reef	5	-	-	60.96	-	-	5	-	-	61.38	-	-
	Thevenard Island	8	-	-	10.46	-	-	5	-	-	11.13	-	-
RAMSAR	Eighty-mile Beach	33	-	-	21.21	-	-	28	-	-	21.42	-	-
	Roebuck Bay	21	-	-	44.04	-	-	18	-	-	47.08	-	-
RSB	Barrow Island Reefs and Shoals	10	-	-	11.71	-	-	8	-	-	12.21	-	-
	Baylis Patches	5	-	-	12.50	-	-	2	-	-	12.58	-	-

Receptor	Unmitigated						Mitigated					
	Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Beryl Reef	4	-	-	12.67	-	-	1	-	-	15.21	-	-
Brewis Reef	6	-	-	12.29	-	-	4	-	-	11.50	-	-
Clerke Reef	44	-	-	28.21	-	-	38	-	-	28.50	-	-
Eliassen Rocks	2	-	-	10.96	-	-	-	-	-	-	-	-
Exmouth Reef	5	-	-	11.79	-	-	2	-	-	11.88	-	-
Fortescue Reef	7	-	-	5.67	-	-	4	-	-	6.50	-	-
Glomar Shoal	95	3	-	3.58	8.75	-	87	2	-	3.75	9.29	-
Herald Reef	5	-	-	12.50	-	-	4	-	-	12.21	-	-
Imperieuse Reef	55	1	-	23.83	35.29	-	52	-	-	25.50	-	-
Lightfoot Reef	4	-	-	13.67	-	-	4	-	-	13.88	-	-
Locker Reef	5	-	-	14.21	-	-	4	-	-	12.67	-	-
Madeleine Shoals	28	-	-	4.29	-	-	22	-	-	4.13	-	-
Manicom Bank	4	-	-	12.75	-	-	3	-	-	13.38	-	-
Meda Reef	3	-	-	11.67	-	-	3	-	-	11.63	-	-
Mermaid Reef	29	-	-	32.92	-	-	24	-	-	35.13	-	-
Montebello Shoals	41	4	-	4.00	9.79	-	28	1	-	4.21	11.17	-
Ningaloo Reef	19	-	-	10.83	-	-	17	-	-	10.92	-	-
O'Grady Shoal	7	-	-	5.04	-	-	1	-	-	9.67	-	-
Paroo Shoal	6	-	-	11.17	-	-	2	-	-	12.29	-	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
	Penguin Bank	7	-	-	8.67	-	-	8	-	-	9.21	-	-
	Rankin Bank	85	5	-	6.33	6.71	-	72	1	-	6.21	6.88	-
	Ripple Shoals	13	-	-	6.00	-	-	7	-	-	10.17	-	-
	Rosily Shoals	9	-	-	11.29	-	-	5	-	-	10.42	-	-
	South East Reef	4	-	-	5.04	-	-	4	-	-	5.08	-	-
	Tongue Shoals	5	-	-	12.21	-	-	3	-	-	12.71	-	-
	Tryal Rocks	35	-	-	4.17	-	-	25	-	-	4.54	-	-
	Vaughan Shoal	1	-	-	12.50	-	-	1	-	-	15.96	-	-
	Ward Reef	5	-	-	14.63	-	-	2	-	-	16.67	-	-
	Weeks Shoal	6	-	-	11.88	-	-	3	-	-	14.46	-	-
	West Reef	6	-	-	12.33	-	-	4	-	-	10.79	-	-
State Waters	Western Australia State Waters	99	21	3	1.42	3.67	5.96	96	9	2	1.50	3.71	6.04

Table 2-3 Summary of the potential sea surface exposure to individual receptors, for both, the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during transitional conditions. The results were calculated from 100 spill trajectories per case.

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Abrolhos	8	-	-	41.21	-	-	8	-	-	40.04	-	-
	Argo-Rowley Terrace	68	6	-	12.00	24.33	-	65	2	-	13.08	21.67	-
	Carnarvon Canyon	10	-	-	25.00	-	-	10	-	-	23.46	-	-
	Dampier	6	-	-	5.42	-	-	4	-	-	4.92	-	-
	Eighty Mile Beach	5	-	-	23.33	-	-	5	-	-	23.79	-	-
	Gascoyne	75	19	7	6.92	11.88	15.17	72	6	1	7.17	11.92	15.42
	Kimberley	9	-	-	54.21	-	-	6	-	-	54.58	-	-
	Mermaid Reef	21	-	-	29.58	-	-	12	-	-	30.00	-	-
	Montebello	96	60	14	1.04	2.25	6.04	95	35	2	1.04	2.25	5.50
	Ningaloo	24	9	-	14.67	17.38	-	22	-	-	14.58	-	-
	Roebuck	2	-	-	60.58	-	-	2	-	-	60.71	-	-
	Shark Bay	3	-	-	31.29	-	-	5	-	-	34.29	-	-
EEZ	Indonesian Exclusive Economic Zone	60	-	-	32.13	-	-	56	-	-	33.00	-	-
IBRA	Cape Range	28	-	-	4.46	-	-	27	-	-	4.54	-	-
	Christmas Island	1	-	-	59.54	-	-	2	-	-	62.04	-	-
	Pindanland	2	-	-	59.58	-	-	3	-	-	59.50	-	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Roebourne	16	-	-	19.71	-	-	8	-	-	27.88	-	-
IMCRA	Canning	6	-	-	54.33	-	-	4	-	-	54.54	-	-
IMCRA	Ningaloo	37	9	-	13.75	17.38	-	28	-	-	13.83	-	-
IMCRA	Northwest Shelf	100	100	97	0.21	0.21	0.25	100	100	97	0.21	0.21	0.25
IMCRA	Pilbarra (nearshore)	12	2	-	2.00	8.08	-	12	1	-	2.00	8.50	-
IMCRA	Pilbarra (offshore)	100	100	100	0.04	0.04	0.04	100	100	100	0.04	0.04	0.04
IMCRA	Zuytdorp	8	-	-	30.88	-	-	8	-	-	33.96	-	-
KEF	Ancient coastline at 125 m depth contour	100	94	29	3.54	6.33	7.63	100	68	8	3.21	6.29	7.88
KEF	Canyons linking the Argo Abyssal Plain with the Scott Plateau	37	-	-	41.38	-	-	32	-	-	41.29	-	-
KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	61	17	2	6.96	14.71	15.17	55	4	1	7.21	15.00	16.13
KEF	Commonwealth waters adjacent to Ningaloo Reef	24	9	-	14.67	17.38	-	22	-	-	14.58	-	-
KEF	Continental Slope Demersal Fish Communities	100	58	13	4.00	7.29	10.04	100	29	4	3.75	5.88	10.29
KEF	Exmouth Plateau	89	22	-	9.71	21.13	-	86	1	-	10.13	27.29	-
KEF	Glomar Shoals	96	39	7	2.21	3.63	6.46	92	23	3	2.21	3.67	6.38
KEF	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	36	1	-	22.04	48.21	-	21	-	-	22.04	-	-
KEF	Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	8	-	-	56.25	-	-	8	-	-	56.88	-	-
KEF	Wallaby Saddle	8	-	-	41.79	-	-	6	-	-	42.04	-	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Western demersal slope and associated fish communities	9	-	-	34.13	-	-	8	-	-	35.21	-	-
MMA	Barrow Island	38	-	-	4.50	-	-	34	1	-	5.00	7.58	-
MMA	Muiron Islands	7	-	-	18.21	-	-	6	-	-	25.00	-	-
MP	Barrow Island	23	-	-	10.04	-	-	19	-	-	9.88	-	-
MP	Montebello Islands	56	4	-	2.58	6.13	-	48	1	-	2.58	5.83	-
MP	Ningaloo	14	-	-	15.38	-	-	15	-	-	15.50	-	-
MP	Rowley Shoals	27	1	-	22.63	48.21	-	19	-	-	22.58	-	-
NR	Scott Reef	3	-	-	59.83	-	-	2	-	-	67.79	-	-
RAMSAR	Thevenard Island	4	-	-	42.25	-	-	-	-	-	-	-	-
RAMSAR	Roebuck Bay	2	-	-	61.17	-	-	2	-	-	61.71	-	-
RSB	Barrow Island Reefs and Shoals	2	-	-	54.58	-	-	-	-	-	-	-	-
RSB	Baylis Patches	1	-	-	44.71	-	-	-	-	-	-	-	-
RSB	Brewis Reef	5	-	-	42.04	-	-	-	-	-	-	-	-
RSB	Clerke Reef	15	-	-	27.88	-	-	9	-	-	27.67	-	-
RSB	Glomar Shoal	82	4	1	4.29	8.29	9.00	76	2	1	4.50	5.33	9.04
RSB	Imperieuse Reef	19	-	-	22.96	-	-	13	-	-	23.04	-	-
RSB	Madeleine Shoals	2	-	-	9.42	-	-	1	-	-	9.42	-	-
RSB	Mermaid Reef	14	-	-	30.21	-	-	3	-	-	35.83	-	-
RSB	Montebello Shoals	23	-	-	5.33	-	-	26	-	-	5.38	-	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Ningaloo Reef	6	-	-	16.58	-	-	6	-	-	16.75	-	-
	Penguin Bank	5	-	-	41.58	-	-	-	-	-	-	-	-
	Rankin Bank	90	23	1	4.38	12.29	20.21	88	-	-	5.38	-	-
	Ripple Shoals	5	-	-	52.88	-	-	1	-	-	60.38	-	-
	Rosily Shoals	5	-	-	42.96	-	-	1	-	-	43.88	-	-
	Tongue Shoals	3	-	-	43.08	-	-	-	-	-	-	-	-
	Tryal Rocks	64	3	-	3.58	19.08	-	60	2	-	3.38	7.46	-
State Waters	Western Australia State Waters	83	6	-	3.00	5.83	-	74	2	-	3.04	5.79	-

Table 2-4 Summary of the potential sea surface exposure to individual receptors, for both, the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during winter conditions. The results were calculated from 100 spill trajectories per case.

Receptor		Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Abrolhos	42	-	-	19.33	-	-	31	-	-	19.83	-	-
	Argo-Rowley Terrace	27	1	-	23.25	71.38	-	23	-	-	23.63	-	-
	Carnarvon Canyon	57	1	-	15.42	46.96	-	55	-	-	15.67	-	-
	Dampier	5	-	-	8.46	-	-	5	-	-	8.00	-	-
	Gascoyne	99	26	2	6.92	16.00	20.29	97	11	1	6.67	14.67	20.29
	Montebello	100	87	5	0.92	2.17	2.96	100	72	1	1.04	2.17	3.79
	Ningaloo	61	3	-	7.67	14.13	-	61	1	-	7.88	14.08	-
	Shark Bay	20	-	-	18.88	-	-	18	-	-	18.08	-	-
EEZ	Indonesian Exclusive Economic Zone	14	-	-	34.29	-	-	12	-	-	36.08	-	-
IBRA	Cape Range	88	4	-	3.38	7.75	-	86	2	-	3.38	8.50	-
	Edel	1	-	-	34.08	-	-	-	-	-	-	-	-
	Roebourne	50	-	-	8.50	-	-	52	-	-	9.04	-	-
IMCRA	Abrolhos Islands	1	-	-	58.96	-	-	1	-	-	58.13	-	-
	Central West Coast	2	-	-	60.42	-	-	1	-	-	58.13	-	-
	Ningaloo	77	6	-	6.79	13.83	-	76	2	-	6.92	13.96	-
	Northwest Shelf	100	100	84	0.21	0.21	0.29	100	97	73	0.21	0.21	0.29
	Pilbarra (nearshore)	39	3	-	4.42	8.46	-	31	-	-	4.38	-	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Pilbarra (offshore)	100	100	100	0.04	0.04	0.04	100	100	100	0.04	0.04	0.04
	Zuytdorp	30	-	-	18.67	-	-	26	-	-	18.08	-	-
KEF	Ancient coastline at 125 m depth contour	100	69	14	3.04	3.96	9.29	100	48	5	3.29	5.54	9.17
KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	99	8	-	6.58	16.33	-	96	3	-	6.54	14.29	-
KEF	Commonwealth waters adjacent to Ningaloo Reef	61	3	-	7.67	14.13	-	61	1	-	7.88	14.08	-
KEF	Continental Slope Demersal Fish Communities	100	76	17	3.67	6.21	8.67	100	54	8	3.58	7.04	8.63
KEF	Exmouth Plateau	100	24	4	9.08	12.88	20.67	100	14	-	9.13	12.13	-
KEF	Glomar Shoals	61	19	1	2.25	3.88	45.13	52	7	-	2.79	3.88	-
KEF	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	5	-	-	43.83	-	-	4	-	-	43.96	-	-
KEF	Perth Canyon and adjacent shelf break, and other west coast canyons	2	-	-	23.79	-	-	3	-	-	25.63	-	-
KEF	Wallaby Saddle	31	-	-	19.63	-	-	28	-	-	20.17	-	-
KEF	Western demersal slope and associated fish communities	26	-	-	21.79	-	-	17	-	-	21.96	-	-
KEF	Western rock lobster	2	-	-	58.96	-	-	1	-	-	58.13	-	-
MMA	Barrow Island	90	12	-	4.58	8.46	-	86	4	-	4.25	13.17	-
MMA	Muiron Islands	41	2	-	9.29	31.42	-	42	-	-	9.25	-	-
MP	Barrow Island	63	2	-	8.38	19.67	-	66	1	-	8.42	19.42	-
MP	Montebello Islands	97	20	-	3.29	5.33	-	97	6	-	2.88	5.08	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Ningaloo	57	1	-	9.67	13.83	-	57	2	-	9.79	13.96	-
	Rowley Shoals	5	-	-	44.25	-	-	4	-	-	43.96	-	-
NR	Great Sandy Island	4	-	-	18.54	-	-	4	-	-	18.58	-	-
NR	Thevenard Island	22	-	-	9.75	-	-	27	-	-	10.04	-	-
RSB	Barrow Island Reefs and Shoals	5	2	-	17.54	18.58	-	5	1	-	17.00	18.54	-
RSB	Brewis Reef	12	-	-	10.08	-	-	10	-	-	9.67	-	-
RSB	Clerke Reef	1	-	-	70.46	-	-	-	-	-	-	-	-
RSB	Exmouth Reef	1	-	-	20.21	-	-	2	-	-	19.88	-	-
RSB	Glomar Shoal	26	4	-	6.38	7.88	-	20	1	-	6.63	7.54	-
RSB	Herald Reef	2	-	-	19.04	-	-	2	-	-	19.54	-	-
RSB	Imperieuse Reef	4	-	-	52.71	-	-	2	-	-	56.88	-	-
RSB	Locker Reef	8	-	-	16.54	-	-	6	-	-	16.50	-	-
RSB	Madeleine Shoals	4	-	-	8.46	-	-	3	-	-	8.83	-	-
RSB	Manicom Bank	1	-	-	20.33	-	-	1	-	-	21.13	-	-
RSB	Montebello Shoals	73	-	-	4.71	-	-	74	-	-	4.17	-	-
RSB	Ningaloo Reef	34	-	-	10.71	-	-	29	-	-	10.67	-	-
RSB	Paroo Shoal	4	-	-	16.67	-	-	3	-	-	16.58	-	-
RSB	Penguin Bank	38	-	-	9.08	-	-	30	-	-	8.50	-	-
RSB	Rankin Bank	94	6	1	4.38	9.83	10.75	83	3	-	5.46	7.79	-

