# SASANOF-1 EXPLORATION DRILLING

# ENVIRONMENT PLAN

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# DOCUMENT INFORMATION

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# TABLE OF CONTENTS

## Contents

**FIGURES**

**TABLES**

# ACRONYMS

| Abbreviation | Description |
|---|---|
| °C | Degrees Celsius |
| cui | Cubic Inches |
| " | Inch |
| µ | Micron |
| µm | Micrometre |
| µPa | Micropascal |
| ABARES | Australian Bureau of Agricultural and Resource Economics and Sciences |
| ADIOS | Automated Data Inquiry for Oil Spills |
| AFMA | Australian Fisheries Management Authority |
| AFZ | Australian Fishing Zone |
| AGR | AGR Australia Pty Ltd |
| AHS | Australian Hydrographic Service |
| AHSV | Anchor Handling Supply Vessel |
| ALARP | As low as reasonably practicable |
| AMBA | Area that may be affected |
| AMOSC | Australian Marine Oil Spill Centre |
| AMP | Australian Marine Park |
| AMSA | Australian Maritime Safety Authority |
| APASA | Asia-Pacific Applied Science Associates |
| API | American Petroleum Institute |
| APPEA | Australian Petroleum Production and Exploration Association |
| AS/NZS | Australian Standard/New Zealand Standard |
| BACI | Before-After-Control-Impact |
| bbl | Barrels |
| BHA | Bottom Hole Assembly |
| BIA | Biologically important area |

| Abbreviation | Description |
|---|---|
| BML | Below mud level |
| BOEM NLO | Bureau of Ocean Energy Management notices to Lessees and Operators |
| BOP | Blow out preventer |
| BPMF | Broome Prawn Managed Fishery |
| AHSVs | Anchor handling support vessels |
| APPEA | Australian Petroleum Production and Exploration Association |
| API | American Petroleum Institute |
| AS/NZS | Australian Standard/ New Zealand Standard |
| BACI | Before-After-Control-Impact |
| bbl | Barrel (units of oil) |
| BoM | Bureau of Meteorology |
| dB | Decibel |
| chl a | chlorophyll-a |
| cm | Centimetre |
| CM | Control measure |
| CMT | Crisis Management Team |
| $CO_2$ | Carbon dioxide |
| COLREGS | International Regulations for Preventing Collisions at Sea |
| cP | Centipoise |
| CSS | Capping Stack System |
| DAWE | Department of Agriculture, Water and the Environment |
| DEWHA | Department of the Environment, Water, Heritage and the Arts |
| DAWR | Department of Agriculture and Water Resources |
| DDR | Daily Drilling Report |

| Abbreviation | Description |
|---|---|
| DMC | Drilling Management Contractor |
| DMP | Department of Mines and Petroleum (WA) |
| DNP | Department of National Parks |
| DNV | Det Norske Veritas |
| DEE | Department of the Environment and Energy (formerly the Department of Environment) |
| DIMT | Drilling Incident Management Team |
| DoT | Department of Transport (Western Australia) |
| DP | Dynamic positioning |
| DPAW | Department of Parks and Wildlife (Western Australia) |
| DPIRD | Department of Primary Industries and Regional Development – Fisheries (Western Australia) (Previously Department of Fisheries). |
| DSEWPC | Department of Sustainability, Environment, Water, Population and Communities |
| EEZ | Economic exclusion zone |
| EHS | Environment, Health and Safety |
| EHSMS | Environment, Health and Safety management System |
| EMBA | Environment that May be Affected |
| ENVID | Environmental impact identification |
| EP | Environment Plan, prepared in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 |
| EPBC Act | Environment Protection and Biodiversity Conservation Act 1999 |
| EPO | environmental performance outcomes |

| Abbreviation | Description |
|---|---|
| EPS | environmental performance standards |
| ERP | Emergency Response Plans |
| ERC | Emergency Response Coordinator |
| ESD | Ecological Sustainable Development |
| FE | Formation Evaluation |
| FPSO | Floating Production Storage and Offloading |
| $g/m^2$ | Grams per square metre |
| GHG | Greenhouse gases |
| GLE | Green Light Environmental |
| GPS | Global positioning system |
| Ha | Hectare |
| HEA | Hydrocarbon Exposure Area |
| hr | Hour |
| HSE | Health, Safety and Environment |
| Hz | Hertz |
| IAP | Incident Action Plan |
| IAPP | International Air Pollution Prevention |
| IBC | Intermediate bulk container |
| IMCRA | Interim Marine and Coastal Regionalisation for Australia |
| IMO | International Maritime Organisation |
| IMP | Incident Management Plan |
| IMS | Invasive marine species |
| IMT | Incident Management Team |
| IAP | Incident Action Planning |
| IOGP | International Oil and Gas Producers |
| IOT | Indian Ocean Territories |
| IOPP | International Oil Pollution Prevention |
| ISO | International Standards Organization |

| Abbreviation | Description |
|---|---|
| ITF | Indonesian Throughflow |
| ITOPF | International Tanker Owners Pollution Federation Ltd |
| IUCN | International Union for Conservation of Nature |
| JHA | Job hazard analysis |
| JPDA | Joint Petroleum Development Area |
| JSA | Job safety analysis |
| KEF | Key ecological feature |
| kg | Kilogram |
| km | Kilometre |
| kHz | Kilohertz |
| km | Kilometre |
| L | Litre |
| LCM | Lost circulation materials |
| LEL | Lower explosive limit |
| LNG | Liquid nitrogen gas |
| LoR | Limit of reporting |
| LOWC | Loss of well control |
| LWD | Logging while Drilling |
| m | Metre |
| $m^2$ | Square metre |
| $m^3$ | Metres cubed |
| mg/L | Milligrams per litre |
| m/s and m $s^{-1}$ | Metres per second |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MC | Measurement criteria |
| MDO | Marine diesel oil |

| Abbreviation | Description |
|---|---|
| MES | Monitoring, Evaluation and Surveillance |
| MFO | Marine Fauna Observer |
| mm | Millimetre |
| MNES | matters of national environmental significance |
| MO | Marine Orders |
| MODU | Mobile Offshore Drilling Unit |
| MOU | Memorandum of Understanding |
| MP | Marine Park |
| MPA | Marine protected area |
| MS | Method statement |
| MWD | Measurement while Drilling |
| N/A | Not applicable |
| NBPMF | Nickol Bay Prawn Managed Fishery |
| NCB | Northern Carnarvon Basin |
| NE | North east |
| NEBA | Net environmental benefit analysis |
| NEPM | National Environment Protection Measure |
| nm | Nautical mile is a unit of distance equal to 1,852 metres |
| NMFS | National Marine Fisheries Service |
| NNW | North-north west |
| NW | North west |
| NWMR | North-west Marine Region |
| NWSTF | North West Slope Trawl Fishery |
| NOAA | National Oceanic and Atmospheric Administration |
| NOPSEMA | National Offshore Petroleum Safety and Environmental Management Authority |

| Abbreviation | Description |
|---|---|
| NRC | National Research Council |
| NSF | National Science Foundation |
| NT | Northern Territory |
| NWS | North west shelf |
| OCS | Offshore Constitutional Settlement |
| ODME | Oil Discharge Monitoring Equipment |
| ODS | Ozone-depleting substances |
| OWS | Oily water separator |
| OGUK | Oil and Gas UK |
| OIM | Offshore Installation Manager |
| OPEP | Oil pollution emergency plan |
| OPGGS | Offshore Petroleum and Greenhouse Gas Storage |
| OPGGS(E)R | Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) |
| OPMF | Onslow Prawn Managed Fishery |
| OSC | Operations Sections Chief |
| OSMP | Operational and Scientific Monitoring Plan |
| OSPAR | Oslo and Paris Commission |
| OSRL | Oil Spill Response Limited |
| OSTM | Oil spill trajectory modelling |
| OWR | Oiled wildlife response |
| OWS | Oily Water Separator |
| pa | Pascal (unit of pressure) |
| P&A | Plug and abandon |
| PAH | Polycyclic aromatic hydrocarbon |
| PMS | Preventative maintenance system |
| PMST | Protected Matters Search Tool |
| PNEC | Predicted No Effect Concentration |

| Abbreviation | Description |
|---|---|
| POB | Persons on board |
| ppb | Parts per billion |
| PPE | Personal protection equipment |
| ppm | Parts per million |
| PPS | Precise Positioning Service |
| PSVs | Platform support vessels |
| PSZ | Petroleum safety zone |
| PTS | Permanent threshold shift |
| QA/QC | Quality Assurance / Quality Control |
| RAAF | Royal Australian Air Force |
| RAMSAR | Convention on Wetlands of International Importance |
| RMS | Root mean squared |
| RO | reverse osmosis |
| ROV | Remotely operated vehicle |
| ROC | Retained Oil Cuttings |
| RCC | Rescue Coordination Centre |
| SAG | Scientific Advisory Group |
| SAP | Sampling and analysis plan |
| SBM | Synthetic-based mud |
| SBTF | Southern Bluefin Tuna Fishery |
| SC | Safety Case |
| SCERP | Source Control Emergency Response Plan |
| SCR | Safety Case Revision |
| SECP | Safety and Environmentally Critical Positions |
| SEL | Sound exposure level |
| SEEMP | Ship Energy Efficiency Management Plan |

| Abbreviation | Description |
|---|---|
| SIMAP | Spill Impact Mapping and Analysis Program |
| SMIP | Scientific Monitoring Implementation Plan |
| SMPEP | Shipboard Marine Pollution Emergency Plan |
| SOLAS | Safety Of Life At Sea |
| SOPEP | Shipboard Oil Pollution Emergency Plan |
| SPL | Sound pressure level |
| SWMR | South West Marine Region |
| SSW | South-south west |
| TL | Technical Lead |
| TPHs | Total Petroleum Hydrocarbons |
| TSSC | Threatened Species Scientific Committee |
| TTS | Temporary threshold shift |
| TVD | True vertical depth |
| UNCLOS | United Nations Law of the Sea Convention |
| VHF | Very High Frequency |
| VOC | Volatile organic compounds |
| VSP | Vertical seismic profiling |
| WA | Western Australia |
| WG | Western Gas |
| WGCT | Western Gas Crisis Team |
| WBM | Water-based mud |
| WCD | Worst Case Discharge |
| WDCS | Whale and Dolphin Conservation Society |
| WDP | Well Delivery Process |
| WDTF | Western Deepwater Trawl Fishery |

| Abbreviation | Description |
|---|---|
| WHA | World Heritage Area |
| WOMP | Well Operations Management Plan |
| WSOG | Well Specific Operating Guidelines |
| WSTF | Western Skipjack Tuna Fishery |
| WTBF | Western Tuna and Billfish Fishery |

# 1 INTRODUCTION

## 1.1 PROJECT OVERVIEW

Western Gas is planning to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth Waters in the Carnarvon Basin offshore Western Australia (Figure 1-1).

Drilling will be undertaken using a Mobile Offshore Drilling Unit (MODU) and is planned to commence in Q1/Q2 2022. Drilling activities are expected to take approximately 25 days.

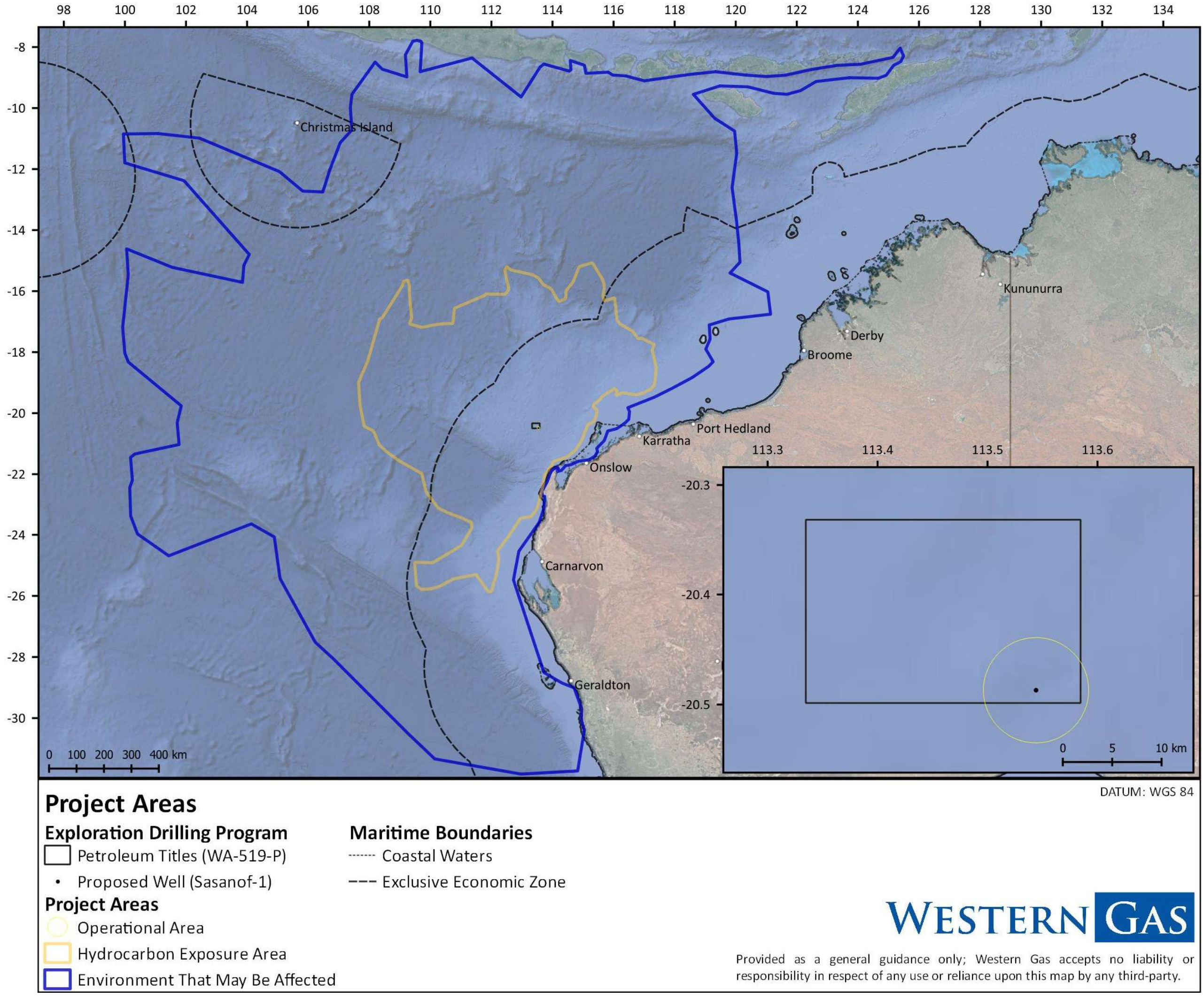



**Figure 1-1 Location of Exploration Permit WA-519-P and Sasanof-1 well**

## 1.2 ENVIRONMENT PLAN SUMMARY

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

**Table 1-1: Sasanof-1 Exploration Drilling EP Summary**

| EP Summary Material Requirement | Relevant Section of EP Containing EP Summary Material |
|---|---|
| The location of the activity | Section 3.1.1 |
| A description of the receiving environment | Section 5 |
| A description of the activity | Section 3 |
| Details of the environmental impacts and risks | Section 6 |
| The control measures for the activity | Section 6.6 |
| The arrangements for ongoing monitoring of the titleholder's environmental performance | Section 9.6, Section 9.8 and Section 9.9 |
| Response arrangements in the oil pollution emergency plan | Refer to OPEP |
| Consultation already undertaken and plans for ongoing consultation | Section 8 |
| Details of the titleholders nominated liaison person for the activity | Section 1.5.2 |

## 1.3 PURPOSE OF THIS ENVIRONMENT PLAN

This EP has been prepared in accordance with the OPGGS (Environment) Regulations for acceptance by NOPSEMA. This EP details the potential environmental impacts and risks associated with the Activity and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level through the application of mitigation and control measures. The EP provides an implementation strategy that will be used to measure and report on environmental performance during both routine and non-routine activities.