	Receptor	Unmitigated						Mitigated					
		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Ripple Shoals	14	-	-	10.13	-	-	12	-	-	10.13	-	-
	Rosily Shoals	28	1	-	9.25	10.63	-	27	-	-	9.58	-	-
	Tongue Shoals	9	-	-	16.08	-	-	6	-	-	15.88	-	-
	Tryal Rocks	98	7	-	3.71	7.50	-	98	3	-	2.21	5.83	-
	Ward Reef	2	-	-	18.13	-	-	1	-	-	18.54	-	-
	Weeks Shoal	2	-	-	16.92	-	-	1	-	-	19.96	-	-
	West Reef	1	-	-	24.83	-	-	1	-	-	26.58	-	-
State Waters	Western Australia State Waters	98	36	1	2.54	4.63	11.08	98	15	-	2.54	4.50	-

3 SHORELINE EXPOSURE

Table 3-1 presents a summary of the predicted shoreline contact for the unmitigated and mitigated cases. For the unmitigated case, the probability of contact to any shoreline at, or above, the low threshold (10 g/m2) during the summer, transitional and winter seasons was 97%, 67% and 94%, respectively, compared to 97%, 57%, 94% for the mitigated case. The minimum time before shoreline contact was approximately 3.21 days (~77 hours), 4.46 days (107 hours) and 3.42 days (82 hours), respectively for each season, while after considering the mitigation option, the earliest shoreline contact was 3.04 days (~73 hours), 4.54 days (~109 hours) and 3.38 days (81 hours), respectively. The greatest volume of oil predicted to come ashore from an unmitigated spill trajectory was 5,606 m3 and reduced to 2,737 m3 when surface dispersant was applied, a 48% reduction.

While, the maximum length of shoreline contact at, or above the moderate threshold (or actionable threshold) was 698 km, this distance reduced to 483 km by applying surface dispersant.

Table 3-1 Summary of oil contact to any shorelines for the unmitigated and mitigated cases. Results are based on of a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season and per case.

Shoreline Statistics	Unmitigated			Mitigated		
	Summer	Transitional	Winter	Summer	Transitional	Winter
Probability of contact to any shoreline at, or above **10 g/m²** (%)	97	67	94	97	57	94
Absolute minimum time before of oil shoreline contact at, or above **10 g/m²** (days)	3.21	4.46	3.42	3.04	4.54	3.38
Maximum volume of oil ashore (m³)	5,606	1,575	1,981	2,737	309	995
Average volume of oil ashore (m³)	1,208	174	327	543	63	209
Maximum length of shoreline contact of oil at, or above **10 g/m²** (km)	898	227	233	691	160	190
Average length of shoreline contact of oil at, or above **10 g/m²** (km)	214	38	76	156	32	67
Maximum length of shoreline contact of oil at, or above **100 g/m²** (km)	698	168	183	483	88	157
Average length of shoreline contact of oil at, or above **100 g/m²** (km)	154	28	50	104	19	43
Maximum length of shoreline contact of oil at, or above **1,000 g/m²** (km)	164	38	52	72	12	28
Average length of shoreline contact of oil at, or above **1,000 g/m²** (km)	37	12	11	15	5	6

Table 3-2 to Table 3-4 summarise the shoreline contact to individual receptors assessed for each season, for the unmitigated and mitigated cases.

Under summer conditions, the highest probabilities of shoreline contact above the low threshold were predicted at Cunningham Island (59% - unmitigated; 56% - mitigated), Montebello Islands (64% - unmitigated; 56% - mitigated) and Imperieuse Reef (59% - unmitigated; 58% - mitigated) while the earliest shoreline contact was recorded on Kendrew Island (3.21 days – unmitigated; 3.04 days mitigated) (Table 3-2).

In the transitional months, the greatest probabilities of low shoreline contact were recorded at Barrow Island (26% - unmitigated; 23% - mitigated), Montebello Islands (31% - unmitigated; 29% - mitigated) and Imperieuse Reef (28% - unmitigated; 16% - mitigated). Additionally, Montebello Islands registered the earliest shoreline contact (4,46 days – unmitigated; 4.54 - mitigated) (Table 3-3).

During winter, the greatest probabilities of low shoreline contact were recorded at Barrow Island (66% - unmitigated; 71% - mitigated), Boodie Island (54% - unmitigated; 52% - mitigated), Exmouth (50% - unmitigated; 53% - mitigated) and Montebello Islands (93% - unmitigated; 93% - mitigated), Middle Island (59% - unmitigated; 52% - mitigated). Additionally, Montebello Islands registered the earliest shoreline contact (3.42 days – unmitigated; 3.38 - mitigated)

Table 3-2 Summary of oil contact to individual shoreline receptors for the unmitigated and mitigated cases. Results are based on of a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during summer conditions. The results were calculated from 100 spill trajectories per case.

Shoreline Receptor	Unmitigated																		Mitigated																	
	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Adele Island	2	-	-	64.7	64.2	64.2	74	81	<1	2	2	-	-	2	-	-	1	-	-	62.8	62.8	62.8	83	83	<1	1	1	-	-	1	-	-
Airlie Island	9	8	7	10.5	10.6	11.8	2594	4921	3	58	1	1	1	1	1	1	8	8	1	11.1	11.7	17.2	573	1215	1	14	1	1	1	1	1	1
Angel Island	13	9	1	9.42	9.46	41.1	189	1014	2	46	5	4	2	9	7	2	11	9	-	9.17	9.2	9.08	169	950	1	46	4	3	-	9	7	-
Ashburton	7	7	3	11.3	12.5	16.4	192	1946	11	314	62	39	2	88	63	4	7	7	-	12.4	12.5	12.3	122	704	4	153	33	16	-	65	46	-
Ashburton ISland	7	6	5	11.2	11.7	12.7	1262	3200	2	47	2	2	1	2	2	2	6	5	1	12.3	12.3	18.1	387	1143	1	19	2	2	1	2	2	1
Ashmore Reef	1	-	-	69.5	67.5	67.5	55	55	<1	1	1	-	-	1	-	-	1	1	-	68.9	68.9	67.6	178	183	<1	4	2	2	-	2	2	-
Barrow Island	52	37	18	4.46	4.75	6.08	330	6983	97	1321	25	26	15	80	74	33	44	32	13	5.04	5.17	6.13	236	5080	47	700	23	21	9	74	62	25
Bedout Island	35	33	25	18.7	20.5	21.7	2400	6213	10	73	1	1	1	1	1	1	28	26	12	19.2	19.2	22.0	1093	3841	4	45	1	1	1	1	1	1
Bessieres Island	11	7	5	10.2	10.6	11.6	482	2002	2	57	3	3	2	4	4	3	7	7	2	9.83	10.1	12.7	226	1381	1	24	3	2	1	4	4	1
Bezout Island	8	7	-	17.0	17.0	9.33	333	622	<1	7	1	1	-	1	1	-	6	4	-	22.0	22.0	9.29	185	453	<1	5	1	1	-	1	1	-
Boodie Island	35	30	10	6.71	6.75	13.8	897	7394	11	198	3	2	2	3	3	3	24	22	5	6.71	6.75	20.0	429	2149	3	58	3	2	2	3	3	3
Broome	45	40	29	23.5	24.5	27.9	356	7168	411	3201	182	147	39	423	321	111	44	37	21	24.7	24.8	29.8	226	4637	206	1612	142	111	16	343	248	54
Cape Bruguieres	22	20	4	5.2	5.29	5.96	350	2492	3	58	3	2	2	5	5	2	20	15	2	5.17	5.38	36.2	258	1761	2	38	3	2	1	5	5	1
Cartier Island	1	-	-	70.0	69.9	69.9	56	56	<1	1	2	-	-	2	-	-	-	-	-	69.5	69.5	69.5	-	-	-	-	-	-	-	-	-	-
Clerke Reef	50	44	15	29.2	29.5	33.6	639	4272	15	126	4	3	3	4	4	4	45	38	7	29.1	29.5	33.9	376	2594	8	66	4	3	2	4	4	4
Cohen Island	32	29	13	5.0	5.04	5.21	1353	7418	6	88	1	1	1	1	1	1	27	23	6	5.04	5.13	5.21	838	5729	3	68	1	1	1	1	1	1
Conzinc Island	4	2	-	10.2	10.3	10.0	84	105	<1	1	1	1	-	1	1	-	4	3	-	9.67	9.88	9.58	161	295	<1	3	1	1	-	1	1	-
Cunningham Island	59	58	29	27.8	27.8	37.0	1041	8082	21	170	3	3	2	3	3	3	56	51	12	27.5	27.5	37.2	474	1681	9	46	3	3	1	3	3	2
Delambre Island	16	14	-	9.2	9.29	9.29	247	976	1	24	2	2	-	4	4	-	11	9	-	6.21	6.29	6.21	160	526	1	15	2	2	-	4	4	-
Derby - West Kimberely	4	1	-	64.8	69.5	64.8	82	109	<1	3	2	1	-	4	1	-	1	-	-	61.5	61.5	61.5	81	85	<1	3	3	-	-	3	-	-
Direction Island	7	7	4	12.9	12.9	17.8	1030	2469	2	39	2	2	1	2	2	2	7	7	2	12.0	13.0	19.3	416	1185	1	28	2	2	2	2	2	2
Dolphin Island	13	11	-	5.63	6.13	5.58	121	402	1	11	3	2	-	7	3	-	10	7	-	5.58	6.08	5.17	114	622	<1	9	3	1	-	5	2	-
Eaglehawk Island	15	13	-	6.04	6.38	5.17	459	971	1	11	1	1	-	1	1	-	12	9	-	5.58	6.08	5.17	370	923	1	11	1	1	-	1	1	-
East Lewis Island	5	3	-	11.1	13.2	11.1	90	189	<1	4	2	1	-	4	1	-	6	3	-	10.5	10.6	10.4	138	496	<1	9	2	2	-	3	3	-
East Pilbara	29	25	15	20.7	20.9	22.4	410	8152	87	1103	44	39	16	81	74	37	28	23	5	20.7	20.7	22.3	219	3240	33	577	34	29	10	71	64	19
Enderby Island	22	17	4	5.00	5.21	9.71	198	1768	8	171	12	11	3	28	22	5	20	16	1	5.00	5.13	10.0	160	1418	5	177	9	7	8	27	23	8
Exmouth	32	29	11	9.46	9.88	11.4	235	3334	39	762	32	22	8	127	85	20	32	24	2	9.54	9.63	11.5	137	2003	14	365	22	16	5	100	69	5
Flat Island	19	17	6	9.79	9.79	11.7	1123	6010	7	154	2	2	3	3	3	3	16	11	3	9.83	10.1	14.2	434	2961	2	81	2	2	2	3	3	3

Shoreline Receptor	Unmitigated: Maximum probability of shoreline loading (%)			Unmitigated: Minimum time before shoreline accumulation (days)			Unmitigated: Load on shoreline (g/m²)		Unmitigated: Volume on shoreline (m³)		Unmitigated: Mean length of shoreline contacted (km)			Unmitigated: Maximum length of shoreline contacted (km)			Mitigated: Maximum probability of shoreline loading (%)			Mitigated: Minimum time before shoreline accumulation (days)			Mitigated: Load on shoreline (g/m²)		Mitigated: Volume on shoreline (m³)		Mitigated: Mean length of shoreline contacted (km)			Mitigated: Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Fly Island	6	5	5	10.8	10.9	14.1	1142	2129	2	41	2	2	1	2	2	2	6	5	2	11.6	13.0	17.0	483	1667	1	30	2	2	1	2	2	1
Gidley Island	20	18	2	5.33	5.58	35.9	206	1412	3	69	4	3	2	11	10	3	18	12	-	5.25	5.38	5.21	182	990	2	55	4	4	-	11	10	-
Goodwyn Island	23	21	5	5.17	5.29	9.75	705	2127	2	25	1	1	1	1	1	1	20	14	2	4.96	5.08	9.67	474	1664	1	20	1	1	1	1	1	1
Haury Island	12	9	-	11.0	11.0	7.38	217	592	<1	7	1	1	-	1	1	-	11	6	-	7.92	9.75	7.92	140	484	<1	6	1	1	-	1	1	-
Imperieuse Reef	59	57	35	26.9	27.2	29.6	1030	8082	35	222	5	5	3	5	5	5	58	55	20	27.0	27.1	28.4	490	2388	16	97	5	4	2	5	5	4
Karratha	23	16	1	5.38	5.46	31.5	116	1476	9	102	24	17	1	71	34	1	22	16	-	5.58	5.67	5.50	90	722	3	65	13	7	-	55	32	-
Keast Island	33	27	13	5.08	5.13	5.54	1104	4906	5	58	1	1	1	1	1	1	25	19	7	5.13	5.13	6.08	804	2656	2	31	1	1	1	1	1	1
Kendrew Island	29	29	20	3.21	3.42	5.96	1964	5474	7	65	1	1	1	1	1	1	26	24	12	3.04	3.04	6.25	1205	3148	4	37	1	1	1	1	1	1
Lacepede Islands	17	13	1	43.2	43.2	67.5	291	5861	6	462	8	6	11	14	12	11	18	12	1	44.4	44.4	67.6	171	2894	3	201	5	4	8	12	12	8
Legendre Island	39	37	18	4.75	4.92	5.63	391	4897	24	207	9	8	3	16	16	9	36	35	9	5.08	5.13	5.67	270	4510	12	180	8	6	2	16	15	4
Little Turtle Islet	27	26	18	14.4	14.9	16.0	3232	14785	21	277	2	2	2	2	2	2	22	21	15	14.4	14.5	15.9	1838	11279	9	217	2	2	2	2	2	2
Locker Island	5	5	5	11.7	11.7	15.0	2006	2492	1	29	1	1	1	1	1	1	6	6	2	12.7	12.7	18.1	826	1783	1	21	1	1	1	1	1	1
Lowendal Island	32	29	5	6.58	6.75	20.0	291	6311	7	170	5	3	4	8	8	8	24	18	1	5.25	5.33	21.5	158	2594	2	61	5	4	2	8	7	2
Malus Island	22	19	3	6.00	6.08	22.6	280	2324	3	46	3	3	1	5	5	2	20	17	1	5.17	6.08	12.6	189	1344	2	30	3	3	1	5	5	1
Mangrove Islands	7	7	3	12.2	12.2	16.8	507	1712	2	51	6	5	1	6	6	1	6	6	-	15.8	15.9	15.0	189	645	1	19	6	4	-	6	5	-
Mary Anne Group	12	12	7	12.7	12.8	15.9	524	2538	9	177	9	8	4	13	13	7	10	10	2	11.3	12.8	16.0	251	2066	3	85	8	6	2	13	12	2
Mermaid Reef	38	27	6	36.6	37.5	38.5	406	2667	5	62	2	2	3	3	3	3	32	25	1	35.5	36.5	39.1	295	1572	3	45	2	2	3	3	3	3
Middle Island	34	27	18	5.00	5.08	7.25	725	6787	11	159	3	3	2	4	4	4	26	22	7	5.00	6.75	13.7	400	3080	5	64	4	3	1	4	4	2
Montebello Islands	64	61	28	3.92	4.00	4.88	540	12644	145	1583	23	20	14	41	41	35	56	50	19	3.67	4.04	5.0	300	6449	60	752	20	17	7	41	41	25
Murion Islands	26	23	9	9.00	9.13	10.2	520	3026	13	227	6	6	4	9	9	9	17	14	2	9.25	9.29	13.4	231	1271	3	91	5	5	3	9	9	4
North Turtle Island	28	26	16	14.9	15.3	19.2	2352	11820	8	139	1	1	1	1	1	1	24	22	12	15.7	15.7	19.7	1114	3571	3	42	1	1	1	1	1	1
Observation Island	13	10	5	10.2	10.8	13.5	1204	4566	5	141	2	2	3	3	3	3	9	6	2	11.4	11.8	14.5	608	2718	2	73	2	3	3	3	3	3
Passage Islands	22	17	7	5.04	5.04	8.83	249	1807	13	229	15	15	3	30	29	6	19	17	1	5.04	5.67	18.5	162	1164	4	64	11	8	1	28	24	1
Peak Island	17	14	8	9.17	9.25	9.75	1242	3985	2	47	1	1	1	1	1	1	12	11	1	9.25	9.42	12.8	530	2268	1	27	1	1	1	1	1	1
Port Hedland	32	30	15	13.4	13.5	17.7	314	11622	113	1168	80	55	15	201	155	36	30	27	11	13.1	13.1	17.5	229	8982	49	736	51	35	6	166	99	18
Pulau Dana	1	-	-	64.1	64.1	64.1	63	63	<1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulau Dao	1	-	-	66.7	66.6	66.6	62	62	<1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulau Lahalura	1	-	-	61.5	61.4	61.4	67	67	<1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulau Rote	1	1	-	67.1	67.1	67.0	104	644	<1	28	23	6	-	23	6	-	1	1	-	67.0	67.2	67.0	82	237	<1	13	14	3	-	14	3	-

Shoreline Receptor	Unmitigated: Maximum probability of shoreline loading (%)			Unmitigated: Minimum time before shoreline accumulation (days)			Unmitigated: Load on shoreline (g/m^2)		Unmitigated: Volume on shoreline (m^3)		Unmitigated: Mean length of shoreline contacted (km)			Unmitigated: Maximum length of shoreline contacted (km)			Mitigated: Maximum probability of shoreline loading (%)			Mitigated: Minimum time before shoreline accumulation (days)			Mitigated: Load on shoreline (g/m^2)		Mitigated: Volume on shoreline (m^3)		Mitigated: Mean length of shoreline contacted (km)			Mitigated: Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Pulau Sawu	1	1	-	65.0	65.5	64.9	78	185	<1	9	10	2	-	10	2	-	1	1	-	66.0	66.3	65.9	81	135	<1	4	4	1	-	4	1	-
Pulau Semau	1	-	-	71.8	71.4	71.4	57	61	<1	1	2	-	-	2	-	-	1	-	-	72.0	71.9	71.9	76	76	<1	1	1	-	-	1	-	-
Ragnard Islands	11	11	1	5.92	6.00	31.9	317	1316	1	19	2	2	1	2	2	1	9	6	-	7.13	7.21	5.58	193	738	<1	10	2	2	-	2	2	-
Rivoli Islands	6	5	1	11.7	11.7	16.2	252	1835	2	50	9	7	1	11	9	1	7	6	-	11.7	11.7	11.6	166	976	1	36	5	3	-	10	7	-
Rosemary Island	37	34	18	3.58	3.67	6.13	410	3798	23	198	9	8	4	17	16	8	35	30	7	3.67	3.88	5.13	286	3682	13	276	8	7	3	17	15	9
Round Island	10	10	5	11.1	11.7	15.9	1681	4671	2	55	1	1	1	1	1	1	7	7	2	11.4	11.5	15.9	753	2079	1	25	1	1	1	1	1	1
Sandy Islet	7	6	-	60.2	60.7	60.1	149	355	<1	6	3	2	-	3	2	-	5	5	-	62.0	62.6	60.7	105	189	<1	4	2	1	-	3	2	-
Serrurier Island	11	7	5	10.2	10.7	11.7	872	3231	4	104	3	4	4	4	4	4	9	6	2	10.6	11.0	11.7	407	2213	2	56	3	4	2	4	4	2
Sumba Timur	2	2	-	61.5	62.0	61.1	112	145	<1	8	5	3	-	7	3	-	2	1	-	61.3	62.2	61.2	88	204	<1	10	5	3	-	9	3	-
Sunday Island	15	14	7	9.71	9.75	11.0	1453	7124	10	231	4	4	3	4	4	4	12	9	3	9.71	9.75	11.2	594	3506	3	126	3	4	3	4	4	4
Table Island	8	8	5	10.2	11.4	15.2	1408	2548	1	30	1	1	1	1	1	1	8	6	1	10.8	11.7	20.7	461	1635	<1	19	1	1	1	1	1	1
Thevenard Island	11	8	5	10.4	11.0	12.0	763	2468	5	98	4	5	4	5	5	5	8	7	1	11.1	11.2	22.6	309	1233	1	42	4	4	1	5	5	1
Tortoise Island	9	6	4	11.4	15.0	16.2	1243	2626	1	31	1	1	1	1	1	1	6	6	2	11.7	11.7	18.0	574	1464	<1	17	1	1	1	1	1	1
Twin Island	7	7	3	12.5	12.6	39.9	707	1247	1	25	2	2	1	2	2	2	7	7	-	12.5	12.5	12.4	263	641	<1	12	2	2	-	2	2	-
West Lewis Island	19	15	3	6.04	6.13	12.2	184	1613	3	71	7	6	1	16	14	1	13	11	1	6.04	6.33	22.3	140	1083	2	43	6	4	1	14	9	1
Wyndham - East Kimberley	1	-	-	69.5	40.9	40.9	77	79	<1	3	3	-	-	3	-	-	2	-	-	70.0	38.5	38.5	79	79	<1	1	1	-	-	1	-	-

Table 3-3 Summary of oil contact to individual shoreline receptors for the unmitigated and mitigated cases. Results are based on of a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during transitional conditions. The results were calculated from 100 spill trajectories per case.

Shoreline Receptor	Unmitigated: Maximum probability of shoreline loading (%)			Unmitigated: Minimum time before shoreline accumulation (days)			Unmitigated: Load on shoreline (g/m^2)		Unmitigated: Volume on shoreline (m^3)		Unmitigated: Mean length of shoreline contacted (km)			Unmitigated: Maximum length of shoreline contacted (km)			Mitigated: Maximum probability of shoreline loading (%)			Mitigated: Minimum time before shoreline accumulation (days)			Mitigated: Load on shoreline (g/m^2)		Mitigated: Volume on shoreline (m^3)		Mitigated: Mean length of shoreline contacted (km)			Mitigated: Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Me an	Peak	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Airlie Island	5	4	-	31.7	43.2	31.1	465	885	<1	10	1	1	-	1	1	-	2	-	-	54.0	53.6	53.6	86	86	<1	1	1	-	-	1	-	-
Ashburton ISland	5	5	-	42.9	42.9	42.9	229	453	<1	7	2	1	-	2	2	-	3	3	-	42.5	43.1	-	138	162	<1	2	1	1	-	2	1	-
Barrow Island	26	22	5	17.3	17.4	42.6	294	7,884	36	849	18	13	17	55	46	20	23	17	-	16.0	16.2	9.8	105	994	4	87	14	8	-	39	23	-
Bedout Island	3	2	-	30.9	55.9	30.8	221	343	<1	4	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bessieres Island	5	5	-	41.2	41.3	41.2	429	699	1	20	3	3	-	4	3	-	5	5	-	41.3	41.3	41.3	133	428	<1	8	4	2	-	4	3	-
Boodie Island	12	7	5	30.7	31.6	52.4	1,104	3,348	5	104	2	3	3	3	3	3	9	4	-	27.9	31.4	27.9	108	426	<1	9	2	2	-	3	3	-
Broome	4	2	-	59.3	59.4	58.5	109	878	3	181	35	37	-	90	50	-	4	3	-	58.5	59.4	58.4	112	579	1	119	22	15	-	63	33	-

Shoreline Receptor	Unmitigated																Mitigated															
	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Carnarvon	3	2	-	55.2	55.4	53.7	68	185	<1	6	5	2	-	7	2	-	4	1	-	52.6	55.8	52.6	69	120	<1	2	2	1	-	2	1	-
Clerke Reef	29	23	3	28.1	28.1	45.2	396	3,600	5	99	3	3	4	4	4	4	16	11	2	29.7	30.8	35.3	317	2,811	2	79	3	3	3	4	4	4
Cunningham Island	23	19	8	24.6	24.6	26.6	873	4,989	7	110	3	3	3	3	3	3	16	13	7	23.5	23.5	27.5	667	2,865	4	66	3	3	2	3	3	3
Exmouth	8	7	2	16.6	16.7	56.7	143	1,069	8	205	52	33	1	86	55	1	8	7	-	16.7	16.9	16.6	96	462	3	60	36	14	-	46	18	-
Flat Island	5	5	-	41.0	41.0	41.0	506	994	1	20	3	3	-	3	3	-	5	5	-	41.9	43.2	41.9	179	346	<1	6	3	2	-	3	2	-
Fly Island	2	-	-	42.6	42.6	42.6	36	36	<1	<1	1	-	-	1	-	-	2	-	-	49.0	49.0	49.0	87	87	<1	1	1	-	-	1	-	-
Imperieuse Reef	28	26	8	24.1	24.6	26.6	791	4,989	13	217	4	4	5	5	5	5	16	14	7	23.4	23.4	28.8	765	2,917	7	139	4	4	4	5	5	5
Lacepede Islands	1	-	-	64.5	62.3	62.3	60	60	<1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Locker Island	5	4	-	43.0	43.1	43.0	228	350	<1	4	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lowendal Island	16	9	1	18.5	18.6	60.8	175	1,052	2	45	4	4	2	8	8	2	15	6	-	16.3	16.9	16.3	73	240	<1	8	3	2	-	6	3	-
Mary Anne Group	2	2	-	53.6	53.7	53.6	222	222	<1	3	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mermaid Reef	19	19	3	33.4	34.4	36.5	511	2,780	3	76	3	2	2	3	3	3	13	8	-	36.0	36.6	32.4	153	818	1	22	2	2	-	3	3	-
Middle Island	17	12	5	20.1	20.1	43.1	667	5,488	5	106	3	3	3	4	4	4	16	12	-	27.9	27.9	27.8	132	509	1	9	2	1	-	4	2	-
Montebello Islands	31	27	11	4.4	4.8	5.96	259	2,953	24	210	23	19	3	40	33	6	29	28	2	4.54	4.9	5.50	185	2,371	13	167	21	13	4	38	28	7
Murion Islands	5	5	5	40.9	41.1	51.0	973	1,810	5	111	9	9	4	9	9	6	5	5	-	40.7	40.9	25.9	180	345	1	19	8	6	-	9	7	-
Observation Island	5	5	-	41.7	41.9	41.7	172	326	<1	6	3	2	-	3	2	-	2	-	-	41.7	-	-	73	73	<1	1	1	-	-	1	-	-
Passage Islands	4	-	-	55.7	55.7	55.7	57	72	<1	1	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peak Island	6	5	-	41.0	41.0	40.9	624	980	<1	12	1	1	-	1	1	-	5	3	-	42.7	42.7	42.4	223	569	<1	7	1	1	-	1	1	-
Pulau Komodo	1	1	-	67.4	68.6	67.3	72	130	<1	8	9	1	-	9	1	-	1	1	-	67.4	68.0	67.3	85	145	<1	5	5	1	-	5	1	-
Pulau Mules	1	-	-	71.6	71.5	71.5	66	66	<1	1	1	-	-	1	-	-	1	-	-	71.8	-	-	81	81	<1	1	1	-	-	1	-	-
Round Island	5	5	-	42.6	42.6	42.5	380	630	<1	7	1	1	-	1	1	-	4	3	-	42.1	42.1	42.1	176	220	<1	3	1	1	-	1	1	-
Sandy Islet	5	4	-	60.2	63.8	59.6	160	675	<1	11	3	2	-	3	3	-	6	3	-	63.2	63.3	60.1	105	227	<1	4	2	1	-	3	2	-
Serrurier Island	5	5	-	41.3	41.4	41.0	355	613	1	21	4	4	-	4	4	-	5	5	-	41.2	41.4	41.2	153	280	<1	6	3	2	-	4	2	-
Sumba Barat	1	1	-	68.7	70.2	68.7	91	154	<1	17	16	6	-	16	6	-	1	1	-	68.7	70.2	68.7	115	219	<1	15	11	5	-	11	5	-
Sumbawa	2	1	-	66.2	66.5	65.5	74	250	<1	43	22	13	-	42	13	-	2	1	-	64.9	66.6	64.4	78	324	<1	48	26	11	-	50	11	-
Sunday Island	5	5	-	43.9	43.9	43.9	638	948	1	32	4	4	-	4	4	-	5	4	-	42.1	43.7	42.0	179	252	<1	5	2	1	-	3	2	-
Table Island	5	5	-	41.5	41.5	41.5	483	629	<1	7	1	1	-	1	1	-	4	4	-	41.5	43.3	41.5	132	212	<1	2	1	1	-	1	1	-
Thevenard Island	5	5	-	42.0	42.1	32.0	397	796	1	25	5	5	-	5	5	-	1	1	-	44.5	44.7	43.7	58	107	<1	2	3	1	-	3	1	-
Tortoise Island	5	5	-	42.9	42.9	42.9	779	813	<1	10	1	1	-	1	1	-	4	3	-	43.0	43.3	43.0	123	143	<1	2	1	1	-	1	1	-