The EP has been prepared to enable compliance with the Western Gas Health, Safety and Environment Policy (Appendix A**: Western Gas Health, Safety and Environment Policy**) and all relevant legislation. This EP documents and considers all relevant stakeholder consultation performed during the planning of the Activity.

## 1.4 SCOPE

This EP describes the activities related to the drilling of the Sasanof-1 exploration well in exploration permit area WA-519-P. This comprises all activities undertaken within the Operational Area described in Section 3.1.2, from the time of anchoring the MODU until the time the last anchor is retrieved.

## 1.5 TITLEHOLDER DETAILS

Western Gas is a proud Western Australian company that's focused on timely, responsible resource development, providing local customers with secure, reliable and clean energy, and flow-on economic and social contributions for Western Australia. Western Gas is led by a senior management team comprising long-term petroleum professionals, with a strong track record in the delivery of large-scale gas development projects in Australia and internationally.

#### 1.5.1 Titleholder

Name: Western Gas (519 P) Pty Ltd

Business address: 330 Churchill Avenue, Subiaco, 6008

Telephone no: +61 (0) 8 6323 2311

Email: info@westerngas.com.au

ACN: 622 203 794

#### 1.5.2 Nominated Liaison Person

Name: Richard Barker

Business address: 330 Churchill Avenue, Subiaco, 6008

Telephone no: +61 (0) 8 6323 2311

Email: feedback@westerngas.com.au

In the event of a change in titleholder, nominated liaison person or contact details, Western Gas will submit the amended details to NOPSEMA referencing the EP document number and NOPSEMA reference.

### 1.6 RELATED DOCUMENTATION

This EP interfaces with a number of other plans including:

- WG-EHS-PLN-003 Oil Pollution Emergency Plan (OPEP) (submitted with this EP for acceptance)
- Sasanof-1 Drilling Program Operational and Scientific Monitoring Program (OSMP)
- MODU Safety Case (SC) and/or Safety Case Revision (SCR) (under preparation)
- WG-HSE-PLN-004 Emergency Response Plan (ERP)
- Specific MODU and Vessel Shipboard Marine Pollution Emergency Plan (SMPEP)

### 1.7 REQUIREMENTS

This section provides information on the requirements that apply to the activity. Requirements include relevant laws, codes, other approvals and conditions, standards, agreements, treaties, conventions or practices (in whole or part) that apply to jurisdiction that the activity takes place in.

The activity is in Commonwealth waters. Table 1-3 details the Commonwealth requirements and any codes or guidelines applicable to the activity, and Table 1-4 details the Recovery Plans, Threat Abatement Plans and Species Conservation Advices relevant to this activity.

Planned petroleum activities undertaken in this area are regulated by Commonwealth legislation, primarily under the Offshore Petroleum and Greenhouse Gas Storage (OPGGS) Act 2006 and associated regulations. Table 1-2 details the requirements of the OPGGS(E)R and OPGGS Act, and the corresponding section of this EP.

**Table 1-2 Requirements of the OPGGS(E) Regulations**

| OPGGS(E) Regulations | Description | Document Section |
|---|---|---|
| 13 (1) | A description of proposed activities | Section 3 |
| 13 (2) and (3) | A description of the existing environment including details of the particular relevant values and sensitivities (if any) of that environment that may be affected by the activity including details of matters of National Ecological Significance (NES) as outlined under Part 3 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). | Section 5 |
| 13 (4), 14 (10) | An overview of the environment legislation applicable to the proposed activities and a demonstration on how they are met. | Section 1.7 (this section) |
| 13 (5) and (6) | An identification and evaluation of environmental risks of described activities and details of control measures that will be used to reduce impacts and risks to As Low as Reasonably Practicable (ALARP) and an Acceptable level, for both planned and unplanned activities. | Section 6 |
| 13 (7) | The environmental performance outcomes, standards and measurement criteria that apply to both planned and unplanned activities. | Section 6.6 |
| 14 (1) and (2) | An appropriate implementation strategy including routine reporting arrangements to the Regulator in relation to environmental performance. | Section 9 |
| 14 (3) | A description of the environmental management system and measures to ensure that impacts and risks are continually identified and reduced, control measures are effective in reducing impacts and risks, and that performance outcomes and standards are being met to as low as reasonably practicable. | Section 9 |
| 14 (4) and (5) | Details of role and responsibilities of personnel in relation to implementation, management and review of this EP, including measures to ensure personnel are aware of their responsibilities | Section 9.2 |
| 14 (6), 26C | Details of monitoring, recording, auditing, management of non-conformance and review of environmental performance and the implementation strategy. | Section 9.6 |
| 14 (7) | Details of monitoring and maintenance of quantitative records for emissions and discharges. | Section 9.9 |
| 14 (8) | Details of the Oil Pollution Emergency Plan (OPEP), provision for its updating, inclusion of arrangements for monitoring and responding to oil pollution and details of testing of the plan. | Section 7 and Section 9.10 |
| 16(c), 26A and B | Details of reportable incidents in relation to the activity, procedures for reporting and notifying reportable and recordable incidents. | Section 9.6 |
| 11A, 14 (9) and 16 (b) | Details of stakeholder consultation that has been undertaken prior to, and during preparation of the EP, including all correspondence. | Section 8 |
| 15 (1), (2) and (3), | Details of the titleholder and an appropriate nominated liaison person, including arrangements for notifying the Regulator should this change. | Section 1.5 |
| 16 (a) | Details of the titleholders' environmental policy. | Appendix A |
| 25(a) | Details of titleholder notification requirements at end of activity. | Section 9.6 |

**Table 1-3: Summary of Requirements Relevant to the Activity**

| Requirement | Scope | Application to Activity | Administering Authority |
|---|---|---|---|
| *Australian Maritime Safety Authority Act 1990* | Facilitates international cooperation and mutual assistance in preparing and responding to major oil spill incidents and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. | In Commonwealth waters Australian Maritime Safety Authority (AMSA) is the Statutory Agency for vessels and must be notified of all incidents involving a vessel.<br>In Commonwealth waters AMSA is the Control Agency for all ship-sourced marine pollution incidents and will respond in accordance with its Marine Pollution Response Plan. | 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. | Provides requirements on how vessel operators should manage ballast water when operating within Australian seas to comply with the *Biosecurity Act 2015*. | Department of Agriculture, Water and the Environment (DAWE) |
| *Biosecurity Act 2015*<br>Biosecurity Regulations 2016 | The objects of this Act include the provision to manage risks related to ballast water and biosecurity emergencies. | 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.<br>For the activity it regulates vessels entering Australian territory regarding ballast water and hull fouling. | DAWE |
| *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) | The Act aims to:<br>• Protect matters of national environmental significance (MNES);<br>• Provides for Commonwealth environmental assessment and approval processes; and<br>• Provides an integrated system for biodiversity conservation and management of protected areas. | 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.<br>The EP must describe matters protected under Part 3 of the EPBC Act and assess any impacts and risks to these.<br>Section 5 describes matters protected under Part 3 of the EPBC Act.<br>The EP must assess any actual or potential impacts or risks to MNES from the activity. | DAWE |

| Requirement | Scope | Application to Activity | Administering Authority |
|---|---|---|---|
| | MNES are:<br>• World heritage properties;<br>• RAMSAR wetlands;<br>• Listed threatened species and communities;<br>• Migratory species under international agreements;<br>• Nuclear actions;<br>• Commonwealth marine environment;<br>• Great Barrier Reef Marine Park; and<br>• Water trigger for coal seam gas and coal mining developments.<br>The assessment process is overseen by NOPSEMA as the delegated authority under the EPBC Act. | Section 6 provides an assessment of any impacts and risks to matters protected under Part 3 of the EPBC Act. | |
| Environment Protection and Biodiversity Conservation Regulations 2000 | Part 8 of the regulations provide distances and actions to be taken when interacting with cetaceans. | The interaction requirements are applicable to the activity in the event that a cetacean is sighted and have been implemented as a control for vessels and helicopters as detailed in Section 6. | DAWE |
| *Underwater Cultural Heritage Act 2018*<br>*Underwater Cultural Heritage (Consequential and Transitional Provisions) Act 2018* | Protects the heritage values of Australia's shipwrecks, sunken aircraft and other types of underwater cultural heritage. | Anyone who finds the remains of a vessel or aircraft, or an article associated with a vessel or aircraft, needs to notify the relevant authorities, as soon as possible but ideally no later than after one week, and to give them information about what has been found and its location.<br>There are no historic shipwrecks, sunken aircraft or other known cultural heritage site or artefact near or within the Operational Area. | DAWE |

| Requirement | Scope | Application to Activity | Administering Authority |
|---|---|---|---|
| National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009 | The guidance document provides recommendations for the management of biofouling hazards by the petroleum industry. | Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species. | DAWE |
| *Navigation Act 2012* | Regulates international ship and seafarer safety, shipping aspects of protecting the marine environment and the actions of seafarers in Australian waters.<br>It gives effect to the relevant international conventions (MARPOL 73/78, COLREGS 1972) relating to maritime issues to which Australia is a signatory.<br>The Act also has subordinate legislation contained in Regulations and Marine Orders. | All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act.<br>Several Marine Orders (MO) are enacted under this Act which relate to offshore petroleum activities, including:<br>• MO 21: Safety of navigation and emergency procedures<br>• MO 30: Prevention of collisions<br>• MO 31: Vessel surveys and certification | AMSA |
| *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act)<br>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.<br>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. | 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:<br>Consistent with the principles of ecologically sustainable development as set out in section 3A of the EPBC Act.<br>So that environmental impacts and risks of the activity are reduced to ALARP and are of an acceptable level. | NOPSEMA |

| Requirement | Scope | Application to Activity | Administering Authority |
|---|---|---|---|
| | | Demonstration that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities are ALARP and acceptable is provided in Section 6. | |
| *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* | The Act aims to protect the marine environment from pollution by oil and other harmful substances discharged from ships in Australian waters. It also invokes certain requirements of the MARPOL Convention such as those relating to discharge of noxious liquid substances, sewage, garbage and air pollution.<br><br>Requires ships greater than 400 gross tonnes to have pollution emergency plans in place and provides for emergency discharges from ships. | All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act.<br><br>Several MOs are enacted under this Act relating to offshore petroleum activities, including:<br>• MO Part 91: Marine Pollution Prevention – Oil<br>• MO Part 93: Marine Pollution Prevention – Noxious Liquid Substances<br>• MO Part 94: Marine Pollution Prevention – Harmful Substances in Packaged Forms<br>• MO Part 95: Marine Pollution Prevention – Garbage<br>• MO Part 96: Marine Pollution Prevention – Sewage<br>• MO Part 97: Marine Pollution Prevention – Air Pollution<br>• MO Part 98: Marine Pollution Prevention – Anti-fouling Systems. | AMSA |
| *Protection of the Sea (Harmful Antifouling Systems) Act 2006* | The Act aims to protect the marine environment from the effects of harmful anti-fouling systems.<br><br>Under this Act, it is an offence to engage in negligent conduct that results in a harmful anti-fouling compound being applied to a ship.<br><br>This Act requires Australian ships to hold 'anti-fouling certificates', if they meet certain criteria. | All ships involved in offshore petroleum activities in Australian waters are required to abide to the requirements under this Act.<br><br>The M0 98: Marine Pollution Prevention – Anti-fouling Systems is enacted under this Act. | AMSA |

**Table 1-4: Recovery Plans, Threat Abatement Plans and Species Conservation Advices**

| Relevant Plan/Advice | Applicable Management Advice |
|---|---|
| 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.<br>**Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. |
| *National recovery plan for threatened albatrosses and giant petrels 2011-2016* | The overall objective of this recovery plan is to ensure the long-term survival and recovery of albatross and giant petrel populations breeding and foraging in Australian jurisdiction by reducing or eliminating human related threats at sea and on land.<br>**Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. |
| Recovery Plan for the White Shark (*Carcharodon carcharias*) | 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.<br>**Threats:**<br>• None identified. |
| Recovery Plan for Marine Turtles in Australia, 2017-2027 | 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.<br>**Threats:**<br>• Chemical and terrestrial discharge,<br>• Marine debris,<br>• Light pollution,<br>• Habitat modification,<br>• Vessel strike,<br>• Noise interference, |

| Relevant Plan/Advice | Applicable Management Advice |
|---|---|
| | • Vessel disturbance. |
| Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) | See above for Recovery Plan for Marine Turtles in Australia, 2017-2027. |
| Conservation Management Plan for the Blue Whale, 2015-2025 | 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.<br>**Threats:**<br>• **Noise interference:** Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented.<br>• **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.<br>**Threats:**<br>• **Noise disturbance**: Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented.<br>• **Vessel strike:** 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.<br>**Threats:**<br>• **Noise disturbance:** Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented.<br>• **Vessel strike**: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. |
| Approved Conservation Advice for *Megaptera novaeangliae* (Humpback Whale) | Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Humpback Whale.<br>**Threats:** |

| Relevant Plan/Advice | Applicable Management Advice |
|---|---|
| | • **Noise interference**: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented.<br>• **Vessel strike**: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. |
| Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (2018) | Threat abatement plans guides the implementation of actions where industry groups lead the implementation of a threat abatement plan.<br>**Action:**<br>• Improve shipping waste management. |
| National Light Pollution Guidelines for Wildlife including marine turtles, seabirds and migratory shorebirds (DAWE, 2020) | Guideline outlines the process to be followed where there is the potential for artificial lighting to affect wildlife.<br>**Provides:**<br>• Assessment Guidelines<br>• Best Practise Lighting Design Guidelines<br>• Light Auditing Guidelines<br>• Management measures for wildlife |
| National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Commonwealth of Australia, 2017a) | The overarching goal of the strategy is to provide guidance on understanding and reducing the risk of vessel collisions and the impacts they may have on marine megafauna. |

# 2 IMPACT AND RISK ASSESSMENT APPROACH

## 2.1 RISK ASSESSMENT AND MANAGEMENT SYSTEM FRAMEWORK

The Western Gas Health, Safety and Environment Management System (HSEMS) framework provides a risk-based methodology to manage environmental impacts and risks through their activities. This involves:

- Identification of environmental aspects and impacts / risks;
- Assessment of impacts and risks to receptors;
- Selection, implementation and maintenance of a structured system of controls; and
- Monitoring the effectiveness of the process and identifying areas for improvement.

## 2.2 ENVIRONMENTAL RISK ASSESSMENT METHODOLOGY

The Western Gas Environmental Risk Assessment Methodology considers impacts resulting from planned activities, and risks resulting from unplanned events, and assessed the potential impacts to receptors. The methodology evaluates the consequence of impacts associated with planned activities on receptors (Section 2.2.2), and the likelihood and consequence of risks associated with unplanned events on receptors (Section 2.2.3).

The Environmental Risk Assessment Methodology is consistent with the approach outlined in the following standards:

- Australian Standard/New Zealand Standard (AS/NZS) ISO 31000:2009 Risk Management – Principles and Guidelines (Standards Australia / Standards New Zealand 2009).
- AS/NZS Handbook 203:2012 Environmental Risk Management – Principles and Process (Standards Australia / Standards New Zealand 2012).

### 2.2.1 Terminology

Throughout the impact and risk assessment process, the following terminology is used in accordance with the OPGGS(E)R and standard industry practice (Table 2-1).