Table 3-4 Summary of oil contact to individual shoreline receptors for the unmitigated and mitigated cases. Results are based on of a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during winter conditions. The results were calculated from 100 spill trajectories per case.

Shoreline Receptor	Unmitigated																	Mitigated															
	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Airlie Island	24	14	6	10.1	10.4	22.1	521	1,389	1	16	1	1	1	1	1	1	18	14	1	10.1	10.2	18.7	520	2,379	1	28	1	1	1	1	1	1
Ashburton	8	4	-	17.9	18.0	17.5	80	378	<1	11	4	2	-	10	4	-	3	3	-	18.1	18.1	17.9	109	157	<1	7	3	2	-	4	4	-
Ashburton ISland	11	10	1	17.5	17.5	19.6	332	1,001	1	15	2	2	1	2	2	1	12	12	-	17.9	17.9	17.9	246	892	1	14	2	2	-	2	2	-
Barrow Island	66	61	19	9.0	9.0	10.2	289	10,528	86	1,030	26	19	10	55	49	22	71	61	14	9.0	9.1	18.1	200	4,443	50	454	21	15	7	50	46	12
Bessieres Island	43	38	7	9.5	9.5	9.7	418	4,144	8	129	3	2	3	4	4	4	42	29	6	9.6	9.6	9.7	311	3,623	5	97	3	3	3	4	4	4
Boodie Island	54	46	10	9.8	12.5	18.6	553	5,765	10	172	3	2	2	3	3	3	52	44	5	9.7	11.4	19.2	323	3,224	6	86	3	2	2	3	3	3
Cape Bruguieres	3	2	-	9.2	9.3	9.0	101	112	<1	1	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carnamah	2	-	-	64.2	64.2	64.2	69	82	<1	1	2	-	-	2	-	-	-	-	-	65.3	65.3	65.3	-	-	-	-	-	-	-	-	-	-
Carnarvon	3	1	-	28.8	28.8	28.7	93	405	<1	11	3	3	-	7	3	-	5	2	-	29.8	29.8	29.2	85	113	<1	2	2	1	-	2	1	-
Chapman Valley	1	-	-	65.7	65.4	65.5	58	58	<1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clerke Reef	2	2	-	54.6	55.1	54.6	169	401	<1	9	4	2	-	4	3	-	2	-	-	57.7	57.7	57.7	64	65	<1	1	2	-	-	2	-	-
Cohen Island	4	3	-	9.3	9.4	8.9	321	506	<1	6	1	1	-	1	1	-	-	-	-	9.0	9.0	9.0	-	-	-	-	-	-	-	-	-	-
Cunningham Island	4	4	2	50.6	50.6	58.3	596	1,863	1	45	3	2	2	3	3	2	3	2	-	49.6	49.6	49.6	292	778	<1	14	2	3	-	3	3	-
Dandaragan	3	1	-	63.7	67.0	61.6	81	125	<1	3	2	1	-	4	1	-	2	-	-	61.3	61.2	61.2	64	81	<1	2	2	-	-	3	-	-
Direction Island	5	4	-	18.5	18.6	18.5	315	534	<1	12	2	2	-	2	2	-	4	4	-	18.5	18.5	18.0	264	513	<1	9	2	2	-	2	2	-
Dirk Hartog Island	3	2	-	34.1	65.0	34.1	76	118	<1	6	3	2	-	6	2	-	2	1	-	59.9	65.1	59.7	73	146	<1	8	5	1	-	9	1	-
Dolphin Island	3	2	-	12.2	12.3	12.0	82	111	<1	5	5	2	-	5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Easter Group	1	-	-	62.7	-	-	50	50	<1	1	1	-	-	1	-	-	2	-	-	59.7	59.4	59.4	69	86	<1	1	1	-	-	1	-	-
Exmouth	50	41	6	10.7	10.8	13.3	133	2,498	31	239	32	20	2	78	52	3	53	46	2	10.8	10.8	13.5	113	1,306	21	171	26	14	2	78	47	2
Flat Island	44	34	6	9.6	9.6	14.8	352	3,796	5	96	2	2	2	3	3	3	41	26	4	9.6	9.6	16.4	256	1,649	3	39	2	2	1	3	3	1
Fly Island	1	-	-	27.7	20.0	20.0	64	64	<1	1	1	-	-	1	-	-	1	-	-	19.9	19.9	19.9	59	59	<1	1	1	-	-	1	-	-
Fremantle	1	-	-	69.6	65.1	65.1	81	81	<1	1	1	-	-	1	-	-	1	-	-	65.2	65.1	65.1	73	90	<1	2	3	-	-	3	-	-
Gidley Island	2	2	-	9.2	9.3	9.1	70	112	<1	2	2	1	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gingin	2	1	-	62.9	65.8	62.8	65	124	<1	5	3	1	-	5	1	-	2	-	-	64.9	64.8	64.8	51	60	<1	2	2	-	-	3	-	-
Greater Geraldton	1	-	-	63.2	62.9	62.9	53	53	<1	1	1	-	-	1	-	-	1	-	-	62.2	62.1	62.1	78	78	<1	1	1	-	-	1	-	-
Haury Island	3	-	-	9.6	9.5	9.5	32	33	<1	<1	1	-	-	1	-	-	2	-	-	14.7	9.4	9.46	94	94	<1	1	1	-	-	1	-	-
Imperieuse Reef	4	4	2	46.1	47.0	57.1	761	1,960	2	89	4	4	5	5	5	5	3	2	-	44.1	48.1	44.1	352	778	1	29	4	5	-	5	5	-
Irwin	2	1	-	64.0	70.5	64.0	74	123	<1	3	4	1	-	5	1	-	2	1	-	64.1	64.7	63.8	76	126	<1	6	5	2	-	6	2	-
Joondalup	1	-	-	65.2	65.1	65.1	65	76	<1	2	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Karratha	2	2	-	15.7	15.9	15.7	103	107	<1	2	2	1	-	2	1	-	1	1	-	31.0	31.0	-	110	110	<1	1	1	1	-	1	1	-
Keast Island	4	3	-	9.1	9.1	8.9	272	431	<1	5	1	1	-	1	1	-	2	2	-	9.4	9.4	9.4	349	349	<1	4	1	1	-	1	1	-

Unmitigated

Shoreline Receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Kendrew Island	1	-	-	23.6	23.5	23.5	54	54	<1	1	1	-	-	1	-	-
Legendre Island	5	3	-	8.9	8.9	8.9	131	988	1	30	8	7	-	13	7	-
Locker Island	3	2	-	16.1	16.2	16.1	313	773	<1	9	1	1	-	1	1	-
Lowendal Island	32	20	2	11.0	11.2	24.2	163	1,967	2	67	3	3	3	8	8	3
Mary Anne Group	3	-	-	18.6	18.6	18.6	72	86	<1	2	2	-	-	3	-	-
Middle Island	59	47	16	9.5	9.6	10.8	504	10,158	13	178	3	3	2	4	4	4
Montebello Islands	93	92	63	3.4	3.5	4.5	406	7,600	128	633	25	18	5	41	40	22
Murion Islands	41	37	5	9.7	9.7	28.5	285	2,701	10	216	5	4	8	9	9	9
Northhampton	2	-	-	65.1	65.1	65.1	56	60	<1	2	3	-	-	4	-	-
Observation Island	11	7	-	17.9	18.0	17.9	137	808	<1	19	2	2	-	3	3	-
Passage Islands	1	-	-	28.0	20.7	20.7	79	99	<1	3	3	-	-	3	-	-
Peak Island	39	25	4	10.1	10.5	16.8	498	4,905	2	58	1	1	1	1	1	1
Pelsaert Group	1	-	-	56.2	56.1	56.1	57	57	<1	1	1	-	-	1	-	-
Rosemary Island	4	1	-	9.2	14.4	9.0	61	103	<1	2	2	1	-	2	1	-
Rottnest Island	1	1	-	64.2	64.4	63.9	121	121	<1	1	1	1	-	1	1	-
Round Island	17	14	6	9.7	9.7	10.9	925	4,664	2	55	1	1	1	1	1	1
Serrurier Island	35	23	7	9.7	9.7	10.4	413	4,528	6	135	3	2	3	4	4	4
Shark Bay	2	1	-	64.6	69.5	-	72	108	<1	8	7	1	-	11	1	-
Sunday Island	19	11	4	10.2	10.2	31.0	308	2,657	2	62	2	2	2	4	4	2
Table Island	24	16	7	9.7	9.7	10.9	935	4,278	3	50	1	1	1	1	1	1
Thevenard Island	33	22	8	9.7	10.0	10.7	295	1,624	5	56	3	3	2	5	5	3
Tortoise Island	14	11	3	10.2	15.1	19.1	593	1,270	1	15	1	1	1	1	1	1
Twin Island	4	3	-	18.5	18.5	18.5	226	501	<1	11	2	1	-	2	2	-
Wallabi Group	1	-	-	46.0	45.8	45.8	71	71	<1	1	1	-	-	1	-	-

Mitigated

Shoreline Receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)		Volume on shoreline (m³)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
	Low	Mod.	High	Low	Mod.	High	Mean	Peak	Mean	Peak	Low	Mod.	High	Low	Mod.	High
Kendrew Island	1	1	-	23.6	24.1	23.6	160	160	<1	2	1	1	-	1	1	-
Legendre Island	4	2	-	9.5	9.6	8.9	74	100	<1	3	4	1	-	5	1	-
Locker Island	5	4	-	15.7	15.7	15.7	137	224	<1	3	1	1	-	1	1	-
Lowendal Island	31	15	-	9.7	9.8	9.7	115	830	1	27	3	3	-	8	7	-
Mary Anne Group	2	2	-	18.8	18.8	18.8	134	278	<1	5	3	2	-	4	2	-
Middle Island	52	45	12	9.5	9.6	19.2	342	3,698	8	84	3	3	1	4	4	3
Montebello Islands	93	88	59	3.3	3.5	5.8	308	5,843	88	494	23	16	3	40	38	16
Murion Islands	41	32	4	9.6	9.7	28.8	182	1,341	6	81	5	4	2	9	9	3
Northhampton	2	1	-	65.2	65.2	65.2	84	120	<1	2	2	1	-	2	1	-
Observation Island	7	4	-	19.7	19.7	19.7	129	395	<1	9	2	2	-	3	3	-
Passage Islands	3	1	-	21.7	21.7	21.7	82	123	<1	3	2	1	-	5	1	-
Peak Island	33	19	3	10.5	10.5	39.2	276	1,204	1	14	1	1	1	1	1	1
Pelsaert Group	2	-	-	59.8	59.7	59.7	58	69	<1	2	3	-	-	3	-	-
Rosemary Island	1	-	-	23.7	23.7	23.7	53	54	<1	1	2	-	-	2	-	-
Rottnest Island	1	-	-	68.7	68.7	68.7	39	39	<1	<1	1	-	-	1	-	-
Round Island	19	11	3	9.7	10.1	31.5	369	1,388	1	16	1	1	1	1	1	1
Serrurier Island	36	25	5	9.7	9.7	15.6	294	3,131	4	86	3	2	3	4	4	4
Shark Bay	1	-	-	57.5	-	-	61	77	<1	4	6	-	-	6	-	-
Sunday Island	15	9	-	9.8	9.8	9.8	214	777	1	28	3	3	-	4	4	-
Table Island	22	16	7	9.7	9.7	10.5	874	2,900	2	34	1	1	1	1	1	1
Thevenard Island	32	24	2	10.0	10.1	16.7	233	1,356	4	53	3	3	2	5	5	2
Tortoise Island	16	13	-	10.2	10.2	10.1	368	828	1	10	1	1	-	1	1	-
Twin Island	3	3	-	19.3	19.3	19.0	172	346	<1	6	2	1	-	2	2	-
Wallabi Group	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4 IN WATER EXPOSURE

4.1 Dissolved Hydrocarbons

Table 4-1 to Table 4-6 summarise the probability of exposure to receptors from instantaneous dissolved hydrocarbons in the 0-10 m and 10-20 m depth layers, respectively, across all seasonal conditions, at the low (10-50 ppb), moderate (50-400 ppb) and high (≥ 400 ppb) thresholds.

The seasonal stochastic modelling demonstrated an overall increase of the dissolved hydrocarbon exposure within the 0-10 m and 10-20 m depth layers following the application of surface dispersant. However, it is worth noting that none of the receptors assessed were predicted to be exposed at, or above the high thresholds.

In the surface (0-10 m) depth layer, the Pilbara (offshore) IMCRA recorded the greatest probability of instantaneous dissolved hydrocarbon exposure at low threshold during all three seasons for the unmitigated (89 – 94%) and mitigated (100%) cases. Probabilities of low instantaneous dissolved hydrocarbon exposure ranged from 77% (winter) to 86% (transitional) for the Northwest Shelf IMCRA (compared to 96%-98% for the mitigated case), (refer to Table 4-1 (summer), Table 4-2 (transitional), Table 4-3 (winter)).

In the 10-20 m depth layer, the Pilbara (offshore) IMCRA was predicted to be exposed to instantaneous dissolved hydrocarbons (above the low threshold) with probabilities ranging from 79% (transitional) to 92% (winter) for the unmitigated case and 92% (transitional) to 100% (winter) for the mitigated case. The Northwest Shelf IMCRA also recorded probabilities low dissolved hydrocarbon exposure of up to 79% for the unmitigated case and 94%, for the mitigated option (refer to Table 4-4 (summer), Table 4-5 (transitional), Table 4-6 (winter).

Table 4-1 Probability of exposure to individual receptors from instantaneous dissolved hydrocarbons in the 0–10 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during summer conditions. The results were calculated from 100 spill trajectories per case.

0-10 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
	Receptor		Low	Mod.	High		Low	Mod.	High
AMP	Carnarvon Canyon	4	-	-	-	14	2	-	-
	Dampier	37	2	-	-	30	3	-	-
	Gascoyne	55	2	1	-	44	5	-	-
	Montebello	146	23	2	-	151	39	4	-
	Ningaloo	19	1	-	-	34	4	-	-
EEZ	Australian EEZ	261	89	17	-	241	100	28	-
IBRA	Cape Range	82	15	2	-	92	17	2	-
	Roebourne	34	1	-	-	45	2	-	-
IMCRA	Ningaloo	17	2	-	-	26	4	-	-
	Northwest Shelf	199	85	16	-	241	98	28	-
	Pilbarra (nearshore)	57	6	1	-	91	8	2	-
	Pilbarra (offshore)	261	89	17	-	239	100	28	-
KEF	Ancient coastline at 125 m depth contour	86	10	1	-	100	13	2	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	46	3	-	-	38	5	-	-
	Commonwealth waters adjacent to Ningaloo Reef	19	1	-	-	34	4	-	-
	Continental Slope Demersal Fish Communities	80	4	1	-	77	9	2	-
	Exmouth Plateau	15	1	-	-	10	1	-	-
	Glomar Shoals	105	38	3	-	90	48	3	-
MMA	Barrow Island	114	11	3	-	119	13	2	-
	Muiron Islands	12	1	-	-	22	2	-	-
MP	Barrow Island	44	6	-	-	94	8	1	-
	Montebello Islands	118	16	3	-	117	19	3	-
	Ningaloo	17	1	-	-	26	3	-	-
RSB	Glomar Shoal	80	11	1	-	48	18	-	-
	Madeleine Shoals	19	1	-	-	18	1	-	-
	Montebello Shoals	54	8	1	-	42	7	-	-
	Ningaloo Reef	11	1	-	-	22	2	-	-
	Penguin Bank	7	-	-	-	20	1	-	-
	Rankin Bank	40	5	-	-	38	5	-	-
	Ripple Shoals	19	2	-	-	11	1	-	-

0-10 m Depth layer		Unmitigated				Mitigated			
	Receptor	Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure Low	Mod.	High	Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure Low	Mod.	High
State Waters	Tryal Rocks	33	6	-	-	24	9	-	-
	Western Australia State Waters	118	16	3	-	119	19	3	-

Table 4-2 Probability of exposure to individual receptors from instantaneous dissolved hydrocarbons in the 0–10 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during transitional conditions. The results were calculated from 100 spill trajectories per case.

0-10 m Depth layer		Unmitigated				Mitigated			
	Receptor	Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure Low	Mod.	High	Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure Low	Mod.	High
AMP	Gascoyne	29	2	-	-	40	5	-	-
	Montebello	150	63	5	-	165	79	7	-
	Ningaloo	37	3	-	-	45	4	-	-
EEZ	Australian EEZ	166	91	12	-	206	99	24	-
IBRA	Cape Range	32	4	-	-	64	6	2	-
IMCRA	Ningaloo	38	4	-	-	75	4	1	-
	Northwest Shelf	136	86	9	-	206	96	18	-
	Pilbarra (nearshore)	7	-	-	-	31	2	-	-
	Pilbarra (offshore)	166	91	12	-	184	99	24	-
KEF	Ancient coastline at 125 m depth contour	70	16	2	-	108	18	2	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	55	5	1	-	40	5	-	-
	Commonwealth waters adjacent to Ningaloo Reef	37	3	-	-	45	4	-	-
	Continental Slope Demersal Fish Communities	81	11	1	-	95	15	3	-
	Exmouth Plateau	9	-	-	-	14	2	-	-
	Glomar Shoals	75	31	3	-	100	41	4	-
MMA	Barrow Island	38	4	-	-	51	7	1	-
	Muiron Islands	16	1	-	-	43	2	-	-
MP	Barrow Island	21	2	-	-	12	1	-	-
	Montebello Islands	55	18	1	-	108	26	3	-
	Ningaloo	38	2	-	-	75	4	1	-
RSB	Glomar Shoal	27	9	-	-	43	9	-	-
	Montebello Shoals	20	1	-	-	30	7	-	-

0-10 m Depth layer	Receptor	Unmitigated: Maximum dissolved hydrocarbon exposure (ppb)	Unmitigated: Probability of hydrocarbon exposure Low	Mod.	High	Mitigated: Maximum dissolved hydrocarbon exposure (ppb)	Mitigated: Probability of hydrocarbon exposure Low	Mod.	High
	Ningaloo Reef	38	2	-	-	40	2	-	-
	Rankin Bank	25	5	-	-	24	6	-	-
	Tryal Rocks	61	29	2	-	99	37	7	-
State Waters	Western Australia State Waters	103	20	1	-	108	26	3	-

Table 4-3 Probability of exposure to individual receptors from instantaneous dissolved hydrocarbons in the 0–10 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during winter conditions. The results were calculated from 100 spill trajectories per case.

0-10 m Depth layer	Receptor	Unmitigated: Maximum dissolved hydrocarbon exposure (ppb)	Unmitigated: Probability of hydrocarbon exposure Low	Mod.	High	Mitigated: Maximum dissolved hydrocarbon exposure (ppb)	Mitigated: Probability of hydrocarbon exposure Low	Mod.	High
AMP	Carnarvon Canyon	13	1	-	-	14	1	-	-
	Gascoyne	50	5	-	-	41	5	-	-
	Montebello	253	92	11	-	306	100	17	-
	Ningaloo	28	4	-	-	49	5	-	-
EEZ	Australian EEZ	253	94	13	-	318	100	24	-
IBRA	Cape Range	44	32	-	-	65	41	2	-
	Roebourne	14	1	-	-	42	4	-	-
IMCRA	Ningaloo	43	5	-	-	63	7	1	-
	Northwest Shelf	210	77	6	-	201	96	10	-
	Pilbarra (nearshore)	11	1	-	-	11	1	-	-
	Pilbarra (offshore)	253	94	13	-	318	100	24	-
	Zuytdorp	8	-	-	-	10	1	-	-
KEF	Ancient coastline at 125 m depth contour	120	28	3	-	124	46	4	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	45	6	-	-	51	7	1	-
	Commonwealth waters adjacent to Ningaloo Reef	28	4	-	-	49	5	-	-
	Continental Slope Demersal Fish Communities	201	22	2	-	147	32	4	-
	Exmouth Plateau	15	1	-	-	17	3	-	-
	Glomar Shoals	35	5	-	-	44	10	-	-
MMA	Barrow Island	61	25	1	-	72	33	1	-
	Muiron Islands	14	1	-	-	37	5	-	-

0-10 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
	Receptor		Low	Mod.	High		Low	Mod.	High
MP	Barrow Island	44	8	-	-	45	17	-	-
	Montebello Islands	101	68	5	-	208	83	7	-
	Ningaloo	19	3	-	-	34	4	-	-
RSB	Glomar Shoal	8	-	-	-	15	1	-	-
	Montebello Shoals	25	7	-	-	41	13	-	-
	Ningaloo Reef	12	1	-	-	19	1	-	-
	Penguin Bank	19	5	-	-	15	5	-	-
	Rankin Bank	22	3	-	-	21	3	-	-
	Ripple Shoals	12	2	-	-	12	1	-	-
	Rosily Shoals	14	2	-	-	25	2	-	-
	Tryal Rocks	52	72	1	-	164	87	7	-
State Waters	Western Australia State Waters	101	70	5	-	208	86	7	-

Table 4-4 Probability of exposure to individual receptors from instantaneous dissolved hydrocarbons in the 10–20 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during summer conditions. The results were calculated from 100 spill trajectories per case.

10-20 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
	Receptor		Low	Mod.	High		Low	Mod.	High
AMP	Dampier	20	1	-	-	30	2	-	-
	Gascoyne	46	3	-	-	46	4	-	-
	Montebello	128	19	2	-	210	32	3	-
	Ningaloo	25	1	-	-	39	3	-	-
EEZ	Australian EEZ	243	81	12	-	264	98	19	-
IBRA	Cape Range	59	9	1	-	116	8	2	-
	Roebourne	14	1	-	-	24	2	-	-
IMCRA	Ningaloo	25	1	-	-	39	4	-	-
	Northwest Shelf	178	79	11	-	230	94	18	-
	Pilbarra (nearshore)	69	5	1	-	105	8	1	-
	Pilbarra (offshore)	243	81	12	-	264	98	19	-
KEF	Ancient coastline at 125 m depth contour	51	10	1	-	96	14	2	-

10-20 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
	Receptor		Low	Mod.	High		Low	Mod.	High
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	36	2	-	-	40	6	-	-
	Commonwealth waters adjacent to Ningaloo Reef	25	1	-	-	39	3	-	-
	Continental Slope Demersal Fish Communities	100	4	1	-	60	8	1	-
	Exmouth Plateau	17	1	-	-	14	1	-	-
	Glomar Shoals	125	25	2	-	106	36	4	-
MMA	Barrow Island	70	6	1	-	90	7	1	-
MMA	Muiron Islands	21	1	-	-	18	2	-	-
MP	Barrow Island	47	5	-	-	133	6	1	-
MP	Montebello Islands	67	12	1	-	116	18	2	-
MP	Ningaloo	17	1	-	-	32	2	-	-
RSB	Glomar Shoal	103	10	1	-	47	13	-	-
RSB	Madeleine Shoals	7	-	-	-	11	1	-	-
RSB	Montebello Shoals	35	3	-	-	83	3	1	-
RSB	Ningaloo Reef	5	-	-	-	16	2	-	-
RSB	Penguin Bank	12	1	-	-	12	1	-	-
RSB	Rankin Bank	30	4	-	-	33	5	-	-
RSB	Tryal Rocks	37	4	-	-	34	9	-	-
State Waters	Western Australia State Waters	123	14	2	-	134	18	2	-

Table 4-5 Probability of exposure to individual receptors from instantaneous dissolved hydrocarbons in the 10–20 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season and per case.

10-20 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
	Receptor		Low	Mod.	High		Low	Mod.	High
AMP	Gascoyne	32	3	-	-	45	7	-	-
AMP	Montebello	144	57	4	-	179	72	6	-
AMP	Ningaloo	58	3	1	-	37	5	-	-
AMP	Shark Bay	4	-	-	-	10	1	-	-
EEZ	Australian EEZ	159	79	6	-	186	92	13	-

10-20 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
	Receptor		Low	Mod.	High		Low	Mod.	High
IBRA	Cape Range	36	3	-	-	41	5	-	-
IMCRA	Ningaloo	58	3	1	-	51	5	1	-
	Northwest Shelf	141	75	5	-	155	89	13	-
	Pilbarra (nearshore)	10	-	-	-	28	1	-	-
	Pilbarra (offshore)	159	79	6	-	186	92	10	-
	Zuytdorp	4	-	-	-	11	1	-	-
KEF	Ancient coastline at 125 m depth contour	71	13	1	-	138	16	2	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	45	3	-	-	69	6	1	-
	Commonwealth waters adjacent to Ningaloo Reef	58	3	1	-	37	5	-	-
	Continental Slope Demersal Fish Communities	59	11	2	-	86	14	2	-
	Exmouth Plateau	14	1	-	-	10	2	-	-
	Glomar Shoals	89	21	2	-	69	39	2	-
MMA	Barrow Island	31	3	-	-	68	5	1	-
	Muiron Islands	28	1	-	-	17	2	-	-
MP	Barrow Island	10	-	-	-	18	2	-	-
	Montebello Islands	79	13	1	-	60	23	2	-
	Ningaloo	43	2	-	-	30	3	-	-
RSB	Glomar Shoal	25	4	-	-	42	10	-	-
	Montebello Shoals	21	1	-	-	18	2	-	-
	Ningaloo Reef	21	1	-	-	17	1	-	-
	Rankin Bank	32	4	-	-	20	5	-	-
	Tryal Rocks	50	27	-	-	53	28	1	-
State Waters	Western Australia State Waters	102	13	1	-	82	23	2	-

Table 4-6 Probability of exposure to individual receptors from instantaneous dissolved hydrocarbons in the 10–20 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during winter conditions. The results were calculated from 100 spill trajectories per case.