**Table 2-1: Risk management and environmental performance terminology**

| Terminology | Definition |
|---|---|
| Planned Activity | An activity that is intended to occur. |
| Unplanned Event | An event that is not intended to occur despite control measures in place. |
| Project Areas | Defined areas within impacts may occur.<br>Project Areas for this EP are defined in Section 4.3. |
| Environmental Impact | Any change to the environment, whether adverse or beneficial, that wholly or partially results from an activity. |
| Environmental Risk | A function of the likelihood of an event occurring and the consequence of the environmental impact. |

| Terminology | Definition |
|---|---|
| Likelihood | The probability or frequency of an event occurring. |
| Severity (Consequence) | The severity of the impact being realised (i.e. an impact in terms of adverse effects on the people, environment, assets or reputation). |
| Control Measure (CM) | A system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks. |
| ALARP | As Low As Reasonably Practicable<br>The ALARP principle is that the residual impacts and risks shall be 'as low as reasonably practicable'. |
| Acceptability | A measure of whether the impact or risk will be of an acceptable level to affected receptors.<br>Determined from a demonstration of the ALARP principle, consistency the principles of ecologically sustainable development (ESD) with internal context (e.g. corporate requirements), applicable state, national and international legislations; other requirements (national, international standards and best practice); and external context (e.g. consideration of relevant stakeholder consultation when determining control measures). |
| Environmental Performance Outcome | An outcome that demonstrates that the environmental performance will meet or better the acceptable level of impacts and risks of the activity. |
| Environmental Performance Standard | A statement of the performance required of a control measure. |
| Environmental Measurement Criteria | Verification to demonstrate that the Environmental Performance Outcome and Environmental Performance Standard are being met. |

### 2.2.2 Environmental Risk Assessment Methodology (Unplanned Events)

The methodology used to assess risks resulting from unplanned events is illustrated schematically in Figure 2-1.

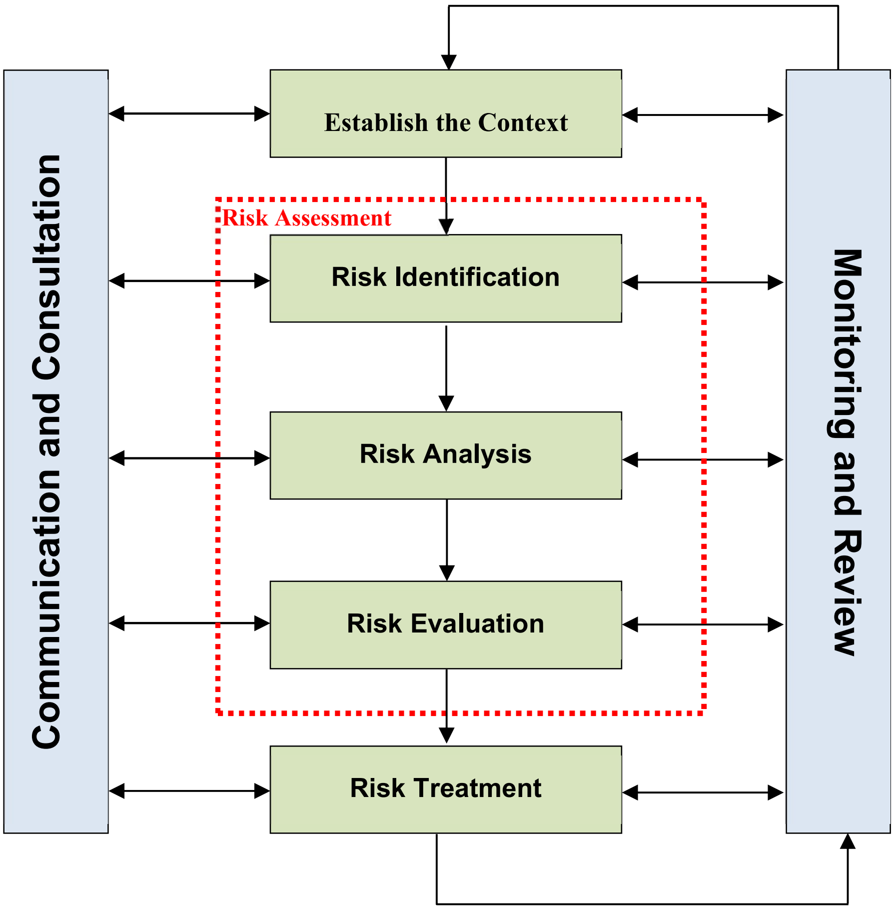



**Figure 2-1: Schematic of risk assessment methodology**

The main components of the risk assessment methodology include:

- Identify the activities and the events / aspects associated with them that could cause a potential impact to the values (receptors) at risk within and adjacent to the Project Areas.
- Determine the likelihood and severity (i.e. consequence) of the events with standard control measures. Where practicable, quantification of the magnitude of the stressor, the concentration of the contaminant and/or level of disturbance was made. Further, timing, duration and other factors affecting the risk were considered.
- The environmental risk rating of an unplanned event is determined from the combination of the likelihood and the expected severity (i.e. consequence). Risks are rated using the Western Gas EHS Qualitative Risk Matrix (Figure 2-2) with a ‘severity’ ranking of 1 (slight) to 5 (catastrophic) and a ‘likelihood’ ranking of A (rare) to E (almost certain).

The likelihood of an event’s occurrence is assessed with standard industry controls in place; however, the severity (i.e. consequence) is assessed without controls.

The risk ratings are aligned with Western Gas’ risk tolerance and associated response guidance to manage or to reduce (as necessary) the risks as described in Table 2-2. Review of the standard industry control measures for each of the risks and proposing additional control measures is then considered, as required.

| Severity | A | B | C | D | E |
|---|---|---|---|---|---|
| | Likelihood | | | | |
| 5 Catastrophic | Medium 5 | Medium 10 | High 15 | High 20 | High 25 |
| 4 Major | Medium 4 | Medium 8 | Medium 12 | High 16 | High 20 |
| 3 Severe | Low 3 | Medium 6 | Medium 9 | Medium 12 | High 15 |
| 2 Minor | Low 2 | Low 4 | Medium 6 | Medium 8 | Medium 10 |
| 1 Slight | Low 1 | Low 2 | Low 3 | Medium 4 | Medium 5 |

| A | B | C | D | E |
|---|---|---|---|---|
| The event may only occur in exceptional circumstances | The event could occur at some time | The event may occur at some time | The event will probably occur in most cuircumstances | The event is expected to occur in most circumstances |
| Rare | Unlikely | Possible | Probable | Almost Certain |
| Likelihood | | | | |

**Figure 2-2: Western Gas HSE qualitative risk matrix**

**Table 2-2: Western Gas risk rating and risk tolerance**

| Risk Rating | | Risk Tolerance | Definition and Response |
|---|---|---|---|
| | **High** | Intolerable (Unacceptable) | If the risk level is High, it is considered to be unacceptable. If a high-risk result remains, once all available controls have been identified, the task must not be undertaken. Further review, consultation and risk assessment is required. |
| | **Medium** | Tolerable (Acceptable) | A risk defined as Medium is considered tolerable. Although risk is tolerable, efforts should still be made to reduce them to levels that are as low as reasonably practicable (ALARP). |
| | **Low** | Acceptable | A risk defined as Low is considered acceptable. If a risk is acceptable, this does not necessarily preclude the initiation of improvements if they are economic, readily identified and practicable. |

### 2.2.3 Environmental Impact Assessment Methodology (Planned Events)

The impact assessment methodology for planned events is based on the risk assessment methodology outlined in Section 2.2.2. However, for planned events, environmental impacts are assessed solely on the severity (i.e. consequence) component of the risk matrix as per the descriptors in Table 2-3. Corresponding Western Gas acceptability criteria and response guidance for severity levels are also described.

**Table 2-3: Western Gas severity categories and descriptors**

| Severity/ Consequence Level | Environment Severity Descriptor | Impact Acceptability (only applicable for planned events) | Notes on Impact |
|---|---|---|---|
| **Catastrophic** | Massive effect; environmental impact could last for decades; long term contamination requiring remediation. | Unacceptable | Not meeting legal, community or stakeholder requirements and expectations or Western Gas standards. Impact not acceptable based on severity and the planned event leading to the impact. |
| **Major** | Major effect; environmental impact could last for years; area becomes restricted for a limited period of time. | Unacceptable | Not meeting legal, community or stakeholder requirements and expectations or Western Gas standards. Impact not acceptable based on severity and the planned event leading to the impact. |
| **Severe** | Severe effect; environmental impact could last for months; reportable quantity spill or release; spill or release requires clean-up. | Unacceptable | Impact not acceptable and the planned activity leading to the impact cannot progress without additional long-term impact reduction measures. Increased resources and management focus required to ensure impact reduced to ALARP and an acceptable level. |

| Severity/ Consequence Level | Environment Severity Descriptor | Impact Acceptability (only applicable for planned events) | Notes on Impact |
|---|---|---|---|
| **Minor** | Minor effect; environmental impact could last for weeks; spill or release external to facility; no clean-up required. | Acceptable with impacts managed via the Company's Management Systems and ALARP demonstrated. | Impact is acceptable if reasonable safeguards/management systems are confirmed to be in place, where it has been demonstrated as being ALARP and of an acceptable level. |
| **Slight** | Slight effect; environmental impact could last for days; no long-term consequences; spill or release internal to facility. | Acceptable, with impacts managed via the Company's Management Systems and ALARP demonstrated. | Impact is generally regarded as acceptable by a broad range of stakeholders. Adequate resources and management focus to ensure impact are ALARP and of an acceptable level. |

### 2.2.4 ALARP Demonstration

Regulation 10A(a) of the OPGGS(E)R requires that the Environment Plan must demonstrate that the environmental impacts and risks of the activity will be reduced to ALARP.

For an activity to be considered ALARP, the Environment Plan must demonstrate, through reasoned and supported arguments, that there are no other practicable control measures that could reasonably be implemented to reduce the environmental impacts and risks of the Activity.

The key principles underpinning the ALARP principle include:

- There are no reasonably practicable alternatives to the activity.
- There are no additional reasonably practicable measures available to further reduce the risk or impact.
- The sacrifice (cost, time, effort) for implementing further control measures is grossly disproportionate to the reduction in risk or impact and the environmental benefit gained.

In alignment with NOPSEMA's ALARP Guidance Note (N-04300-GN0166, Rev 6, 2015), Western Gas have adapted the approach developed by Oil and Gas UK (OGUK) (OGUK, 2014) for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure 2-3). Specifically, the framework considers impact severity and several guiding factors:

- Activity type;
- Risk and uncertainty; and
- Stakeholder influence.

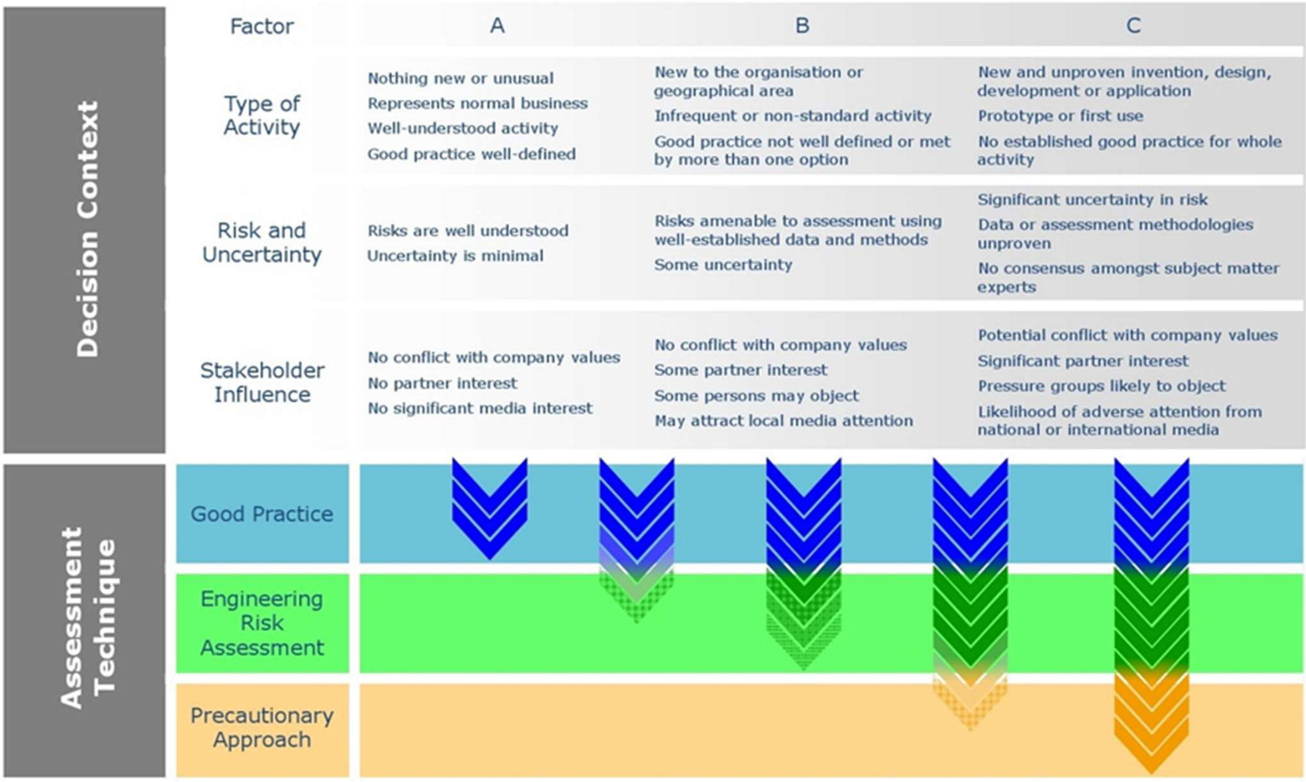



**Figure 2-3: ALARP Decision Support Framework (Oil & Gas UK 2014)**

A **Type A decision** is made if the risk is relatively well understood, the potential impacts are low, activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. However, if good practice is not sufficiently well-defined, additional assessment may be required.

A **Type B decision** is made if there is greater uncertainty or complexity around the activity and/or risk, the potential impact is moderate, and there are no conflict with company values, although there may be some partner interest, some persons may object, and it may attract local media attention. In this instance, established good practice is not considered sufficient and further assessment is required to support the decision and ensure the risk is ALARP.

A **Type C decision** typically involves sufficient complexity, high potential impact, uncertainty, or stakeholder influence to require a precautionary approach. In this case, relevant good practice still must be met, additional assessment is required, and the precautionary approach applied for those controls that only have a marginal cost benefit.

In accordance with the regulatory requirement to demonstrate that environmental impacts and risks are ALARP, Western Gas has considered the above decision context in determining the level of assessment required. This is applied to each aspect described in Section 6.

The assessment techniques considered include:

- Good practice;
- Engineering risk assessment; and

- Precautionary approach.

#### 2.2.4.1 Good Practice

OGUK (2014) defines 'Good Practice' as:

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

'Good Practice' can also be used as the generic term for those measures that are recognised as satisfying the law. For this EP, sources of good practice include:

- Requirements from Australian legislation and regulations;
- Relevant Australian policies;
- Relevant Australian Government guidance;
- Relevant industry standards; and
- Relevant international conventions.

If the ALARP technique is determined to be 'Good Practice', further assessment ('Engineering Risk Assessment') is not required to identify additional controls. However, additional controls that provide a suitable environmental benefit for an insignificant cost are also identified at this point.

#### 2.2.4.2 Engineering Risk Assessment

All potential impacts and risks that require further assessment are subject to an 'Engineering Risk Assessment'. Based on the various approaches recommended in OGUK (2014), Western Gas believes the methodology most suited to this activity is a comparative assessment of risks, costs, and environmental benefit. A cost–benefit analysis should show the balance between the risk benefit (or environmental benefit) and the cost of implementing the identified measure, with differentiation required such that the benefit of the risk reduction measure can be seen and the reason for the benefit understood.

#### 2.2.4.3 Precautionary Approach

OGUK (2014) state that if the assessment, considering all available engineering and scientific evidence, is insufficient, inconclusive, or uncertain, then a precautionary approach to impact and risk management is needed. A precautionary approach will mean that uncertain analysis is replaced by conservative assumptions that will result in control measures being more likely to be implemented.

That is, environmental considerations are expected to take precedence over economic considerations, meaning that a control measure that may reduce environmental impact is more likely to be implemented. In this decision context, the decision could have significant economic consequences to an organisation.

Following the determination of ALARP Decision Context, and identification of controls, the residual environmental risk is evaluation. Table 2-4 shows the determination of ALARP for residual risk.