10-20 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
	Receptor		Low	Mod.	High		Low	Mod.	High
AMP	Carnarvon Canyon	12	1	-	-	14	1	-	-
	Gascoyne	59	6	1	-	65	7	1	-
	Montebello	227	86	9	-	263	99	16	-
	Ningaloo	43	4	-	-	55	5	1	-
EEZ	Australian EEZ	227	92	10	-	263	100	16	-
IBRA	Cape Range	44	20	-	-	74	28	1	-
	Roebourne	8	-	-	-	15	1	-	-
IMCRA	Ningaloo	43	6	-	-	65	7	1	-
	Northwest Shelf	113	58	4	-	156	72	5	-
	Pilbarra (offshore)	227	92	10	-	263	100	16	-
KEF	Ancient coastline at 125 m depth contour	117	32	3	-	120	38	3	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	51	7	1	-	65	9	1	-
	Commonwealth waters adjacent to Ningaloo Reef	43	4	-	-	55	5	1	-
	Continental Slope Demersal Fish Communities	117	20	3	-	92	31	3	-
	Exmouth Plateau	14	1	-	-	20	3	-	-
	Glomar Shoals	26	4	-	-	46	7	-	-
MMA	Barrow Island	46	25	-	-	80	26	1	-
	Muiron Islands	35	3	-	-	33	8	-	-
MP	Barrow Island	37	13	-	-	29	5	-	-
	Montebello Islands	98	61	4	-	116	78	5	-
	Ningaloo	28	2	-	-	25	3	-	-
RSB	Glomar Shoal	9	-	-	-	18	3	-	-
	Montebello Shoals	25	2	-	-	30	5	-	-
	Ningaloo Reef	8	-	-	-	19	3	-	-
	Penguin Bank	16	3	-	-	23	5	-	-
	Rankin Bank	25	2	-	-	42	6	-	-
	Rosily Shoals	12	1	-	-	17	2	-	-
	Tryal Rocks	91	62	4	-	89	87	6	-

10-20 m Depth layer		Unmitigated				Mitigated			
		Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure			Maximum dissolved hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		
Receptor			Low	Mod.	High		Low	Mod.	High
State Waters	Western Australia State Waters	98	61	3	-	159	80	5	-

4.2 Entrained Hydrocarbons

Table 4-7 to Table 4-9 summarise the probability of exposure to individual receptors from instantaneous entrained hydrocarbons in the 0-10 m depth layer, across all seasonal conditions, at the low (10-100 ppb) and high (≥ 500 ppb) exposure thresholds.

The seasonal stochastic modelling demonstrated an overall increase of the instantaneous entrained hydrocarbon exposure within the 0-10 m depth layer following the application of surface dispersant.

During summer conditions, the receptors predicted with a probability greater than 50% and low entrained hydrocarbon exposure in the surface (0-10 m) layer were: Montebello AMP (81% - unmitigated; 96% - mitigated), North West Shelf IMCRA (88% - unmitigated; 100% - mitigated), Pilbara (offshore) IMCRA (88% - unmitigated; 100% - mitigated), Ancient coastline at 125 m depth contour KEF (87% - unmitigated; 98% - mitigated), Continental Slope Demersal Fish Communities (81% - unmitigated; 97% - mitigated), Glomar Shoals KEF (87% - unmitigated; 98% - mitigated), Montebello Islands MP (54% - unmitigated; 66% - mitigated), Glomar Shoals RSB (83% - unmitigated; 93% - mitigated), Rankin Bank RSB (83% - unmitigated; 95% - mitigated) and Tryal Rocks RSB (52% - unmitigated; 70% - mitigated) (Table 4-7).

In the transitional months, probabilities of low entrained hydrocarbon exposure greater than 50% were recorded for: Gascoyne AMP (54% - unmitigated; 76% - mitigated), Montebello AMP (88% - unmitigated; 98% - mitigated), Cape Range IBRA (51% - unmitigated; 68% - mitigated), Ningaloo IMCRA (53% - unmitigated; 70% - mitigated), North West Shelf IMCRA (91% - unmitigated; 99% - mitigated), Pilbara (offshore) IMCRA (91% - unmitigated; 99% - mitigated), Ancient coastline at 125 m depth contour KEF (91% - unmitigated; 99% - mitigated), Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (55% - unmitigated; 74% - mitigated), Continental Slope Demersal Fish Communities (91% - unmitigated; 99% - mitigated), Exmouth Plateau (64% - unmitigated; 69% - mitigated), Glomar Shoals KEF (89% - unmitigated; 93% - mitigated), Barrow Islands MMA (50% - unmitigated; 60% - mitigated), Montebello Islands MP (64% - unmitigated; 73% - mitigated), Glomar Shoals RSB (73% - unmitigated; 78% - mitigated), Rankin Bank RSB (87% - unmitigated; 99% - mitigated) and Tryal Rock RSB (64% - unmitigated; 75% - mitigated) (Table 4-8).

During winter conditions, probabilities of low entrained hydrocarbon exposure greater than 50% were recorded for: Gascoyne AMP (89% - unmitigated; 100% - mitigated), Montebello AMP (92% - unmitigated; 100% - mitigated), Ningaloo AMP (79% - unmitigated; 94% - mitigated), Cape Range IBRA (91% - unmitigated; 100% - mitigated), Roebourne IBRA (66% - unmitigated; 74% - mitigated), Ningaloo IMCRA (86% - unmitigated; 98% - mitigated), North West Shelf IMCRA (92% - unmitigated; 100% - mitigated), Pilbara (offshore) IMCRA (92% - unmitigated; 100% - mitigated), Ancient coastline at 125 m depth contour KEF (92% -

unmitigated; 100% - mitigated), Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF (88% - unmitigated; 99% - mitigated), Commonwealth waters adjacent to Ningaloo Reef (79% - unmitigated; 94% - mitigated), Continental Slope Demersal Fish Communities (92% - unmitigated; 100% - mitigated), Exmouth Plateau KEF (89% - unmitigated; 99% - mitigated), Glomar Shoals KEF (58% - unmitigated; 56% - mitigated), Barrow Island MMA (91% - unmitigated; 100% - mitigated), Muiron Island MMA (65% - unmitigated; 85% - mitigated), Barrow Island MP (86% - unmitigated; 96% - mitigated), Montebello Islands MP (92% - unmitigated; 100% - mitigated), Ningaloo MP (60% - unmitigated; 77% - mitigated), Montebello Shoals RSB (85% - unmitigated; 99% - mitigated), Ningaloo Reef RSB (52% - unmitigated; 67% - mitigated), Penguin Bank RSB (76% - unmitigated; 90% - mitigated), Rankin Bank RSB (90% - unmitigated; 95% - mitigated), Rosily Shoals (73% - unmitigated; 83% - mitigated) and Tryal Rocks RSB (92% - unmitigated; 100% - mitigated) (Table 4-9).

Table 4-7 Probability of exposure to individual receptors from instantaneous entrained hydrocarbons in the 0–10 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during summer conditions. The results were calculated from 100 spill trajectories per case.

0-10 m Depth Layer		Unmitigated			Mitigated		
		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure	
	Receptor		Low	High		Low	High
AMP	Abrolhos	18	2	-	34	7	-
	Argo-Rowley Terrace	132	28	1	141	29	2
	Carnarvon Canyon	31	9	-	49	17	-
	Dampier	227	40	5	235	43	8
	Eighty Mile Beach	163	34	4	132	32	2
	Gascoyne	260	49	7	366	68	15
	Kimberley	13	1	-	16	1	-
	Mermaid Reef	24	3	-	25	5	-
	Montebello	2051	81	42	2008	96	56
	Ningaloo	242	35	5	246	53	11
	Perth Canyon	7	-	-	12	2	-
	Shark Bay	30	11	-	53	16	-
EEZ	Australian EEZ	10762	88	88	10863	100	100
	Indonesian Exclusive Economic Zone	14	1	-	16	3	-
IBRA	Cape Range	1843	43	20	2125	55	24
	Chichester	22	5	-	23	6	-
	Edel	8	-	-	13	2	-
	Pindanland	63	13	-	52	11	-
	Roebourne	429	29	8	438	32	5
IMCRA	Canning	42	5	-	24	4	-
	Eighty Mile Beach	101	24	1	70	22	-
	Ningaloo	257	43	5	325	66	10
	Northwest Shelf	4355	88	88	4119	100	100
	Pilbarra (nearshore)	697	43	16	751	50	20
	Pilbarra (offshore)	10762	88	88	10863	100	100
	Zuytdorp	37	12	-	64	16	-
IPA	Nyangumarta Warrarn	58	11	-	52	10	-
KEF	Ancient coastline at 125 m depth contour	1326	87	50	1319	98	62
	Canyons linking the Argo Abyssal Plain with the Scott Plateau	14	2	-	16	4	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	288	52	9	392	71	19

0-10 m Depth Layer		Unmitigated			Mitigated		
		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure	
	Receptor		Low	High		Low	High
	Commonwealth waters adjacent to Ningaloo Reef	248	35	5	246	53	11
	Continental Slope Demersal Fish Communities	862	81	16	840	97	22
	Exmouth Plateau	170	42	2	166	52	1
	Glomar Shoals	924	87	69	1100	98	81
	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	92	22	-	85	23	-
	Perth Canyon and adjacent shelf break, and other west coast canyons	12	1	-	13	2	-
	Wallaby Saddle	15	1	-	32	4	-
	Western demersal slope and associated fish communities	22	4	-	35	8	-
MMA	Barrow Island	1427	44	18	1339	52	22
	Muiron Islands	392	31	6	242	42	9
MP	Barrow Island	723	36	12	746	39	14
	Eighty Mile Beach	82	18	-	69	13	-
	Montebello Islands	2249	54	21	2327	66	29
	Ningaloo	252	32	5	325	41	8
	Rowley Shoals	83	21	-	77	20	-
NR	Great Sandy Island	107	18	1	91	16	-
	Thevenard Island	78	7	-	75	8	-
RAMSAR	Eighty-mile Beach	69	13	-	52	12	-
RSB	Barrow Island Reefs and Shoals	154	19	1	96	17	-
	Baylis Patches	75	5	-	45	4	-
	Beryl Reef	31	5	-	31	5	-
	Brewis Reef	50	7	-	41	7	-
	Clerke Reef	34	6	-	29	6	-
	Eliassen Rocks	23	1	-	14	2	-
	Exmouth Reef	28	6	-	30	6	-
	Fortescue Reef	30	7	-	30	3	-
	Glomar Shoal	607	83	44	604	93	54
	Herald Reef	22	7	-	18	5	-
	Imperieuse Reef	64	16	-	50	15	-
	Lightfoot Reef	80	10	-	55	10	-
	Locker Reef	55	5	-	44	6	-
	Madeleine Shoals	192	39	4	252	42	5

0-10 m Depth Layer	Receptor	Unmitigated: Maximum entrained hydrocarbon exposure (ppb)	Unmitigated: Probability of hydrocarbon exposure Low	Unmitigated: Probability of hydrocarbon exposure High	Mitigated: Maximum entrained hydrocarbon exposure (ppb)	Mitigated: Probability of hydrocarbon exposure Low	Mitigated: Probability of hydrocarbon exposure High
	Manicom Bank	43	5	-	21	2	-
	Meda Reef	15	3	-	23	7	-
	Mermaid Reef	19	2	-	14	3	-
	Montebello Shoals	706	41	16	812	44	19
	Ningaloo Reef	169	30	5	295	37	7
	O'Grady Shoal	43	7	-	31	5	-
	Paroo Shoal	37	5	-	40	4	-
	Penguin Bank	290	21	7	266	24	6
	Rankin Bank	227	83	17	352	95	25
	Ripple Shoals	313	13	6	251	17	4
	Rosily Shoals	175	11	4	191	16	2
	South East Reef	68	7	-	56	6	-
	Tongue Shoals	51	5	-	27	3	-
	Tryal Rocks	401	52	18	444	70	24
	Ward Reef	21	4	-	10	1	-
	Weeks Shoal	31	6	-	30	4	-
	West Reef	68	9	-	66	7	-
State Waters	Western Australia State Waters	2249	54	24	2327	66	32

Table 4-8 Probability of exposure to individual receptors from instantaneous entrained hydrocarbons in the 0–10 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during transitional conditions. The results were calculated from 100 spill trajectories per case.