**Table 2-4: Demonstration of ALARP**

| | Residual Risk | | |
|---|---|---|---|
| **Risk (Table 2-2)** | High (intolerable) | Medium (tolerable) | Low (Acceptable) |
| **Impact (** Table 2-3**)** | Severe, Major or Catastrophic (Unacceptable) | Minor (Acceptable) | Slight (Acceptable) |
| **ALARP Determination** | Activity is not ALARP and should not be carried out | The risk and impact are tolerable/acceptable, and ALARP is demonstrated.<br>Efforts should still be made to identify additional control measures (if any) that are not disproportionate to the benefit gained, to demonstrate the levels are reduced to ALARP. | Control measures are consistent with good industry practice, then ALARP is demonstrated.<br>If a readily available control measure will further reduce the impact or risk and the cost of implementation is not disproportionate to the benefit gained, then it is considered 'reasonably practicable' and is implemented. |

### 2.2.5 Acceptability Determination

Regulation 10A(c) of the OPGGS(E)R requires that the Environment Plan demonstrates that the environmental impacts and risks of the Activity will be of an acceptable level. The Acceptable level of impact is considered for each receptor potentially affected by an impact or risk.

The Acceptable Level of Impact is determined for each receptor, based on the values and sensitivities of that receptor in the Project Area relevant to this EP. Acceptable Level of Impact considers several important factors, including sensitivity of the receptor at the location (e.g. BIAs, critical habitats, protected areas), vulnerability of the receptor to change (i.e. is the receptor particularly vulnerable to disturbance events), timing of the activity (i.e. does the activity timings correspond to any important behaviours).

The Acceptable Level of Impact is compared against the predicted level of impact / risk resulting from the proposed activity, as determined during the Impact and Risk Assessment, to determine Acceptability of the impact or risk.

In the context of 'Acceptability' several elements need to be considered. In this Environment Plan, the environmental impacts and risks associated with the activity are determined 'Acceptable' if the following criteria are met:

- Principles of Ecologically Sustainable Development (ESD): The activity (and associated potential risks and impacts) will not contravene the Principles of ESD, as described in Section 3A of the EPBC Act. For planned (routine) events, this is achieved when residual environmental severity (i.e. consequence) is considered 'Minor' or 'Slight' and has been demonstrated ALARP. For unplanned (i.e. accident/incident) events, this is achieved when residual environment risk is considered 'Medium' (tolerable), or 'Low' (acceptable), and has been demonstrated ALARP;

- Internal Context: The activity (and associated potential risks and impacts) to the environment is consistent with Western Gas corporate policies, standards and procedures;
- External Context: Stakeholder objections or claims related to the activity (and associated potential risks and impacts) have been considered and addressed through the consultation process; and
- Other Requirements: The activity (and associated potential risks and impacts) to the environment is consistent with relevant legislation, industry standards and guidelines, offshore practice or benchmarking.

### 2.2.6 Application of the Impact and Risk Management Processes

Western Gas held an environmental hazard identification (ENVID) workshop in May 2021 which included confirming the environmental aspects and associated impacts and risks of the exploration drilling. At the workshop, ALARP and Acceptability considerations were included to evaluate and to select control measures. Stakeholder views were also considered within the process.

Section 6 identifies the environmental impacts and risks of planned activities and unplanned events, assesses the impacts and risks to receptors, identifies control measures to reduce the impact or risk as far as practicable, determines ALARP and Acceptability.

The oil spill response strategies outlined in Section 6 were risk assessed separately along with ALARP and Acceptability justifications. The aim of the assessment was to identify if each spill response strategy is viable with respect to several environmental and operational considerations. Subsequently, ALARP and Acceptability justifications for each of the response strategies were made to enable a decision on their adoption.

### 2.2.7 Environmental Performance

One of the aims of the Environmental Risk Assessment Methodology is to identify the appropriate control measures to reduce the impacts and risks of the activity to ALARP and to an acceptable level. Establishment of environmental performance outcomes (EPO), environmental performance standards (EPS) and their associated measurement criteria (MC) of these control measures is a process that also considers legal requirements, relevant guidelines and stakeholder views. EPOs, EPS and their associated MC are described in Section 6.

# 3 DESCRIPTION OF THE ACTIVITY

## 3.1 OVERVIEW

### 3.1.1 Activity Location

The Petroleum Activity will be undertaken within Exploration Permit WA-519-P, in the Carnarvon Basin off Western Australia's north-west coast. One exploration well, Sansonof-1 will be drilled in Commonwealth Waters, in water depth of approximately 1070 m (MSL). Nominal co-ordinates of this well are provided in Table 3-1. The exact well location will be confirmed in advance of drilling activities.

**Table 3-1: Indicative seabed well-location**

| Exploration Permit | Planned Well | Longitude (E) | Latitude (S) | Approximate water depth |
|---|---|---|---|---|
| WA-519-P | Sasanof-1 | 113.544ºE | 20.4871ºS | 1070 m |

### 3.1.2 Operational Area

The Operational Area for the exploration drilling activity encompasses the 500 m petroleum safety zone (PSZ) around the MODU and support activities such as anchoring and resupply, which typically fall within 3 km of the well location. A conservative boundary of 5 km around the well location has been defined as the Operational Area.

Transit activities of the MODU and support vessels outside of this area are outside of the scope of this EP and managed under the Commonwealth *Navigation Act 2012*.

### 3.1.3 Activity Timeframe

Drilling activities are planned to commence in Q1/Q2 2022, however due to MODU availability could occur any time between Q1 2022 and Q4 2023. Drilling activities are expected to take approximately 25 days (excluding weather and operational delays). Drilling and support activities will typically be conducted on a 24-hour basis. Activity commences from the time of anchoring the MODU until the time the last anchor is retrieved.

### 3.1.4 Project Management Arrangements

AGR Australia Pty Ltd (AGR) is the Drilling Management Contractor (DMC) appointed to this project by Western Gas. AGR is responsible for providing project management and well delivery services for the Sasonof-1 well, including the preparation of all documents required for regulatory approvals and MODU hire.

AGR is the world's largest independent well management consulting group and since 2000 has drilled over 500 wells in 26 countries for over 100 operators without any major health, safety and environment (HSE) incidents. In Australia, AGR has drilled over 40 offshore wells in all the major basins.

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

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

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

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

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

## 3.2 HYDROCARBON CHARACTERISTICS

The properties of the hydrocarbon prospect targeted as part of the exploration drilling is discussed in the following subsections.

### 3.2.1 Hydrocarbon Composition

Given the absence of successful exploration wells penetrating the targeted formation at comparable depths, analogue reservoir data has been used to provide an indication of the expected hydrocarbon properties for the exploration drilling.

The Sasanof prospect is adjacent to the Mentorc cretaceous discovery which is known to contain Mentorc condensate. The targeted prospects are anticipated to contain hydrocarbons like that discovered in the Mentorc field.

Mentorc condensate has been chosen as a suitable analogue given its proximity to the targeted prospects and indicative well locations. The physical characteristics of the expected condensate (using Mentorc condensate as an analogue) are provided in Table 3-2.

**Table 3-2: Expected Physical Characteristics of the Hydrocarbon Prospects**

| Parameter | Hydrocarbon Properties |
|---|---|
| Density @ 15°C | 728 kg/m$^3$ |
| Dynamic Viscosity | 0.5 cP |
| Pour Point (°C) | -100 |
| Hydrocarbon Property Category | Group I |

| Parameter | | Hydrocarbon Properties |
|---|---|---|
| Hydrocarbon Property Classification | | Non – Persistent |
| Boiling Point Curve (% mass) | Volatile (<180°C) | 51.7 |
| | Semi-volatile (180-265°C) | 32.1 |
| | Low Volatility (265-380°C) | 12.1 |
| | Residual (>380°C) | 4.1 |
| API | | 62.8 |

### 3.2.2 Flow Rate

Based upon the proposed well design and expected reservoir characteristics, Western Gas has estimated the potential flow rate during a credible worst-case discharge due to a total loss of well control.

Flow rate estimates were derived following internal guidance consistent with the "Guidance for complying with BOEM NTL No. 2010-N06 on Worst Case Discharge for Offshore Wells" prepared by the Society of Petroleum Engineers. The conservative estimate is at 22, 542 bbl/day at the seabed.

## 3.3 DRILLING ACTIVITIES

This section outlines the planned activities undertaken as part of the Petroleum Activity which have the potential to result in environmental aspects and impacts or risks to the existing environment.

Activities undertaken in support of drilling activities, such as MODU positioning and operation, vessel operations, remotely operated vehicle (ROV) and helicopter operations, are described in Section 3.4.

### 3.3.1 Pre-drilling survey

Pre-drilling site investigations are not proposed for this activity. Knowledge of the seabed characteristics and underlying geology was made available through previous activities to inform positioning of the MODU.

### 3.3.2 Well Design and Drilling Operations

An indicative overview of the exploration drilling design and process is described in this section. This process is subject to change, depending on further well design requirements and location of the well. Well schematics are provided in the Well Operations Management Plan (WOMP) submitted to NOPSEMA for assessment prior to drilling.

The drilling methodology proposed uses a combination of seawater with high-viscosity gel sweeps, water-based muds (WBM), and synthetic based muds (SBM) as outlined in Table 3-3.

**Table 3-3: Indicative Well Profile**

| Well section | Fluid type | Hole size (in) | Approximate metres drilled (m) | Estimated cuttings volume ($m^3$) | Estimated fluid volume discharged ($m^3$) | Cuttings Discharge Location |
|---|---|---|---|---|---|---|
| Top hole - jetted | Seawater with viscous bentonite (PHB sweeps) | 36 | 68 | 45 | 64[1] | Seabed |
| Surface hole – drilled riserless | Seawater with PHB / polymer[2] / KCl[3] sweeps and displacement volume (weighted PHB and / or KCl[3] WBM) | 17.5 | 962 | 149 | 2315[1] | Seabed / Surface (excess volume) |
| Reservoir hole – Closed system | SBM | 12.25 | 400 | 30 | 4[4] | Surface |

[1] Seawater is not included in the estimated Drilling Fluid Volume Discharged

[2] Polymer sweeps may be used to supplement PHB sweeps in the event there is insufficient drill water to hydrate the bentonite

[3] KCl may be used to provide inhibition to clays towards the base of the section

[4] Fluid discharge volume is dried SBM remaining on cuttings, based on 8% ROC and the cuttings having a density of 2,400kg/$m^3$

As is standard industry practice, the top hole well sections will be drilled riserless until a well conductor, surface casing, riser and blow-out preventer can be installed. Once the riser is installed, the 12¼" (311 mm) section will be drilled. This section will be drilled through reactive shale sections requiring the use of a Synthetic-based Mud (SBM) system. In addition to using the shale shakers to reduce the quantity of SBM on the cuttings, the cuttings from these sections will also pass through a cuttings dryer to further reduce the quantity of oil on the cuttings. This is the standard process for reducing the 'retained oil on cuttings' (ROC) with the objective to ensure that the ROC of drilling fluids discharged overboard to less than 8%. To confirm this, onsite testing will be performed to ensure no more than an average of 8% of SBM (dried weight) remains on the cuttings prior to discharge.

On completion of drilling, remaining barite and bentonite not used in the drill fluids may be left onboard the MODU to be handed over to the next operator or discharged to the sea.

### 3.3.3 Contingency Drilling Activities

Contingent drilling activities may be required should difficulties be experienced during drilling. This may include re-spudding the well or side-tracking, and the use of lost circulation materials in the event of downhole fluid losses to the formation.

Potential contingent drilling activities may generate additional volumes of drilling fluids and cuttings to be discharged (Table 3-4). Any discharges, and therefore environmental hazards, will be the same as those described for Drilling Operations (Section 3.3.2).

**Table 3-4: Contingent Drilling Activities**

| Abnormal Condition | Contingent Drilling Activity | Process | Additional Discharge |
|---|---|---|---|
| Operational or technical issues when installing the 36" conductor | Re-spud | Move the MODU and begin to drill a new well in a suitable, safe location within the immediate area of the original well. Well construction issues resulting in a re-spud generally occur during riser-less operations when response or remediation options are more limited. | Increase in the volume of fluids and cuttings discharged i.e. maximum additional discharge equal to double the estimate of fluids and cuttings discharged during the 36" sections. |
| Operational or technical issues when drilling the 17 1/2" open hole or 12 1/4" open hole | Side-track | Drilling a secondary well-bore away from an original well-bore, typically having isolated the original bore. | Increase in the volume of fluids and cuttings discharged i.e. maximum additional discharge equal to doubling the estimate of fluids and cuttings discharged for the relevant hole sections. Cement discharges for an additional cement plug expected to minimal being the volume required to flush surface lines / equipment post cement job (~3m$^3$). |
| Lost circulation.<br><br>When drilling fluid preferentially flows into exposed geological formations instead of returning up the annulus. | Use of lost circulation materials (LCM) | Use of insoluble or fibrous fluid additives, bridging agents such as ground calcium carbonate, or in extreme cases cement. | Potential for additional cement discharges. Quantities will be dependent on the scenario encountered. For example, when using cement to respond to lost circulation it may be possible to continue drilling ahead by drilling out the cement in the wellbore, however in other scenarios it may be necessary to side-track.<br><br>During a lost circulation event it is expected that the volume of drilling fluid and cuttings discharged from surface would remain consistent with normal drilling operations.<br><br>Additional vessel transfer of bulk drilling fluids may be required. |

### 3.3.4 Blowout Preventer Installation and Function Testing

A blow out preventer (BOP) is installed onto the wellhead after completion of the top-hole sections. A BOP consists of a series of hydraulically-operated valves and sealing mechanisms that are open to allow the mud to circulate during drilling but can be quickly closed to isolate the well if required. Whilst the configuration and size of the BOP vary between MODUs and well requirements, the BOP system will comprise 'rams' including annular an annular preventer and pipe rams designed to seal around the tubular components in the well; and blind-shear rams that have the capability to sever the drill pipe and in some cases casing strings. To ensure redundancy within the system, valves can be operated remotely from either the MODU, or via subsea intervention using ROV.

The BOP is tested prior to drilling and then every 21 days to ensure that it is in good operating condition during use. During these function and pressure tests, a small volume of water-based control fluids (such as MacDermid Erifon HD 603HP) is released to the environment. Indicatively, 10 L of water-based fluid is released during installation of the subsea tree, 30 L of water-based fluid per function test of the subsea tree and 1320 to 2250 L of water-based fluid per function test if the BOP is released to the environment.

### 3.3.5 Cementing Operations

After a string of casing or a liner has been installed into the well, spacer fluid is pumped to flush drilling fluids and filter cake to allow a good cement bond to be formed between the steel casing and the formation. During riserless drilling (i.e. top hole section), the spacer is displaced by the cement slurry and discharged directly to the seabed at the mudline.

Following the spacer fluid, a cement slurry is pumped down the inside of the casing (or liner). Drilling fluid is then pumped into the casing with a wiper plug to displace the cement out of the bottom of the casing and up into the annular space between the casing and the borehole wall. Typically, once quality cement returns are seen at the seabed, cement mixing will cease and displacement will commence, with a minimal quantity of cement being deposited around the wellhead during the displacement. Once the cement has cured, the casing and sealing elements are pressure tested.

Upon completion of each cementing activity, the cementing head and blending tanks are cleaned which results in a release of cement-contaminated water to the ocean: approximately 3 $m^3$ per cement activity, depending on the volume left over within the cement unit pipework. Flushing and cleaning of the cement mixing equipment and lines is a necessary operation to prevent plugging of the equipment by cement.

In the rare event that mixed cement products become contaminated, the entire volume may need to be discharged to sea.

On completion of the drilling, remaining bulk cement may be left onboard the MODU to be handed over to the next operator or discharged to the sea.

The list of cement discharge volumes for the above described activities are listed in Table 3-3. Contingency volumes have been included in event contingent drilling activities are required.