0-10 m Depth Layer	Receptor	Unmitigated: Maximum entrained hydrocarbon exposure (ppb)	Unmitigated: Probability of hydrocarbon exposure Low	Unmitigated: Probability of hydrocarbon exposure High	Mitigated: Maximum entrained hydrocarbon exposure (ppb)	Mitigated: Probability of hydrocarbon exposure Low	Mitigated: Probability of hydrocarbon exposure High
AMP	Abrolhos	40	6	-	46	10	-
	Argo-Rowley Terrace	192	46	3	133	38	1
	Carnarvon Canyon	72	11	-	67	16	-
	Dampier	79	4	-	103	5	1
	Eighty Mile Beach	27	3	-	11	1	-
	Gascoyne	362	54	10	396	76	25
	Mermaid Reef	12	1	-	11	1	-

0-10 m Depth Layer		Unmitigated			Mitigated		
		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure	
	Receptor		Low	High		Low	High
	Montebello	1537	88	77	1669	98	85
	Ningaloo	241	43	8	510	61	20
	Perth Canyon	11	1	-	17	2	-
	Shark Bay	43	12	-	76	22	-
EEZ	Australian EEZ	12150	91	91	12150	99	99
EEZ	Indonesian Exclusive Economic Zone	13	1	-	17	2	-
FHPA	Abrolhos Islands	11	1	-	19	1	-
IBRA	Cape Range	533	51	12	504	68	22
IBRA	Geraldton Hills	8	-	-	12	1	-
IBRA	Roebourne	115	23	2	96	30	-
IMCRA	Abrolhos Islands	11	1	-	19	1	-
IMCRA	Central West Coast	12	1	-	18	3	-
IMCRA	Ningaloo	241	53	9	510	70	20
IMCRA	Northwest Shelf	4038	91	91	4173	99	99
IMCRA	Pilbarra (nearshore)	280	8	2	619	11	3
IMCRA	Pilbarra (offshore)	12150	91	91	12150	99	99
IMCRA	Zuytdorp	62	12	-	76	22	-
KEF	Ancient coastline at 125 m depth contour	841	91	56	896	99	72
KEF	Ancient coastline at 90-120m depth	12	1	-	15	1	-
KEF	Canyons linking the Argo Abyssal Plain with the Scott Plateau	11	1	-	11	1	-
KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	364	55	11	652	74	21
KEF	Commonwealth marine environment surrounding the Houtman Abrolhos Islands	13	1	-	19	2	-
KEF	Commonwealth waters adjacent to Ningaloo Reef	241	43	8	510	61	20
KEF	Continental Slope Demersal Fish Communities	855	91	30	957	99	47
KEF	Exmouth Plateau	251	64	7	145	69	3
KEF	Glomar Shoals	1447	89	74	1480	93	76
KEF	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	54	9	-	42	7	-
KEF	Perth Canyon and adjacent shelf break, and other west coast canyons	21	2	-	20	4	-
KEF	Wallaby Saddle	38	4	-	34	5	-
KEF	Western demersal slope and associated fish communities	45	11	-	61	17	-

0-10 m Depth Layer		Unmitigated			Mitigated		
		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure	
	Receptor		Low	High		Low	High
	Western rock lobster	12	1	-	19	2	-
MMA	Barrow Island	324	50	13	416	66	23
	Muiron Islands	80	22	-	195	41	3
MP	Barrow Island	230	34	5	315	38	12
	Jurien Bay	9	-	-	11	1	-
	Montebello Islands	687	64	22	690	73	54
	Ningaloo	184	28	1	404	49	8
	Rowley Shoals	49	9	-	38	6	-
NR	Great Sandy Island	39	4	-	12	1	-
	Thevenard Island	23	4	-	33	6	-
RSB	Barrow Island Reefs and Shoals	59	5	-	12	1	-
	Beryl Reef	5	-	-	10	2	-
	Brewis Reef	21	4	-	23	6	-
	Clerke Reef	26	3	-	18	2	-
	Exmouth Reef	7	-	-	18	5	-
	Glomar Shoal	510	73	42	584	78	48
	Imperieuse Reef	43	7	-	30	6	-
	Lightfoot Reef	9	-	-	11	1	-
	Locker Reef	16	4	-	11	2	-
	Madeleine Shoals	79	3	-	79	4	-
	Montebello Shoals	173	33	3	244	44	12
	Ningaloo Reef	153	21	1	312	35	7
	Penguin Bank	70	21	-	133	30	3
	Rankin Bank	397	87	28	599	99	53
	Ripple Shoals	124	6	3	38	11	-
	Rosily Shoals	56	10	-	88	18	-
	Tryal Rocks	615	64	42	819	75	59
State Waters	Western Australia State Waters	687	64	21	690	73	55

Table 4-9 Probability of exposure to individual receptors from instantaneous entrained hydrocarbons in the 0–10 m depth layer, for the unmitigated and mitigated cases. Results are based on a 25,555 m3 surface release of Wandoo Crude over 43 days, tracked for 73 days during winter conditions. The results were calculated from 100 spill trajectories per case.

0-10 m Depth Layer		Unmitigated			Mitigated		
	Receptor	Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure Low	Probability of hydrocarbon exposure High	Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure Low	Probability of hydrocarbon exposure High
AMP	Abrolhos	48	11	-	59	14	-
	Argo-Rowley Terrace	80	12	-	51	15	-
	Carnarvon Canyon	118	17	2	125	22	2
	Dampier	225	4	2	159	5	2
	Gascoyne	484	89	24	508	100	27
	Jurien	11	1	-	11	1	-
	Montebello	1718	92	92	1731	100	100
	Ningaloo	400	79	11	504	94	26
	Perth Canyon	15	2	-	23	2	-
	Shark Bay	56	14	-	72	21	-
	Two Rocks	10	-	-	10	1	-
EEZ	Australian EEZ	14805	92	92	14678	100	100
FHPA	Abrolhos Islands	20	1	-	23	2	-
IBRA	Cape Range	606	91	44	530	100	58
	Geraldton Hills	18	1	-	23	1	-
	Perth	8	-	-	11	1	-
	Roebourne	223	66	7	316	74	13
IMCRA	Abrolhos Islands	20	1	-	23	2	-
	Central West Coast	26	2	-	26	3	-
	Leeuwin-Naturaliste	11	1	-	14	1	-
	Ningaloo	441	86	15	518	98	33
	Northwest Shelf	4050	92	92	4351	100	100
	Pilbarra (nearshore)	376	27	3	260	35	4
	Pilbarra (offshore)	14805	92	92	14678	100	100
	Zuytdorp	61	15	-	79	22	-
KEF	Ancient coastline at 125 m depth contour	1411	92	88	1311	100	98
	Ancient coastline at 90-120m depth	20	1	-	25	2	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	490	88	17	618	99	31
	Commonwealth marine environment surrounding the Houtman Abrolhos Islands	18	1	-	20	2	-

0-10 m Depth Layer		Unmitigated			Mitigated		
		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure	
	Receptor		Low	High		Low	High
	Commonwealth marine environment within and adjacent to the west coast inshore lagoons	10	-	-	11	1	-
	Commonwealth waters adjacent to Ningaloo Reef	400	79	11	504	94	26
	Continental Slope Demersal Fish Communities	1152	92	77	1294	100	93
	Exmouth Plateau	471	89	21	510	99	21
	Glomar Shoals	868	58	34	829	56	36
	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	21	3	-	11	1	-
	Perth Canyon and adjacent shelf break, and other west coast canyons	20	2	-	23	3	-
	Wallaby Saddle	48	10	-	52	13	-
	Western demersal slope and associated fish communities	55	9	-	60	16	-
	Western rock lobster	20	1	-	25	3	-
MMA	Barrow Island	408	91	47	514	100	69
	Muiron Islands	235	65	8	312	85	16
MP	Barrow Island	278	86	28	460	96	35
	Jurien Bay	12	1	-	11	1	-
	Montebello Islands	924	92	85	1182	100	96
	Ningaloo	265	60	7	359	77	13
	Rowley Shoals	21	3	-	10	1	-
NR	Great Sandy Island	83	7	-	59	7	-
	Thevenard Island	152	48	2	151	54	3
RSB	Barrow Island Reefs and Shoals	83	7	-	59	9	-
	Baylis Patches	41	9	-	35	10	-
	Bennett Shoal	13	2	-	20	7	-
	Beryl Reef	20	3	-	29	6	-
	Brewis Reef	107	33	1	95	42	-
	Exmouth Reef	22	10	-	43	12	-
	Glomar Shoal	176	29	8	363	29	9
	Herald Reef	27	3	-	31	6	-
	Lightfoot Reef	11	2	-	15	4	-
	Locker Reef	63	12	-	71	16	-
	Madeleine Shoals	117	3	1	101	4	2
	Manicom Bank	35	7	-	43	9	-

0-10 m Depth Layer		Unmitigated			Mitigated		
		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure		Maximum entrained hydrocarbon exposure (ppb)	Probability of hydrocarbon exposure	
	Receptor		Low	High		Low	High
	Meda Reef	7	-	-	10	1	-
	Montebello Shoals	246	85	8	377	99	24
	Ningaloo Reef	252	52	4	314	67	12
	Paroo Shoal	33	12	-	42	16	-
	Penguin Bank	224	76	9	195	90	14
	Rankin Bank	379	90	25	295	95	35
	Ripple Shoals	219	20	3	133	30	1
	Rosily Shoals	130	73	4	160	83	7
	Tongue Shoals	77	10	-	91	12	-
	Tryal Rocks	943	92	91	1019	100	100
	Ward Reef	25	5	-	24	9	-
	Weeks Shoal	44	9	-	46	16	-
	West Reef	16	5	-	22	4	-
State Waters	Western Australia State Waters	959	92	86	1182	100	98

Appendix 3. Sensitive Information Document

Appendix 3 consists of consultation records and has been removed from published version of document in accordance with NOPSEMA Environment Plan Assessment Policy (N-04750-PL1347 A662608).

Appendix 4. Response Strategy Performance Standards

CRITICAL PROCEDURE PERFORMANCE STANDARD

VERMILION

TITLE:	ELEMENT 8 – OIL SPILL RESPONSE		
CODE:	WAN-WNAB-CP-ER-02 and WAN-WNAB-CP-ER-03	**RESPONSIBLE**	Ryan Carty
GOAL:	To mitigate the environmental impacts as a result of oil spill.		
OBJECTIVE:	To ensure that measures are in place to mitigate the oil spill hazards associated with activities within the Wandoo Field.		
MAEs & CEEs:	All CEEs		
SCOPE:	**Inclusions:** • Covers oil spill response arrangements for all activities within the Wandoo Field. **Exclusions:** • Excludes environmental impacts addressed in the Wandoo Facility Environment Plan [WPA-7000-YH-0007] associated with: ○ drilling, completions and well interventions, e.g. new wells; ○ construction/installation, e.g. tie-in of new wells or subsea infrastructure; ○ facility and subsea production system modifications; and ○ field decommissioning and abandonment.		

FUNCTIONALITY

Key Component	Key Requirement	Performance Criteria	Assurance Activity	Reference
WAN-WNAB-CP-ER-02-01 OSR Arrangements	The Wandoo Field OSCP is established to mitigate the oil spill hazards identified in the respective environment plan.	• The Wandoo Field OSCP reflects the credible oil spill hazards (volume, duration and potential impact) associated with petroleum activities as outlined within the respective environment plan. • The Wandoo Field OSCP considers oil spill hazards within the context of the seasons for which the petroleum activity occurs, as described in the environment plan. • All oil spill hazards identified in the environment plan are covered by an oil pollution plan (OPP) within the Wandoo Field OSCP.	• Accepted Wandoo Field OSCP [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]
	Response strategies provided in the OPPs are appropriate to: • the nature and scale and associated environmental impact of the potential spill hazards; • the nature and scale and associated environmental impact of the potential spill response strategies; and • the environmental sensitivities and priorities as outlined within the respective environment plan.	• Response strategies described in the OPPs shall take into consideration the range of potential impacts from the spill events including: ○ minimum time to contact; ○ maximum length of shoreline contacted; ○ maximum volume of oil ashore; ○ geographical range of the trajectory of oil; and ○ environmental sensitivities as outlined within the respective environment plan and their prioritisation based on recovery rates and uniqueness.	• Accepted Wandoo Field OSCP [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]
		• The OPPs shall take into consideration the range of potential impacts from the identified response strategies including: ○ the range of potential impact and recovery time for the environmental sensitivities; ○ measures to reduce, manage or monitor environmental impact from the response as outlined within the respective environment plan; and ○ event/ scenario specific environmental impact assessment of the spill and response activities prior to site implementation via Net Environmental Benefit Analysis.	• Accepted Wandoo Field OSCP [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]
	The Wandoo Field OSCP describes incident management system and interfaces.	• Organisational structure and roles and responsibilities of Incident Control Team (ICT) members are defined in the Wandoo Field OSCP. • Interfaces between the VOGA ICT and the command teams representing State and Commonwealth Oil Spill Response Agencies are described in the Wandoo Field OSCP.	• Accepted Wandoo Field OSCP [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]
	Decision making processes support mitigation of environmental impact of spills and assessment of effectiveness of response strategies.	• The Wandoo Field OSCP shall provide a process for completing an Incident Action Plan (IAP) which shall include: ○ an environmental impact assessment of the proposed response activities; ○ selection of the most appropriate response activities (strategies); ○ identification of appropriate operational and scientific monitoring activities; and ○ operational and scientific monitoring outputs shall inform the effectiveness of response strategies.	• Accepted Wandoo Field OSCP [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]
	The Wandoo Field OSCP shall contain processes to assess, test and maintain arrangements to meet the Wandoo Field OSCP outcomes through:	• Regular inspections and audits to ensure arrangements outlined shall be in place. • Response requirements for equipment and personnel shall be assessed throughout the duration of a worst case spill event response.	• Inspections of third party providers undertaken in accordance with the Wandoo Field OSCP Part 3: Performance Management [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]

FUNCTIONALITY				
Key Component	**Key Requirement**	**Performance Criteria**	**Assurance Activity**	**Reference**
	• assurance processes; • capability assessment; and • review triggers.	• Oil spill response exercises shall: ○ provide situational experience to ICT personnel and enabling them to be aware of their assigned roles and responsibilities during a response; ○ assesses the effectiveness, achievability and timeliness of incident action planning for the duration of expected response; and ○ test interfaces between teams and deployment of equipment and resources.	• Oil spill response exercises shall be undertaken in accordance with Table 8-2 of the Wandoo Field OSCP [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]
		• The Wandoo Field OSCP shall identify review triggers linked to significant changes to spill risk profile and availability of equipment and personnel required within the OPPs.	• Accepted Wandoo Field OSCP [WAN-2000-RD-0001].	• Wandoo Field OSCP [1]
WAN-WNAB-CP-ER-02-02 Resources defined and available in a timely manner	Equipment, services and personnel required for the first 20 days are identified within the OPPs.	• Training and competency requirements of key response personnel and contractors shall be defined. • Capability assessment shall be conducted to ensure the availability of equipment and personnel within the desired timeframe.	• Accepted Wandoo Field OSCP [WAN-2000-RD-0001]. • Oil Spill Response Capability Review [VOG-7000-RH-0009] contains up-to-date capability assessment of equipment and personnel.	• Wandoo Field OSCP [1] • Oil Spill Response Capability Review [2]
	A logistics management plan is in place to inform deployment of resources in a timely manner.	• A logistics management plan for oil spill response shall identify resources and activation procedures to ensure a timely activation.	• Emergency Response Logistics Management Plan [VOG-7000-RH-0008].	• Emergency Response Logistics Management Plan [VOG-7000-RH-0008]
	Contracts are established for equipment and services for the full duration of a response.	• Contracts must be established for the full duration of a response if: ○ services are required to be utilised during the first 20 days of proposed response activities; or ○ the contract is deemed to take longer than 20 days to initiate following a spill.	• Signed third party provider contracts.	• HSEMS Element 12 – Performance Assessment Manual [3]
WAN-WNAB-CP-ER-03-01 Response strategy - Monitor and evaluate	Ensure the most effective response strategies are being applied and environmental impact of the spill and response strategies are measured.	• Monitoring shall be activated from time of spill detection to inform implementation of response strategies. • Platform observations commence immediately following the detection of a spill. • Visual observations from chartered vessel to be mobilised immediately following the detection of a spill. • Aerial observations to be initiated within 2 hours of spill being reported (daylight only). • Satellite imagery to be initiated within 2 hours of a spill being reported. • Preliminary Oil Spill Trajectory Modelling (OSTM) to be requested within 3 hours of a spill been reported. • Satellite tracking buoys to be deployed within 30 minutes of a spill being reported. • Tracking buoys data will be monitored and interrogated at least once every 24 hours. • OSTM to continue until the termination criteria is met. • Operational monitoring shall be available to inform IAP process prior to implementation of strategies that have an environmental impact (e.g. dispersant application). • Environmental data to support decision making (IAP) and spill impact assessment shall be available prior to impact. • Shoreline Clean-up Assessment Technique (SCAT) teams will complete surveys before clean-up teams complete assignments so that priority locations are identified and suitable techniques are used.	• Oil Spill Response Capability Review [VOG-7000-RH-0009] contains up-to-date capability assessment of equipment and personnel. • Inspections of third party providers undertaken in accordance with the Wandoo Field OSCP Part 3: Performance Management [WAN-2000-RD-0001]. • IAP records.	• Oil Spill Response Capability Review [2] • HSEMS Element 12 – Performance Assessment Manual [3] • Wandoo Field OSCP [1]
WAN-WNAB-CP-ER-03-02 Response Strategy - Chemical dispersant application	Increase the rate of biodegradation to reduce the environmental impact from surface oil and oil stranding on shoreline sensitivities.	• Dispersant application (aerial and marine) shall be available to be deployed when Wandoo Crude is most amenable to dispersant for the most effective results. • Aerial and marine dispersant will be available to be applied within 36 hours. • Establish an aerial marine operating base and within 24 hours. • Marine dispersant will be available to be applied within 36 hours. • Establish a marine operating base within 24 hours. • Use of the most effective chemical dispersant to treat Wandoo Crude. • Sufficient dispersant shall be available to be applied within the dispersant application zone.	• Dispersant efficacy testing results on Wandoo Crude. • Oil Spill Response Capability Review [VOG-7000-RH-0009] contains up-to-date capability assessment of equipment and personnel. • Inspections of third party providers undertaken in accordance with the Wandoo Field OSCP Part 3: Performance Management [WAN-2000-RD-0001]	• Oil Spill Response Capability Review [2] • HSEMS Element 12 – Performance Assessment Manual [3]
	Minimise environmental impacts associated with dispersant application.	• At no time shall dispersant be applied: ○ in waters shallower than 20m (lowest astronomical tide); ○ within exclusion zones for offshore facilities; ○ within a marine park boundary; and ○ within State waters without approval from the State Environmental Scientific Coordinator.	• IAP records.	• Wandoo Field OSCP [1]
WAN-WNAB-CP-ER-03-03 Response strategy - Mechanical dispersant application	Assist natural dispersion of oil into the water column to reduce environmental impact from surface oil.	• Mechanical dispersion is a secondary strategy that will be used opportunistically based on IAP outcomes.	• IAP records.	• Wandoo Field OSCP [1]
	Minimise environmental impacts associated with mechanical dispersant activities.	• Mechanical dispersion shall only be undertaken in water deeper than 20m.	• IAP records.	• Wandoo Field OSCP [1]

FUNCTIONALITY				
Key Component	Key Requirement	Performance Criteria	Assurance Activity	Reference
WAN-WNAB-CP-ER-03-04 Response strategy - Containment and recovery	Reduce overall volume of surface oil to minimise impacts to environmental sensitivities.	• Containment and recovery to be implemented within 72 hours if the data collected through monitoring and evaluation suggests: ○ the slick is moving toward a sensitive receptor and unable or unsuitable to be dispersed; ○ sea state and weather conditions allow effective boom and skimmer deployment; ○ the weathered oil is able to be recovered with skimmers; and ○ a safe operating environment for responders. • Equipment available for containment and recovery will be suitable for the hydrocarbon type, and access to equipment will be maintained. • Waste storage and transport plan will be developed within 72 hours of the spill event. • Temporary waste storage equipment and arrangements will be maintained.	• Oil Spill Response Capability Review [VOG-7000-RH-0009] contains up-to-date capability assessment of equipment and personnel. • Inspections of third party providers undertaken in accordance with the Wandoo Field OSCP Part 3: Performance Management [WAN-2000-RD-0001]. • IAP records.	• Oil Spill Response Capability Review [2] • HSEMS Element 12 – Performance Assessment Manual [3] • Wandoo Field OSCP [1]
	Minimise environmental impacts associated with improperly deployed equipment.	• Deployments shall be undertaken by trained incident response personnel.	• IAP records.	• Wandoo Field OSCP [1]
WAN-WNAB-CP-ER-03-05 Response strategy - Protection and deflection	Minimise environmental impacts to priority near-shore environmental sensitivities by reducing oil contact.	• Protection and deflection equipment and resources required to be deployed to protection priorities on-site within 48 hours of Category D, E and F spill event. • Equipment available for protection and deflection will be suitable for the hydrocarbon type, and access to equipment will be maintained.	• Oil Spill Response Capability Review [VOG-7000-RH-0009] contains up-to-date capability assessment of equipment and personnel. • Inspections of third party providers undertaken in accordance with the Wandoo Field OSCP Part 3: Performance Management [WAN-2000-RD-0001]. • IAP records.	• Oil Spill Response Capability Review [2] • HSEMS Element 12 – Performance Assessment Manual [3] • Wandoo Field OSCP [1]
	Minimise environmental impacts associated with improperly deployed equipment.	• Deployments shall be undertaken by trained incident response personnel. • A gap analysis of available tactical response plans from titleholders and agencies against VOGA priority areas will be undertaken and potential cooperative arrangements will be investigated in 2017. • Tactical response plans will be available for VOGA priority shorelines outlining favourable equipment deployment locations during 2018.	• IAP records. • Tactical response plans for priority shorelines.	• Wandoo Field OSCP [1]
	Minimise impact to fauna from oil spill response activities.	• Protection and deflection booms shall only be installed after consultation with the Department of Transport and consideration of the sensitive receptors outlined in the environment plan.	• IAP records.	• Wandoo Field OSCP [1]
WAN-WNAB-CP-ER-03-06 Response strategy - Shoreline clean-up	Remove stranded hydrocarbons from shorelines without causing greater environmental impact than leaving the hydrocarbons in-situ.	• Equipment for shoreline clean-up tasks that are suitable for environment and hydrocarbon type are available. • Shoreline clean-up resources can be deployed to protection priorities within 72 hours. • Shoreline clean-up resources will be available within the first three days, consisting of three teams made up of one shoreline team leader and ten shoreline workers. • Shoreline teams will be informed of how to minimise damage to flora and avoid encounters with fauna. • SCAT teams will complete surveys before clean-up teams complete assignments so that priority locations are worked on and suitable techniques are used. • Shoreline clean-up will implement a three-stage methodology: ○ Emergency phase – collection of oil floating close to the shore and pooled bulk oil removal. ○ Project phase – removal of stranded oil and oiled shoreline material that cannot be cleaned in-situ. ○ Polishing phase – final clean-up of light oil contamination and removal of oil stains, where the incident Net Environmental Benefit Analysis demonstrates this is necessary. • Waste storage and transport plan will be developed within 72 hours of the spill event. • Temporary waste storage equipment and arrangements will be maintained.	• Oil Spill Response Capability Review [VOG-7000-RH-0009] contains up-to-date capability assessment of equipment and personnel. • Inspections of third party providers undertaken in accordance with OSCP Part 3: Performance Management [WAN-2000-RD-0001]. • IAP records.	• Oil Spill Response Capability Review [2] • HSEMS Element 12 – Performance Assessment Manual [3] • Wandoo Field OSCP [1]
	Minimise impact to key shoreline habitats associated with shoreline clean-up activities.	• A shoreline assessment form shall be developed and implemented in consultation with appropriate stakeholders and shall detail controls to minimise environmental impacts. • Sorbents shall not be used for shoreline clean-up on high energy shorelines. • Mechanical removal and high pressure flushing shall not be undertaken in mangrove areas. • Water from high pressure flushing shall not be directed in between rocks and onto sediment. • Steam cleaning shall not be undertaken on surfaces that support living plants or animals. • A gap analysis of available tactical response plans from titleholders and agencies against VOGA priority areas will be undertaken and potential cooperative arrangements will be investigated in 2017. • Tactical response plans will be available for VOGA priority shorelines outlining potential clean-up methodologies and waste collection requirements during 2018.	• Completed shoreline assessment form. • IAP records. • Tactical response plans for priority shorelines.	• Wandoo Field OSCP [1]
WAN-WNAB-CP-ER-03-07 Response strategy - Oiled wildlife response	Minimise and mitigate the number of wildlife oiled following a spill.	• Resources for oiled wildlife response activities have been planned for a Level 6 Oiled Wildlife Response. • First strike response kits are activated within 24 hours. • Two oiled wildlife response containers are mobilised to an oiled wildlife response facility location in Dampier within 24 hours. • An Oiled Wildlife Advisor and Wildlife Division Coordinator are activated and assigned to the ICT once the Western Australian Oiled Wildlife Response Plan is activated. • Information contained in POWRP and NEBA is ground truthed. • IAP wildlife sub-plan developed within 48 hours. • Wildlife rescue and staging are developed within 72 hours.	• Oil Spill Response Capability Review [VOG-7000-RH-0009] contains up-to-date capability assessment of equipment and personnel. • Inspections of third party providers undertaken in accordance with OSCP Part 3: Performance Management [WAN-2000-RD-0001]. • IAP records.	• Oil Spill Response Capability Review [2] • HSEMS Element 12 – Performance Assessment Manual [3] • Wandoo Field OSCP [1]

FUNCTIONALITY

Key Component	Key Requirement	Performance Criteria	Assurance Activity	Reference
	Minimise potential impacts on fauna caused by oiled wildlife response activities.	• Induction and training shall cover any special handling requirements to minimise further detrimental impacts to flora and fauna. • Wildlife strategy including hazing, if required, shall be developed in consultation with the Department of Transport.	• Oiled wildlife response induction material. • IAP records.	• Wandoo Field OSCP [1]

EFFECTIVENESS

Key Component	Key Requirement	Performance Criteria	Assurance Activity	Reference
WAN-WNAB-CP-ER-01-04 Arrangements are accessible	Current oil spill response arrangements are accessible to all personnel in the event of an oil spill	• Oil spill response documentation is up to date, maintained and readily available within VOGA Information Systems. • Copies of the Wandoo Field OSCP are available.	• HSEMS audits of Element 8 are conducted in accordance with the HSEMS Element 12 – Performance Assessment Manual [VOG-1100-YG-1201].	• HSEMS Element 12 – Performance Assessment Manual [3]
WAN-WNAB-CP-ER-01-05 Arrangements are understood	Oil spill response personnel understand and competently perform their response roles	• Drills and exercises shall be carried out to review the effectiveness of the plan. • Oil spill response personnel are competent in their required emergency response roles. • All personnel with roles within the Corporate Command Team, ICT and On Site Command Team have training appropriate to their roles. • All training courses and participation in drills and exercises are recorded in training records.	• Exercises conducted in accordance with VOGA Emergency Response Schedule [VOG-1100-YH-0001]. • HSEMS audits of Element 8 are conducted in accordance with the HSEMS Element 12 – Performance Assessment Manual [VOG-1100-YG-1201]. • Inspections of third party providers in accordance with Wandoo Field OSCP Part 3: Performance Management [WAN-2000-RD-0001].	• Emergency Response Schedule [4] • Platform Operations Manual – Emergency Drill Guidelines [5] • HSEMS Element 12 – Performance Assessment Manual [3] • Wandoo Field OSCP [1]

INTERDEPENDENCY

Control Measure	Input / Output	Explanation
WAN-WNAB-CP-ALL-01 Training and Competency	Input	Personnel are competent to perform their emergency response roles
WAN-WNAB-CP-ER-01 Emergency Preparedness, Management and Response	Input	To define the wider emergency response requirements
WAN-WNAB-CE-ES-02 Emergency Communications	Input	To permit relaying of emergency instructions and coordination of emergency response actions

DOCUMENT REFERENCES

Ref	Document No.	Document Title
[1]	WAN-2000-RD-0001	Wandoo Field OSCP
[2]	VOG-7000-RH-0009	Oil Spill Response Capability Review
[3]	VOG-1100-YG-1201	HSEMS Element 12 – Performance Assessment Manual
[4]	VOG-1100-YH-0001	Emergency Response Schedule
[5]	VOG-7000-MN-0001 - WNB-000-001	Platform Operations Manual – Emergency Drill Guidelines

DOCUMENT CONTROL HISTORY

Revision	Description	Comments	Date
A	Issued for review	Initial issue	12 January 2016
0	Issued for use	Issued for use	8 February 2016
1	Issued for use	Issued for use	21 July 2017

APPROVALS

Role	Name	Signature	Date
HSES Advisor	N. Jivan	ORIGINAL SIGNED	ORIGINAL SIGNED
Environmental Advisor	M. Johnson	ORIGINAL SIGNED	ORIGINAL SIGNED
Operations Manager	R. Carty	ORIGINAL SIGNED	ORIGINAL SIGNED