**Table 3-5: Cement Discharge Volumes**

| Planned | | | | |
|---|---|---|---|---|
| **Scenario** | **Cementing operation** | **Discharge type** | **Discharge volume ($m^3$)** | **Discharge location** |
| Cement during planned cementing operation | 13-3/8” Surface Casing | Spacer and excess wet cement | 67 | Surface |

| Planned | | | | |
|---|---|---|---|---|
| **Scenario** | **Cementing operation** | **Discharge type** | **Discharge volume ($m^3$)** | **Discharge location** |
| Discharge during post job cleaning | 13-3/8" Surface Casing | Flushing surface lines / equipment | 3 | Surface |
| | P&A Cement Plugs | | 3 | Surface |
| **Contingency** | | | | |
| **Scenario** | **Cementing operation** | **Discharge type** | **Discharge volume ($m^3$)** | **Discharge location** |
| Discharge during testing of cement unit | As required | Wet cement and flushing surface lines / equipment | 8 | Surface |
| Discharge during contingency cementing operations | 36" Conductor (re-spud with drill and cement) | Excess wet cement | 32 | Seabed |
| | 13-3/8" Surface Casing (re-spud) | Spacer and excess wet cement | 67 | Seabed |
| Discharge during post cleaning (contingency operation) | 36" Conductor (re-spud with drill and cement) | Flushing surface lines / equipment | 3 | Surface |
| | 13-3/8" Surface Casing (re-spud) | | 3 | Surface |
| | 13-3/8" Cased hole suspension cement plug | | 3 | Surface |
| | Open hole sidetracked cement plug | | 3 | Surface |
| | 9-5/8" Contingency liner | | 3 | Surface |
| | 9-5/8" Cased hole suspension cement plug | | 3 | Surface |
| Discharge due to mixed cement contamination | Surface casing cement job | Spacer and wet cement | 162 | Seabed |

| Planned | | | | |
|---|---|---|---|---|
| Scenario | Cementing operation | Discharge type | Discharge volume ($m^3$) | Discharge location |
| | Contingency liner cement job | | 25 | Surface |
| | 13-3/8" Cased hole cement plug | | 24 | Surface |
| | Open hole cement plug | | 23 | Surface |
| | 9-5/8" Cased hole cement plug | | 13 | Surface |

The bulk dry cement may be transported in dry bulk storage tanks to the MODU via project support vessels. During transfer the holding tanks are vented, which may result in small volumes of dry cement being discharged. Additionally, prior to commencement of cementing operations, the cementing unit is tested and may result in a discharge of a volume up to 8 $m^3$ of cement slurry to the sea.

### 3.3.6 Formation Evaluation

As an exploration well, Western Gas is planning a Formation Evaluation (FE) Program. The FE Program is planned to include the following key operational activities:

- Measurement/Logging While Drilling (MWD/LWD);
- Wireline Logging.

***Measurement/Logging While Drilling***

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

The LWD tools will be utilised to gather key geological parameters while drilling to inform progress and anticipate upcoming intervals. The use of LWD tools also provides data redundancy (by replicating some of the data to be obtained through wireline logging).

***Wireline Logging***

Conventional wireline logging operations will be conducted in open hole and cased hole intervals of the well. The objective of the wireline logging is to gather high quality data to evaluate the geological properties of the wellbore. Wireline logs may include vertical seismic profiling (VSP).

***Vertical Seismic Profiling/Check shot***

As a subset of the wireline logging operation, Western Gas intends to conduct zero offset VSP/Checkshot surveys. Vertical seismic profiling (VSP) is a routine activity conducted as part of exploration drilling activities to provide detailed information regarding geological structures and stratigraphy in the vicinity of the well. VSP operations involve deploying an acoustic sound source from the MODU or support vessel, while a number of receivers are positioned at different levels within the drilled hole to measure the travel time. VSP is planned to be undertaken over a 4-hour period, using a source array of 4 x 150 cubic inches (cu.in) at a depth of 4m below sea level.

### 3.3.7 Well Plug and Abandonment

After completion of the drilling activity, Western Gas will plug and abandon (P&A) the exploration well. P&A procedures are designed to isolate the well and mitigate the risk of a potential release of wellbore fluids to the marine environment.

P&A operations involve setting a series of cement and mechanical plugs within the wellbore, including plugs above and between any hydrocarbon bearing intervals, at appropriate barrier depths in the well. These plugs are tested to confirm their integrity.

The wellhead is to be cut 3 m below the seabed using a mechanical cutter and lifted to the MODU using the drill pipe for removal. The mechanical cutter is deployed on drill pipe inside the casing and uses seawater as a lubricant.

All P&A operations will be conducted in accordance with a NOPSEMA accepted WOMP.

### 3.3.8 Post Operation ROV survey

Once the well is plugged and abandoned, a ROV is deployed from the MODU to conduct a post operation survey. This survey records the condition of the seabed at the completion of the program to ensure that no dropped objects or subsea equipment intended for removal remain on the seabed. The ROV will be equipped with a 2D sonar, and, with cameras.

## 3.4 SUPPORT ACTIVITIES

### 3.4.1 MODU Operations

Drilling activities will be undertaken using a Mobile Offshore Drilling Unit (MODU). The MODU will maintain position using either Dynamic Positioning (DP) or an anchored mooring system. It will have an expected persons on board (POB) of 100 to 200 personnel.

The MODU is fitted with various equipment to support operations including:

- power generation systems;
- fuel oil storage;
- cooling water and freshwater systems;
- drainage, effluent and waste systems; and
- solids control equipment used in drilling to separate the solids and drilling fluids (this may include shale shakers, centrifuging systems and cuttings driers).

While on position, a 500 m PSZ will be maintained around the MODU at all times, in accordance with the *OPGGS* Act. A conservative boundary of 5 km around the well location will be maintained as a Cautionary Zone.

**MODU Positioning**

MODU positioning will vary between anchoring or use of DP, depending on the type of MODU used.

A moored MODU will typically have a minimum of eight anchors, deployed by anchor handling support vessels (AHSVs) and lowered to the seabed. Once in place, the MODU winches in the slack from the mooring lines to the required tension. Anchors are spread in a radial pattern extending from the MODU. The size of the anchor spread will be dependent on the MODU and the MODU specific mooring analysis conducted during the well planning stage. Typically, for this water depth, mooring lines extend approximately 3,000 m from the MODU with approximately 1,000 m of grounded chain. Each anchor typically occupies a total seabed area of approximately 30 $m^2$. Retrieval of anchors is the reverse of the deployment procedures.

A DP MODU will maintain position at the well locations using thrusters, resulting in no contact with the seabed.

### 3.4.2 Vessel Operations

The MODU will be supported by two or three vessels, including anchor handling supply vessel (AHSV) and platform support vessels (PSVs). The vessels will be either stationary or operating at slow speeds while undertaking activities within the Operational Area including:

- Towing the MODU to/from the well location;
- Supporting mooring and BOP running operations;
- Providing standby for the MODU;
- Transfer provisions (food, bulk materials, fuel), equipment and wastes to and from the MODU and shore base; and
- Facilitate site and equipment inspections / surveys before and after MODU arrival.

Cement, barite and bentonite are transported as dry bulk to the MODU by support vessels and pneumatically blown to the MODU storage tanks using compressed air. The dry bulk storage tanks on the MODU vent excess compressed air to atmosphere. This venting process carries small amounts of solids, which is discharged below the MODU.

Liquid bulk SBM will be transferred from support vessels onto the MODU via hoses at the start of the activity and upon completion.

The typical maximum tank size of a fuel tank on any vessel undertaking Petroleum Activities within the Operational Area will be 250 $m^3$.

### 3.4.3 ROV Operations

ROVs will also be used to support activities in addition to the post operation survey. This may include during equipment deployment, monitoring and retrieval and during BOP activation under emergency conditions. Hydraulic systems on the ROVs are closed systems and not designed to release hydraulic fluid. These ROVs are intended to be moored on the deck of the vessels and/or MODU and are unlikely to be temporarily parked on the seabed during operations.

### 3.4.4 Helicopter Operations

The MODU is serviced by helicopters, with an expected flight frequency of up to 8 times per week (on average). Helicopters will primarily be used for passenger transfers/crew changes and minor supplies but may also be used in the event of an emergency evacuation.

# 4 DESCRIPTION OF PROJECT CONTEXT

## 4.1 POTENTIAL ENVIRONMENTAL ASPECTS

Based on the activities described in Section 3, potential environmental aspects resulting from each activity have been identified for assessment and management. The relationship between activities and aspects is shown in Table 4-1.

**Table 4-1: Activity – Aspect Relationship**

| Aspects | Drilling Activities | | | | | | Support Activities | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Well Design and Drilling Operations | BOP Installation and Function Testing | Cement Operations | Formation Evaluation | Well P&A | Post Operations ROV Survey | MODU Operations | Vessel Operations | ROV Operations | Helicopter Operations |
| **PLANNED** | | | | | | | | | | |
| Physical Presence – Interaction with Other Users | | | | | | | X | X | | |
| Physical Presence - Seabed Disturbance | | | | | | | X | | | |
| Emissions - Atmospheric | | | | | | | X | X | | |
| Emissions - Light | | | | | | | X | X | | |
| Underwater Sound Emissions - Continuous | | | | | X | | X | X | | X |
| Underwater Sound Emissions - Impulsive | | | | X | | X | | | | |
| Planned Discharge - Drill Cuttings and Fluids | X | | | | X | | | | | |
| Planned Discharge - Cement | | | X | | | | | | | |
| Planned Discharge – Metal shavings | | | | | X | | | | | |
| Planned Discharge - Hydraulic Fluids and Chemicals | | X | | | | | | | X | |
| Planned Discharge - Sewage and Greywater | | | | | | | X | X | | |

| Aspects | Drilling Activities | | | | | | Support Activities | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Well Design and Drilling Operations | BOP Installation and Function Testing | Cement Operations | Formation Evaluation | Well P&A | Post Operations ROV Survey | MODU Operations | Vessel Operations | ROV Operations | Helicopter Operations |
| Planned Discharge - Food Waste | | | | | | | X | X | | |
| Planned Discharge - Deck Drainage and Bilge | | | | | | | X | X | | |
| Planned Discharge - Brine | | | | | | | X | X | | |
| Planned Discharge - Cooling Water | | | | | | | X | X | | |
| **UNPLANNED** | | | | | | | | | | |
| Physical Presence - Interaction with Marine Fauna | | | | | | | | X | | |
| Unplanned Introduction of IMS | | | | | | | X | X | | |
| Accidental Release - Hazardous Materials | | | | | | | X | X | X | |
| Accidental Release - Solid Waste | | | | | | | X | X | | |
| Accidental Release - Bulk Transfer | | | | | | | X | X | | |
| Accidental Release - Unplanned Riser Disconnect | X | | | | | | | | | |
| Accidental Release - Vessel Collision | | | | | | | | X | | |
| Accidental Release - Well Loss of Containment | X | | | | | | | | | |

## 4.2 BASIS OF ASSESSMENT

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

In many cases, activities and aspects 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 aspects, however, are specific to the project described in this EP, and further information is required to understand how such activities or aspects will affect the existing environment, therefore modelling and/or studies have been undertaken.

Modelling undertaken as part of this EP is described in the subsections below.

### 4.2.1 Oil Spill Modelling - Reservoir

Guidance identification of worst-case credible spills scenarios is given in AMSA's Technical guidelines for preparing contingency plans for Marine and Coastal Facilities (AMSA 2015).

Western Gas identified the potential maximum credible spill scenario associated with the Sasanof-1 Exploration Drilling to be the loss of well control (LOWC) (Table 4-2).

**Table 4-2: Potential Maximum Credible Spill Scenario for an Accidental Release of Hydrocarbons**

| Cause | Description | AMSA Basis of Credible Volume | Maximum Credible Volume and Duration |
|---|---|---|---|
| LOWC | The predicted flow rates from the targeted reservoir is based upon analogue reservoir data for the previously drilled well Mentorc-1 given its proximity to the indicative Sasanof-1 well location (~1.8 km west).<br><br>For the Sasanof-1 well Western Gas conservatively estimate that it would take 80 days to drill a relief well. This duration is based on Western Gas' spill response arrangements, which takes into account the time to mobilise a MODU and conduct relief well drilling to kill the well. | Predicted flow rates per day x days estimated to kill the well. | Total volume of 1,803,360 bbl released over 80 days at a variable (decreasing) flow rate of ~22,542 bbl/ day. |

The LOWC scenario is considered the worst-case scenario for an accidental release of reservoir hydrocarbons and is therefore representative of the greatest spatial extent of potential impacts. Therefore, the LOWC scenario is used for the purposes of impact assessment and is carried through into spill modelling.

#### 4.2.1.1 Spill Modelling and Exposure Assessment

Spill modelling has been used to predict the possible trajectories and fate of an accidental release of reservoir hydrocarbons from a LOWC (RPS 2020; Appendix C**: Spill Modelling Report**). The following two models were used during the assessment:

- OILMAP-DEEP – Near-field subsurface discharge modelling was undertaken using OILMAP-DEEP, which predicts the droplet sizes that are generated by the turbulence of the discharge as well as the centreline velocity, buoyancy, width and trapping depth (if any) of the rising gas and oil plumes.
- SIMAP – Oil spill modelling was undertaken using a three-dimensional oil spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program), which is

designed to simulate the transport, spreading and weathering of specific oil types under the influence of changing meteorological and oceanographic forces.

The spill scenario, oil characteristics and behaviours, environmental thresholds for impact assessment and predicted exposures are summarised below.

***Scenario***

The scenario selected for modelling is a subsea release of reservoir hydrocarbons following a LOWC. Table 4-3 detail the spill modelling used for the area that maybe affected by a LOWC spill. The use of the spill modelling that was undertaken for the Mentorc-1 well was considered appropriate for the Sasanof-1 well based on:

- The predicted flow rates from the targeted reservoir is based upon analogue reservoir data for the previously drilled well Mentorc-1.
- The total spill volume for the Mentorc-1 well (2,727,570 bbl) is greater than the predicted volumes for the Sasanof-1 well (1,803,360 bbl) as the period for drilling a relief well has been refined to 80 days based on a review of the proposed relief well design, potential relief well rigs and the required equipment and resources.
- The Mentorc-1 well is within 1,000 m water depth and ~20 km west of the Sasanof-1 well location thus oceanographic conditions at the scale of the modelling would be the same.

**Table 4-3: LOWC event used for spill modelling**

| | |
|---|---|
| **Scenario Description** | Subsea release after LOWC event |
| **Spill Location** | At Mentorc-1 well, release depth 1000 m water |
| **Oil Released** | Mentorc condensate |
| **Spill Duration** | 121 days |
| **Total Volume Released** | 2,727,570 bbl |
| **Flow Rate** | ~22,542 bbl/day |
| **Number of Model Simulations** | 100 during summer conditions (September to March)<br>100 during winter conditions (May to July)<br>100 during transitional conditions (April and August) |

***Oil Characteristics***

Mentorc condensate is a non-persistent oil, with a low dynamic viscosity and low pour point (Table 4-4). The oil has relatively low (4.1%) residual component (i.e. the component that tends not to evaporate and that may persist in the marine environment) (Table 4-4).

**Table 4-4 Characteristics of Mentorc Condensate**

| | |
|---|---|
| **Classification** | Group I, Non-persistent oil |
| **API Gravity** | 62.8 °API |

| | | | | |
|---|---|---|---|---|
| **Density** | 728 kg/cm³ at 15 °C | | | |
| **Viscosity ^** | 0.5 cP | | | |
| **Pour Point ^** | -100 °C | | | |
| **Component** | **Volatile** | **Semi-volatile** | **Low volatility** | **Residual** |
| **Boiling Point** | **<180 °C** | **180–265 °C** | **265–380 °C** | **>380 °C** |
| **Percentage of Total Oil** | 51.7 | 32.1 | 12.1 | 4.1 |

### *Oil Fate and Weathering*

The fate of an oil in the marine environment depends on a number of factors including the physical and chemical properties of the hydrocarbon, the volume released, the prevailing environmental conditions and whether the oil remains at sea or accumulates on a shoreline (ITOPF 2014).

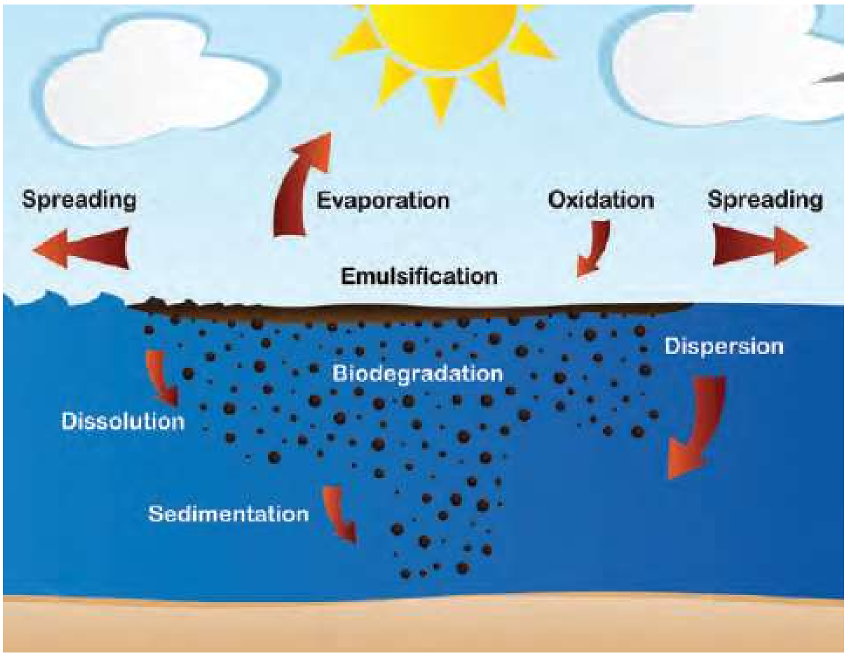
The main physical properties of an oil that affect the behaviour and persistence of Mentorc condensate are:

- Specific gravity – Mentorc condensate has a specific gravity less than seawater and will therefore have the tendency to float.
- Distillation characteristics (volatility) – Mentorc condensate has a high proportion (95.9%) of volatile components that once on the surface will readily evaporate. Typical evaporation times once at the surface and exposed to the atmosphere are:
    - up to 12 hours for the volatile compounds (BP <180 °C)
    - up to 24 hours for the semi-volatile compounds (BP 180–265 °C)
    - several days for the low volatility compounds (BP 265–380 °C) (RPS 2020).

  There is a smaller proportion (4.1%) of the longer and more complex compounds (BP >380 °C) that tends to persist and be subject to relatively slow degradation rather than evaporate. These compounds may persist in the marine environment for weeks to months (RPS 2020).
- Viscosity – Mentorc condensate has a low viscosity and will tend to flow and spread.
- Pour point – Mentorc condensate has a pour point well below ambient seawater temperatures and will therefore stay in liquid form (i.e. it would not tend to form waxy solids).

Once released, varying weathering processes (e.g. spreading, evaporation, dispersion and dissolution) act on the oil, and the relative importance of these processes can change over time (Figure 4-1). Oil at surface will be subject to atmospheric weathering and will be transported by prevailing currents and wind. Oil that entrains or dissolves in the water column will be transported by prevailing currents and be subject to different weathering processes. As such, the different components of oil can follow different trajectory paths.

As oil weathers, its composition changes (French-McCay 2018). When oil is floating, the volatile components evaporate rapidly, and the remaining floating oil becomes more viscous and therefore spreading rates also reduce. Floating oil may also be entrained into the water column by breaking waves, or if the oil is from a subsurface release these droplets can entrain directly into the water column during the release. Soluble and semi-soluble hydrocarbons can also dissolve into the water column. However, the volatilization rates of hydrocarbons from surface slicks are faster than the dissolution rates, and therefore dissolution from oil droplets in the water column is the main source of dissolved hydrocarbons (French-McCay 2018). The uptake of hydrocarbons by micro-organisms (i.e. biodegradation) further reduces water column concentrations.




*Source: ITOPF 2014*

**Figure 4-1 Weathering processes that act on an oil at sea**

Weathering of Mentorc condensate for the trajectory resulting in the largest swept area above 10 g/m$^2$ on the sea surface predicted that at the conclusion of the simulation, approximately 1,976,743 bbl (72%) spilled oil was lost to the atmosphere through evaporation. Approximately 645,504 bbl (24%) of the condensate was predicted to have decayed, while approximately 104,561 bbl (4%) was predicted to remain within the water column and no condensate was predicted to accumulate on the shorelines.

### *Environmental Thresholds*

Oil is a mixture of hydrocarbons of varying physical, chemical, and toxicological characteristics, and therefore, these components have varying fates and impacts (French-McCay 2018). Four components have been modelled and used within the impact assessment:

- In-water (Floating);
- In-water (Dissolved);
- In-water (Entrained); and

- Shoreline accumulation.

The exposure values used in the spill modelling and impact assessment are based on available guidance (NOPSEMA 2019) and literature (e.g. French-McCay 2018; 2016).

**Table 4-5 Exposure values used in modelling and impact assessments for accidental hydrocarbon release**

| Exposure Values | | Environmental Relevance |
|---|---|---|
| **Sea Surface (Floating) thresholds** | | |
| Low | 1 g/m$^2$ | The low of 1 g/m$^2$, which equates approximately to an average thickness of 1 µm, referred to as visible oil. 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).<br>The low threshold has been used to define the EMBA. |
| Moderate | 10 g/m$^2$ | Ecological impact has been estimated to occur at 10g/m$^2$ (a film thickness of approximately 10 µm or 0.01mm) 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).<br>Concentrations above 10 g/m$^2$ is also considered the lower actionable threshold, where oil may be thick enough for containment and recovery as well as dispersant treatment (AMSA, 2015). |
| High | 50 g/m$^2$ | Concentrations above 50 g/m$^2$ are considered the lower actionable threshold, where oil may be thick enough for containment and recovery, therefore the high exposure threshold is considered for response planning. |
| **In-water (Dissolved) thresholds** | | |
| Low | 10 ppb | 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”.<br>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 & Di Toro, 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 |
| Moderate | 50 ppb | |
| High | 400 ppb | |

| Exposure Values | | Environmental Relevance |
|---|---|---|
| | | 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).<br><br>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.<br><br>Thresholds of 10, 50 or 400 ppb over a 1 hour timestep to indicate increasing potential for sub-lethal to lethal toxic effects (low to high).<br><br>The dissolved hydrocarbon 10 ppb exposure value has been used to inform the EMBA. |
| **In-water (Entrained) thresholds** | | |
| Low | 10 ppb | 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, 2003).<br><br>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. |
| High | 100 ppb | The 100 ppb exposure value is considered to be representative of sub-lethal impacts to most species and lethal impacts to sensitive species based on toxicity |

| Exposure Values | | Environmental Relevance |
|---|---|---|
| | | testing. This is considered conservative as toxicity to marine organisms from oil is likely to be driven by the more bioavailable dissolved aromatic fraction, which is typically not differentiated from entrained hydrocarbon in toxicity tests using water accommodated fractions. Given entrained hydrocarbon is expected to have lower toxicity than dissolved aromatics, especially over time periods where these soluble fractions have dissoluted from entrained hydrocarbon, the high exposure value is considered appropriate for risk evaluation. |
| **Shoreline accumulation thresholds** | | |
| Low | 10 g/m$^2$ | The low 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.). French-McCay et al. (2005a; 2005b) also use a threshold of 10 g/m$^2$, equating to approximately two teaspoons of oil per square meter of shoreline, as a low impact threshold when assessing the potential for shoreline accumulation. |
| Moderate | 100 g/m$^2$ | French et al. (1996) and French-McCay (2009) define a shoreline oil accumulation threshold of 100 g/m$^2$, 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/m$^2$, or above, is the minimum limit that the oil can be effectively cleaned according to the AMSA (2015) guideline. This threshold equates to approximately ½ a cup of oil per square meter of shoreline accumulation. The appearance is described as a thin oil coat. |
| High | 1000 g/m$^2$ | The higher threshold of 1,000 g/m$^2$, 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 & Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m$^2$ 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 & Murray, 1999).<br><br>The impacts of surface hydrocarbons on wetlands are generally similar to those described for mangroves and saltmarshes. The degree of impact of oil on wetland vegetation are variable and complex, and can be both acute and chronic, ranging from short-term disruption of plant functioning to mortality (Corn & Copeland, 2010).<br><br>This concentration equates to approximately 1 litre or 4 ¼ cups of fresh oil per square meter of shoreline accumulation. The appearance is described as an oil cover. |

***Predicted Exposure***

The results from OILMAP and SIMAP modelling of the subsea release of Mentorc condensate are summarised below.

Near-field

The results of the OILMAP simulation for the subsea release predicted the gas/liquid will propel the condensate upward from the seabed (i.e. 1,000 m depth) to approximately 600 m below the sea surface corresponding to the plume trapping depth. From this point onward, the condensate droplets will be subject to their own buoyancy and the varying oceanographic conditions (RPS 2020).

Far-field

Stochastic modelling results refer to the cumulative outputs from all model simulations, which for this scope was 300 unique model simulations, with 100 per seasonal period. Under different metocean and environmental conditions, each single model run (known as ‘deterministic’) differs in spill direction, extent and duration (i.e. area of exposure).

The fate of each hydrocarbon component also varies due to different trajectory influences and weathering characteristics (Figure 4-2). Note that for Mentorc condensate, this residual component represents a very small proportion (4.1%) of the total volume released. Similarly, dissolved hydrocarbons may occur when entrained and/or floating oil is present; however due to their volatility they do not tend to persist and travel as far as entrained oil droplets (Figure 4-2).

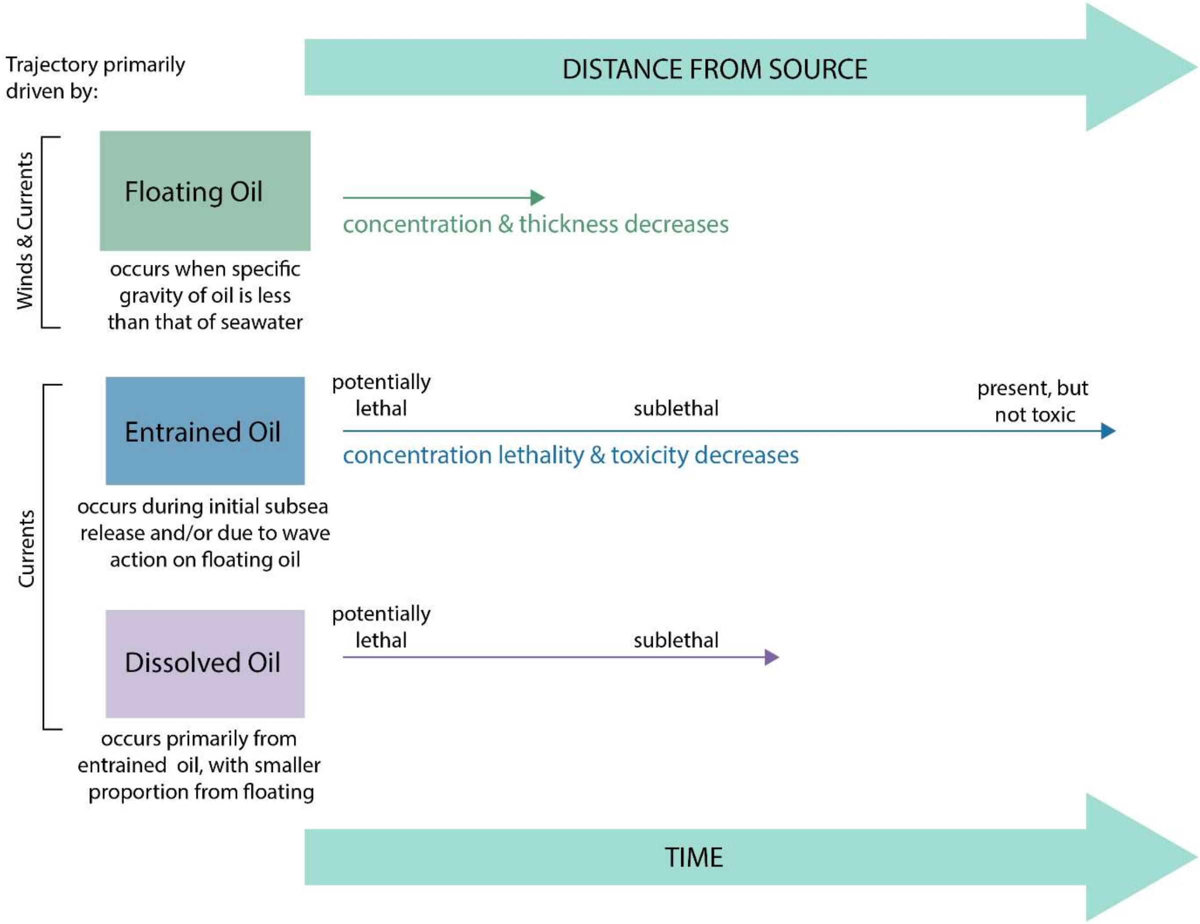



**Figure 4-2 Oil components and typical exposure extent and type of impacts**

The results of the stochastic modelling undertaken using SIMAP (RPS 2020) is presented in Table 4-6 for each of the modelled hydrocarbon components. Receptors marked 'X' refer to where an exposure value is relevant to the receptor, but modelling predicts negligible interaction with the receptor.

No shoreline contact was predicted, consequently no shoreline contact results are presented.

No dissolved hydrocarbon exposure was predicted above the low threshold in the top 30 m of the water column, consequently no dissolved hydrocarbon results are presented.

### Table 4-6 Summary of stochastic modelling results for a LOWC (Accidental Release - Mentorc condensate)

| | | Relevance to Receptors | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Exposure Values** | **Predicted Extent of Exposure** | **Water quality** | **Sediment quality** | **Benthic habitat and communities** | **Coastal habitats and communities** | **Plankton** | **Birds** | **Fish and Sharks** | **Marine mammals** | **Marine reptiles** | **Australian Marine Parks** | **Key Ecological Features** | **State Protected Areas - Marine** | **State Protected Areas - Terrestrial** | **Commercial Fisheries** | **Marine and Coastal Industry** | **Tourism and Recreation** | **Heritage and Cultural** |
| **Surface (floating)** | | | | | | | | | | | | | | | | | | |
| **Low**<br><br>1 g/m² | • No floating oil above this exposure value is predicted to occur outside the Northwest Province provincial bioregion.<br>• Floating oil at this level is expected to be visually detectable but not have biological effects.<br>• The maximum distance from the release location to the low exposure thresholds was 135 km NNW (transitional).<br>• The highest probabilities for oil contact at this threshold is within the Gascoyne Australian Marine Park (AMP) (84–93% depending on seasonal conditions) and Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula Key Ecological Feature (KEF) (2 – 11% depending on seasonal conditions). | ✓ | | | | | | | | | ✓ | ✓ | | | ✓ | | | |
| **Moderate**<br><br>10 g/m² | • No floating oil above this exposure value is predicted to occur outside the Northwest Province provincial bioregion.<br>• Maximum distance from the source predicted for floating oil above 10 g/m² is 63 km SSW (summer).<br>• The highest probabilities for oil contact at this threshold is within the Gascoyne AMP (25–33% depending on seasonal conditions).<br>• Would intersect with BIAs for seabirds, sharks and whales.<br>• Would intersect with Commonwealth and State fishery management areas. | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | |

| Exposure Values | Predicted Extent of Exposure | Relevance to Receptors | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Water quality | Sediment quality | Benthic habitat and communities | Coastal habitats and communities | Plankton | Birds | Fish and Sharks | Marine mammals | Marine reptiles | Australian Marine Parks | Key Ecological Features | State Protected Areas - Marine | State Protected Areas - Terrestrial | Commercial Fisheries | Marine and Coastal Industry | Tourism and Recreation | Heritage and Cultural |
| **High**<br><br>50 g/m$^2$ | • No floating oil above this exposure value is predicted to occur outside the Northwest Province provincial bioregion.<br>• Maximum distance from the source predicted for floating oil above 50 g/m$^2$ is 5.2 km SSW (transitional).<br>• Would intersect with BIAs for seabirds, sharks and whales.<br>• Would intersect with Commonwealth and State fishery management areas. | ✓ | | | | | ✓ | ✓ | ✓ | | ✓ | ✓ | | | ✓ | | | |
| **In-water (entrained)** | | | | | | | | | | | | | | | | | | |
| **Low**<br><br>10 ppb<br>(instantaneous) | • Maximum distance from the source predicted for entrained hydrocarbons above 10 ppb is 1,882 km NE (summer).<br>• The highest occurrence of entrained oil is generally expected to occur within the surface layer (0-10 m); with probabilities of exposure reducing with depth.<br>• Limited benthic interaction is predicted to occur, with entrained oil not expected to exceed depths of greater than 30 m below MSL (typically remaining with surface layers; <10 m). Therefore, in shallower and nearshore areas some benthic interaction from entrained oil may potentially occur.<br>• The probability of contact by entrained hydrocarbons at this exposure value is predicted to be greatest within waters at Gascoyne MP with probabilities of 100% across all seasons.<br>• The Argo-Rowley Terrace, the Carnarvon Canyon and the Ningaloo AMPs, the Ningaloo, Northwest Shelf, and the Pilbarra (offshore) IMCRAs and the Canyons and the Commonwealth waters adjacent to | ✓ | X | X | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | |

| Exposure Values | Predicted Extent of Exposure | Water quality | Sediment quality | Benthic habitat and communities | Coastal habitats and communities | Plankton | Birds | Fish and Sharks | Marine mammals | Marine reptiles | Australian Marine Parks | Key Ecological Features | State Protected Areas - Marine | State Protected Areas - Terrestrial | Commercial Fisheries | Marine and Coastal Industry | Tourism and Recreation | Heritage and Cultural |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ningaloo Reef KEFs all recorded probabilities of low entrained hydrocarbon exposure at or above 30% for each season.<br>• Would intersect with BIAs for turtles, seabirds, sharks, whales and dugongs.<br>• Would intersect with Commonwealth and State fishery management areas. | | | | | | | | | | | | | | | | | |
| **High**<br>100 ppb<br>(instantaneous) | • Maximum distance from the source predicted for entrained hydrocarbons above 100 ppb is 705 km SW (transitional).<br>• No benthic interaction is predicted to occur, with entrained hydrocarbons typically remaining with surface layers (<10 m). The vertical distribution of dissolved oil indicates the plumes may come close to shore but tend to remain over the shelf slope.<br>• The Gascoyne AMP recorded the greatest probabilities of exposure ranging from 91% in summer to 100% during transitional and winter conditions. The Canyons KEF was also predicted to be exposed at the high entrained hydrocarbon threshold with predicted probabilities of 60% in summer, 72% during transitional conditions and 61% during winter.<br>• Would intersect with BIAs for turtles, seabirds, sharks, whales and dugongs.<br>• Would intersect with Commonwealth and State fishery management areas. | ✓ | X | | X | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | |

*Receptors marked 'X' = exposure value is relevant to the receptor, but modelling predicts negligible interaction with receptor via the exposure pathway. Probabilities of exposure vary with seasons.*

## 4.3 PROJECT AREAS

The spatial boundary of the environmental assessment is defined using project areas. These are the areas within which the impacts or risks resulting from environmental aspects are expected to occur.

For this EP the following project areas have been defined (Figure 4-3):

- Operational Area (defined in Section 3.1.2) – the area within which impacts from planned activities will occur. Defined as 5 km from the well location, based on the maximum anchor spread and potential noise impact area from drilling operations. Although impacts from VSP and light emissions may result in impacts outside of this 5 km boundary (refer to Table 6-1), chronic and acute impacts will be restricted to the Operational Area.
- Hydrocarbon Exposure Area (HEA) – the largest area within which hydrocarbon exposure will be moderate (based on moderate exposure values (Table 4-5)) and may result in impacts to fauna.
- Environment that May be Affected (EMBA) – the area within which a change in ambient environmental conditions could occur – this is determined by the extent of hydrocarbon exposure at low levels (based on low exposure values (Table 4-5)).

Aspects 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 aspect. By using the Project Areas, 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 Section 5 Existing Environment Description, ensuring that the understanding of receptors within the environment of each Project Area is sufficient to undertake the impact assessment.

Environmental aspects and potentially impacted receptors within each Project Area were identified during the Environmental Impact Identification (ENVID) (as described in Section 6.2) and are summarised in Table 4-7.

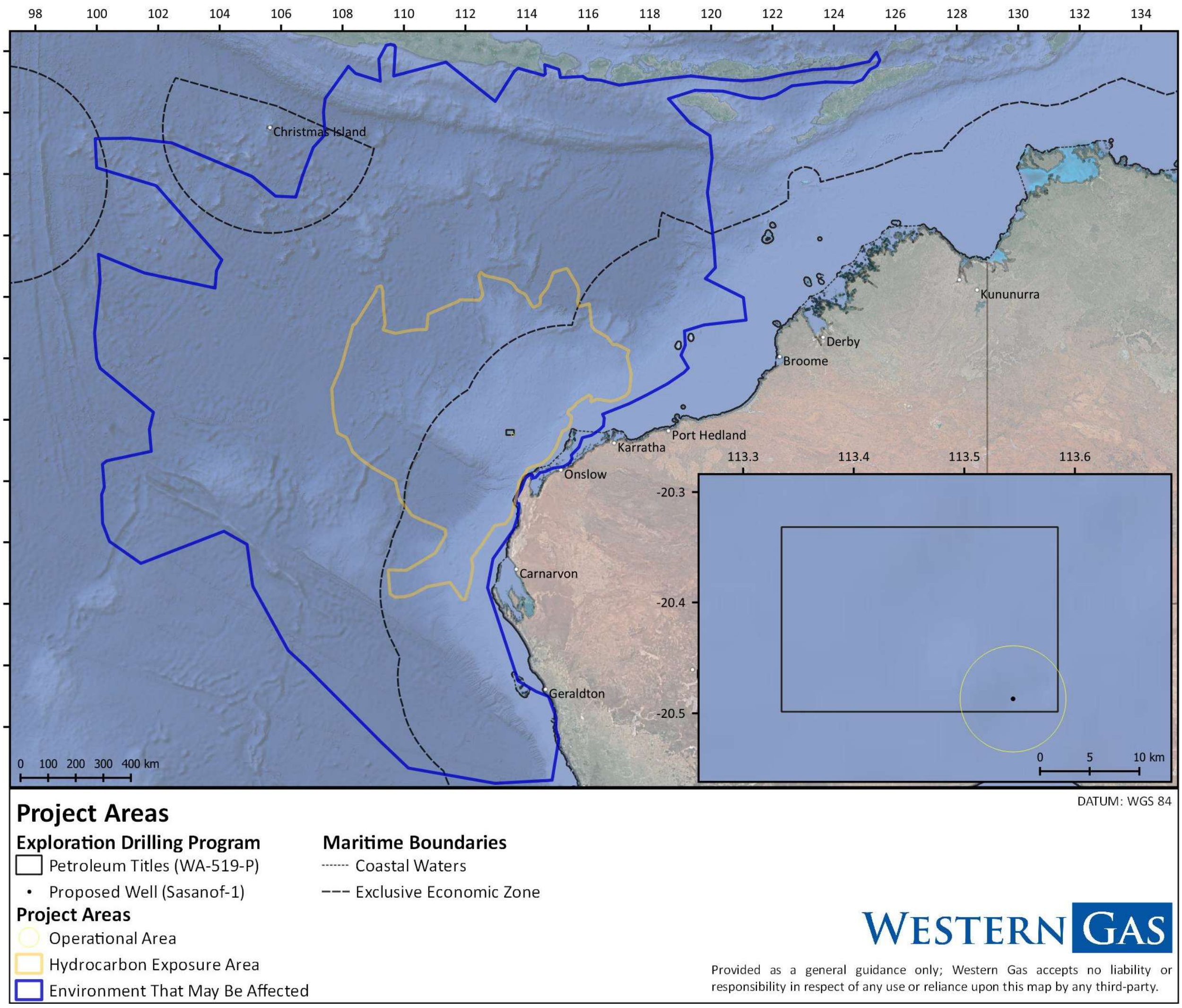



**Figure 4-3 Project Areas relevant to the Sasanof-1 Exploration Drilling**

**Table 4-7: Potentially affected receptors within each Project Area**

| Aspects | Project Areas | | | Physical Environment potentially impacted | | | | | | Ecological Environment potentially impacted | | | | | | | Socio-Economic Environment potentially impacted | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Operational Area | Hydrocarbon Exposure Area | EMBA | Water Quality | Sediment Quality | Air Quality | Climate | Ambient Light | Ambient Noise | Benthic Habitats & Communities | Coastal Habitats & Communities | Plankton | Birds | Fish & Sharks | Marine Mammals | Marine Reptiles | KEFs | AMPs | State Protected Areas – Marine | State Protected Areas – Terrestrial | Commercial Fisheries & Aquaculture | Marine and Coastal Industry | Tourism & Recreation | Heritage & Culture |
| **PLANNED** | | | | | | | | | | | | | | | | | | | | | | | | |
| Physical Presence – Interaction with Other Users | X | | | | | | | | | | | | | | | | | | | | X | X | X | |
| Physical Presence – Seabed Disturbance | X | | | X | | | | | | X | | | | | | | X | | | | | | | |
| Emissions - Atmospherics | X | | | | | X | X | | | | | | | | | | | | | | | | | |
| Emissions - Light | X | | | | | | | X | | | | | X | X | | X | | | | | | | | |
| Underwater Sound Emissions - Continuous | X | | | | | | | | X | | | X | | X | X | X | | | | | X | | | |
| Underwater Sound Emissions – Impulsive | X | | | | | | | | | | | | | | | | | | | | | | | |
| Planned Discharge – Drill Cuttings and Fluids | X | | | X | | | | | | X | | X | | | | | X | | | | | | | |
| Planned Discharge - Cement | X | | | X | X | | | | | X | | X | | | | | X | | | | | | | |
| Planned Discharge – Metal shavings | X | | | | X | | | | | | | | | | | | | | | | | | | |
| Planned Discharge – Hydraulic Fluids and Chemicals | X | | | X | | | | | | | | X | | | | | X | | | | | | | |
| Planned Discharge – Sewage and Greywater | X | | | X | | | | | | | | X | | | | | X | | | | | | | |
| Planned Discharge – Food Waste | X | | | | | | | | | | | | X | X | | | | | | | | | | |
| Planned Discharge – Deck Drainage and Bilge | X | | | X | | | | | | | | | | | | | | | | | | | | |
| Planned Discharge – Brine | X | | | X | | | | | | | | | | | | | | | | | | | | |
| Planned Discharge – Cooling Water | X | | | X | | | | | | | | X | | X | X | X | X | | | | | | | |
| **UNPLANNED** | | | | | | | | | | | | | | | | | | | | | | | | |
| Physical Presence – Interaction with Marine Fauna | X | | | | | | | | | | | | | | | X | X | | | | | | | |
| Introduction of IMS | X | | | | | | | | | X | | | | | | | | | | | X | | | |
| Accidental Release – Hazardous Materials | X | | | X | | | | | | | | X | | X | | | X | | | | | | | |
| Accidental Release – Solid Waste | X | | | | | | | | | | | | X | | | X | X | | | | | | | |
| Accidental Release – Bulk Transfer | X | | | X | | | | | | | | X | | X | X | X | X | | | | | | | |
| Accidental Release – Vessel Collision | | X | | X | | | | | | | | X | X | X | X | X | | | | | | | | |

| Aspects | Project Areas | | | Physical Environment potentially impacted | | | | | | Ecological Environment potentially impacted | | | | | | | Socio-Economic Environment potentially impacted | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Operational Area | Hydrocarbon Exposure Area | EMBA | Water Quality | Sediment Quality | Air Quality | Climate | Ambient Light | Ambient Noise | Benthic Habitats & Communities | Coastal Habitats & Communities | Plankton | Birds | Fish & Sharks | Marine Mammals | Marine Reptiles | KEFs | AMPs | State Protected Areas – Marine | State Protected Areas – Terrestrial | Commercial Fisheries & Aquaculture | Marine and Coastal Industry | Tourism & Recreation | Heritage & Culture |
| Accidental Release - LOWC | | X | X | X | | | | | | X | X | X | X | X | X | X | X | X | X | | X | X | X | X |

# 5 EXISTING ENVIRONMENT DESCRIPTION

The Sasanof-1 Exploration Drilling is located in Commonwealth waters approximately 156 km north of the North West Cape (Exmouth area) and 349 km west of Dampier, in water depths of 1070 m, within the North West (NW) Province (described in Section 5.2.1.4).

Project Areas related to this EP are described in Section 4.3 and shown in Figure 4-3. The nature and scale of existing environment descriptions provided in this Section relates to the potential impacts which may affect receptors within each Project Area, as described in Table 4-7.

The existing environment description is based on publicly available information such as government databases and management plans, published scientific literature, previous studies undertaken in close proximity to the Operational Area by Hess Corporation, and a search of the EPBC Act Protected Matters Search Tool (PMST), the results of which are also included in Appendix B: EPBC Protected Matters Search Tool Results.

While this EP makes use of the data previously collected and compiled by the Hess Corporation to support a detailed impact assessment of activities that were previously proposed, it has been updated with recent information to ensure it is up to date and based on best available information.

## 5.1 SUMMARY OF POTENTIALLY IMPACTED RECEPTORS

The presence of key environmental sensitivities that are potentially impacted by planned activities (Operational Area) and unplanned events (HEA and EMBA) is discussed in Table 5-1. Where impacts to receptors are not expected within defined Project Area, these cells are marked '*Not relevant*'.

**Table 5-1: Key Environmental Sensitivities in the Project Areas**

| | Project Area potential impact summary | | |
|---|---|---|---|
| **Receptor** | **Operational Area** | **Hydrocarbon Exposure Area** | **EMBA** |
| **Physical Environment** | | | |
| **Water Quality** (Section 5.3.1) | High quality - typical of the offshore, unpolluted tropical marine environment | High quality - typical of the offshore, unpolluted tropical marine environment | High quality - typical of the offshore, unpolluted tropical marine environment |
| **Sediment Quality** (Section 5.3.2) | High quality - typical of deep-water, offshore marine environment | High quality - typical of deep-water, offshore marine environment | *Not relevant* |
| **Air Quality** (Section 5.3.3) | High quality - typical of the offshore marine environment | *Not relevant* | *Not relevant* |
| **Climate** (Section 5.3.4) | Typical of the offshore marine environment | *Not relevant* | *Not relevant* |
| **Ambient Light** (Section 5.3.5) | Low light - typical of the offshore marine environment | *Not relevant* | *Not relevant* |
| **Ambient Noise** (Section 5.3.6) | Low noise - typical of the offshore marine environment.<br>Ambient noise expected to be 120 dB SPL RMS (INPEX, 2009). | *Not relevant* | *Not relevant* |
| **Ecological Environment** | | | |
| **Benthic Habitats and Communities** (Section 5.4.1) | • Deep homogeneous seafloor environment<br>• Widespread soft sediments typical of offshore marine environment.<br>• No light-dependent habitats or communities | • Unvegetated soft sediments are a widespread habitat in both intertidal and subtidal areas, particularly in areas beyond the photic zone.<br>• Variable biodiversity and productivity, depending upon depth, light, temperature and the type of | *Not relevant* |

| | Project Area potential impact summary | | |
|---|---|---|---|
| **Receptor** | **Operational Area** | **Hydrocarbon Exposure Area** | **EMBA** |
| | | sediment present. Shallower waters contain reefs, including Ningaloo | |
| **Coastal Habitat and Communities** (Section 5.4.2) | No Coastal Habitats and communities within the Operational Area | No Coastal Habitats and communities within the Hydrocarbon Exposure Area | A range of coastal habitats exist typical of the region, including shorelines rocky, sandy and tidal flats |
| **Plankton** (Section 5.4.3) | Low / medium productivity – typical of the NWMR however nutrient rich waters of the Exmouth Plateau may contribute to enhanced plankton diversity and abundance in the Operational Area. | • Low / medium productivity – typical of the NWMR however higher productivity resulting from nutrient rich waters of the Exmouth Plateau<br>• Offshore phytoplankton communities characterised by smaller taxa (e.g. cyanobacteria), while shelf waters are dominated by larger taxa (e.g. diatoms) | *Not relevant* |
| **Birds** (Section 5.4.4) | Listed Threatened (2): Red Knot (E), Southern Giant-Petrel (E)<br><br>Listed Migratory Marine (3)<br><br>Listed Migratory Wetland (4)<br><br>Listed Marine (7)<br><br>No BIAs. | Listed Threatened (16); Curlew sandpiper (CE), Northern Siberian Bar-tailed Godwit (CE), Eastern Curlew (CE); Red knot (E), Australian Painted-snipe (E), Southern Giant-Petrel (E), Abbott's Booby (E); Shy Albatross (E), Australian Lesser Noddy (V), Soft-plumaged Petrel (V), Northern Giant Petrel (V), Australian Fairy Tern (V), Indian Yellow-nosed Albatross (V), White-capped Albatross (V), Campbell Albatross (V), Black Browed Albatross (V).<br><br>Listed Migratory Marine (16)<br><br>Listed Migratory Wetland (9)<br><br>Listed Marine (30) | *Not relevant* |

| | Project Area potential impact summary | | |
|---|---|---|---|
| **Receptor** | **Operational Area** | **Hydrocarbon Exposure Area** | **EMBA** |
| | | BIAs (5); Wedge-tailed Shearwater breeding and foraging, Roseate Tern breeding, Sooty Tern foraging, Fairy tern breeding, Lesser Crested Tern breeding | |
| **Fish and Sharks** (Section 5.4.5) | Listed threatened (1): Great White Shark (V)<br>Listed Migratory Marine (6)<br>No BIAs in the Operational Area | Listed threatened (5): White Shark (V), Whale Shark (V), Grey Nurse Shark (V), Dwarf sawfish (V), Green Sawfish (V).<br>Listed Migratory Marine (11)<br>BIA (1); for Whale shark foraging | *Not relevant* |
| **Marine Mammals** (Section 5.4.6) | Listed Threatened (4): Blue whale (E), Sei whale (V), Fin whale (V), Humpback whale (V)<br>Listed Migratory Marine (8)<br>Listed Marine (24)<br>BIA (1); Pygmy blue whale migration | Listed Threatened (5): Blue whale (E), Southern Right Whale (E), Sei whale (V), Fin whale (V), Humpback whale (V)<br>Listed Migratory Marine (12)<br>Listed Marine (33)<br>BIA (3); Pygmy blue whale migration; Humpback migration, Dugong | *Not relevant* |
| **Marine Reptiles** (Section 5.4.7) | Listed Threatened (5): Loggerhead turtle (E), Leatherback turtle (E), Green turtle (V), Hawksbill turtle (V), Flatback turtle (V)<br>Listed Migratory Marine (5)<br>Listed Marine (8)<br>No BIAs or habitats critical to the survival of a species in the Operational Area | Listed Threatened (7): Short-nosed Seasnake (CE), Leaf-scaled Seasnake (CE), Loggerhead turtle (E), Leatherback turtle (E), Green turtle (V), Hawksbill turtle (V), Flatback turtle (V)<br>Listed Migratory Marine (5)<br>Listed Marine (22)<br>BIA / habitats critical to the survival of a species (4); Loggerhead – internesting, nesting; Green – aggregation, basking, foraging, internesting, nesting, | *Not relevant* |

| | Project Area potential impact summary | | |
|---|---|---|---|
| **Receptor** | **Operational Area** | **Hydrocarbon Exposure Area** | **EMBA** |
| | | mating; Hawksbill – foraging, internesting, nesting, mating; Flatback – aggregation, internesting, nesting, foraging, mating | |
| **Socio-Economic Environment** | | | |
| **Key Ecological Features** (Section 5.5.1.2) | Operational Area is located entirely within the Exmouth Plateau KEF | Hydrocarbon Exposure Area transects 8 KEFs | EMBA transects 16 KEFs. |
| **Australian Marine Parks** (Section 5.5.1.1) | There are no AMPs located within the Operational Area. Closest AMP to the Operational Area is the Gascoyne Marine Park (~ 22 km). | Hydrocarbon Exposure Area transects 6 AMPs | EMBA transects 11 AMPs |
| **State Protected Areas - Marine** (Section 5.5.2.1) | There are no State Marine Protected Areas located within the Operational Area | Hydrocarbon Exposure Area transects one State Marine Protected Area | EMBA transects 12 State Marine Protected Areas |
| **State Protected Areas – Terrestrial** (Section 5.5.2.2) | There are no State Terrestrial Protected Areas located within the Operational Area | There are no State Terrestrial Protected Areas located within the Hydrocarbon Exposure Area transects | EMBA transects 11 State Terrestrial Protected Areas |
| **Commercial Fisheries and Aquaculture** (Section 5.5.3) | Operations Area transects four Commonwealth Commercial Fisheries permit areas three State Commercial Fisheries.<br><br>Traditional Indonesian fishing MoU does not transect area. | Hydrocarbon Exposure Area transects five Commonwealth Commercial Fisheries permit areas 14 State Commercial Fisheries.<br><br>Traditional Indonesian fishing MoU does not transect area. | EMBA transects five Commonwealth Commercial Fisheries permit areas 25 State Commercial Fisheries.<br><br>Traditional Indonesian fishing MoU transects Browse Island. |
| **Defence** (Section 5.5.4.4) | Operational Area transects a marine interface for the Learmonth Air-to-Air Air Weapons Range. | Hydrocarbon Exposure Area transects a marine interface for the Learmonth Air-to-Air Air Weapons Range. | EMBA transects a marine interface for the Learmonth Air-to-Air Air Weapons Range. |

| | Project Area potential impact summary | | |
|---|---|---|---|
| **Receptor** | **Operational Area** | **Hydrocarbon Exposure Area** | **EMBA** |
| **Marine Industry (Petroleum and shipping)** (Section 5.5.4) | There is no other petroleum exploration or production within the Operational Area.<br><br>Commercial shipping lanes are located to the east of the Operational Area, and shipping volumes within the Operational Area are expected to be low.<br><br>There are no ports and harbours or submarine cables within the Operational Area. | There are six other petroleum facilities within the Hydrocarbon Exposure Area.<br><br>Commercial shipping lanes transect east portion of the Hydrocarbon Exposure Area.<br><br>The Hydrocarbon Exposure Area transects two submarine cables. | There are 14 other petroleum facilities within the EMBA.<br><br>Commercial shipping lanes transect east portion of the EMBA.<br><br>EMBA transects two ports and two submarine cables. |
| **Tourism and Recreation** (Section 5.5.5) | Given the distance offshore and the lack of features of interest, no tourism or recreation is expected to occur within the Operational Area. | The following activities may occur within the Hydrocarbon Exposure Area; Recreational fishing, Charter vessel tours, Cruises, Recreational diving, snorkelling, and other nature-based activities | The following activities may occur within the EMBA; Recreational fishing, Charter vessel tours, Cruises, Recreational diving, snorkelling, and other nature-based activities |
| **Heritage and Cultural Values** (Section 5.5.6) | There are no heritage or cultural values within the Operational Area. | The Hydrocarbon Exposure Area transects; one World Heritage listed location, one National Heritage listed location, one Commonwealth Heritage listed location and two Underwater Cultural Heritage features occur.<br><br>No Aboriginal heritage or indigenous Protected Areas exist within Hydrocarbon Area. | The EMBA transects; one World Heritage listed location, three National Heritage listed location, two Commonwealth Heritage listed location and two Underwater Cultural Heritage features occur.<br><br>No Aboriginal heritage or indigenous Protected Areas exist within EMBA. |

## 5.2 REGIONAL GEOGRAPHICAL SETTING

Regional descriptions relevant to the Project Area as shown in Table 5-2 are provided in the section below.

**Table 5-2: Marine Regions and Provinces relevant to the Project Areas**

| Marine Regions and Provinces | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| **North-west marine region** | | | |
| Timor Province | - | - | ✓ |
| Northwest Shelf Province | - | - | ✓ |
| Northwest Transition | - | ✓ | ✓ |
| Northwest Province | ✓ | ✓ | ✓ |
| Central Western Shelf Transition | - | ✓ | ✓ |
| Central Western Transition | - | ✓ | ✓ |
| Central Western Shelf Province | - | - | ✓ |
| **South-west marine region** | | | |
| Central Western Province | - | ✓ | ✓ |
| Southwest Shelf Transition | - | - | ✓ |
| Christmas Island Territory | - | - | ✓ |
| Outside Australian Economic Exclusion Zone (EEZ) | - | - | ✓ |
| Cocos (Keeling) Island Territory | - | - | ✓ |

### 5.2.1 North-west Marine Region

The Operational Area, Hydrocarbon Exposure Area and EMBA are all located within the North-west Marine Region (NWMR). The NWMR comprises Commonwealth waters from the Western Australian – Northern Territory border to Kalbarri, south of Shark Bay. It covers some 1.07 million km$^2$ of tropical and sub-tropical waters.

Those parts of the Region adjacent to the Kimberley and Pilbara include thousands of square kilometres of shallow continental shelf (about 30 per cent of the total Region), although Australia's narrowest shelf margin is also to be found within the Region at Ningaloo Reef. Over 60 per cent of the seafloor in the Region is continental slope, of which extensive terraces and plateaux make up a large proportion. Those parts of the Argo and Cuvier abyssal plains that are included within the Region comprise about 10 per cent of the Region's total area. Overall, the Region is relatively shallow with more than 50 per cent of the Region having water depths of less than 500 m. The deepest parts of the Argo and Cuvier abyssal plains within the Region, however, reach water depths of almost 6000 m.

The Region is characterised by shallow-water tropical marine ecosystems. While in general endemism is not particularly high by Australian standards, the Region is home to globally significant populations of internationally threatened species.

IMCRA identifies eight provincial bioregions in this Region within the EMBA, which are described in the sub-sections below.

#### 5.2.1.1 Timor Province

The EMBA overlaps the Timor Province provincial bioregion.

The Timor Province covers almost 15 per cent of the NWMR, predominantly covering the continental slope and abyss between Broome and Cape Bougainville. Water depth ranges from about 200 m near the shelf break to 5,920 m over the Argo Abyssal Plain. In addition to the Argo Abyssal Plain, the major geomorphic features are the Scott Plateau, the Ashmore Terrace, part of the Rowley Terrace and the Bowers Canyon. Ashmore Reef, Cartier Island, Seringapatam Reef and Scott Reef are important features of the provincial bioregion.

The bioregion is dominated by the warm, oligotrophic waters of the Indonesian Throughflow. The variety of geomorphic features in the Timor Province, together with the variation in bathymetry, results in several distinct habitats and biological communities, many of which are in close proximity to each other. The reefs and islands of the bioregion are regarded as particular hotspots for biodiversity. A high level of endemicity exists in demersal fish communities of the continental slope in the Timor Province and two distinct communities have been identified; one associated with the upper slope, the other with the mid slope.

#### 5.2.1.2 Northwest Shelf Province

The EMBA overlaps the Northwest Shelf Province provincial bioregion.

The North-west Shelf Province covers an area of 238,759 km$^2$ and is located primarily on the continental shelf between North West Cape and Cape Bougainville. As such, about half the bioregion has water depths of only 50-100 m, with maximum depths reaching only 200 m. The bioregion varies in width from approximately 50 km at Exmouth Gulf to more than 250 km off Cape Leveque.

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

Fish communities are diverse, with both benthic and pelagic fish communities represented. Humpback whales migrate through the bioregion and Exmouth Gulf is an important resting area, particularly for mothers and calves on their southern migration. Several important seabird breeding sites are located in the region (outside of Commonwealth waters), including Eighty Mile Beach, the Lacepede Islands, and Montebello and Barrow islands. The bioregion is important for the petroleum industry, commercial fishing operations, and shipping, with nationally significant ports of Dampier and Port Hedland present.

#### 5.2.1.3 Northwest Transition

The Hydrocarbon Exposure Area and EMBA overlap the Northwest Transition provincial bioregion.

The North-west Transition covers an area of 184,424 km$^2$ and encompass a range of water depths, from the shelf break (200 m depth) over the continental slope, to depths of more than 1,000 m (DEWHA, 2008).

The provincial bioregion has a complex seafloor topography with a diversity of features including submerged terraces, carbonate banks, pinnacles, reefs and sand banks. The carbonate banks and pinnacles 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.

The biological communities are typical of Indo-west Pacific tropical flora and fauna and occur across a range of soft-bottom and harder substrate habitats. The inshore waters off the Kimberley are where the Western Australian population of humpback whales mate and give birth. The Northwest Shelf Transition is important for commercial fisheries, defence, and the petroleum industry.

#### 5.2.1.4 Northwest Province

The Operational Area, Hydrocarbon Exposure Area and EMBA are all located within or overlap the Northwest Province provincial bioregion.

The Northwest Province covers an area of 178,651 km$^2$ offshore between Exmouth and Port Headland. It consists entirely of continental slope, with water depths ranging from 1,000-3,000 m.

The dominant geomorphic feature is the Exmouth Plateau, while the Montebello Trough and Swan Canyon are also important features. It contains the steepest shelf break in the Marine Region along the Cape Range Peninsula near Ningaloo Reef. Circulation and recirculation (via the South Equatorial Current) of Indonesian Throughflow waters comprise the dominant surface flow. The predominantly southward moving surface waters consolidate along the narrow shelf break adjacent to Cape Range Peninsula to form the Leeuwin Current, a significant feature of this bioregion and those further south.

The canyons in this bioregion probably channel currents onto the Exmouth Plateau and certainly onto the shelf along Ningaloo Reef, resulting in enhanced localised biological production. The Northwest Province represents the beginning of a transition between tropical and temperate marine species. High endemism in demersal fish communities on the slope is also evident in this provincial bioregion. Commercial fishing and petroleum are important industries in some parts of the bioregion.

#### 5.2.1.5 Central Western Shelf Transition

The EMBA and Hydrocarbon Exposure Area overlap the Central Western Shelf Transition provincial bioregion.

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

Although both the Leeuwin Current and the Leeuwin Undercurrent occur on the adjacent slope, this bioregion is strongly influenced by the interactions between these currents and the nearshore, northward flowing Ningaloo Current.

The bioregion is located within a significant biogeographic transition between tropical and temperate species. A large proportion of the bioregion is covered by the Ningaloo Marine Park, and Ningaloo Reef is an area of high biodiversity with over 200 species of coral and more than 460 species of reef fish. Marine turtles, dugongs and dolphins frequently visit the reef lagoon and whale sharks and manta rays visit the outer reef. Commercial fishing and petroleum are the major industries in the bioregion.

#### 5.2.1.6 Central Western Transition

The EMBA and Hydrocarbon Exposure Area overlap the Central Western Transition provincial bioregion.

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 5,330 m, 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.

#### 5.2.1.7 Central Western Shelf Province

The EMBA overlaps the Central Western Shelf Province provincial bioregion.

The Central Western Shelf Province provincial bioregional consists of the continental shelf between Kalbarri and Coral Bay. Most of the bioregion varies in depth between 50–100 m and has a predominantly flat, sandy substrate. The main currents are the Leeuwin (centred on the shelf break), the Ningaloo (which originates around the mouth of Shark Bay and flows north, and the northern extreme of the wind-driven Capes Current. In addition, during summer seepage out of Shark Bay of hypersaline water occurs and is known as the Shark Bay Outflow.

The bioregion abuts the Shark Bay World Heritage Area, a globally important area for dugongs. Commercial fishing and petroleum are the main industries in the bioregion.

### 5.2.2 South-west Marine Region

The EMBA and Hydrocarbon Exposure Area overlap the South-west Marine Region.

The South-west Marine Region (SWMR) comprises Commonwealth waters from the eastern end of Kangaroo Island in South Australia to Shark Bay in Western Australia. The region spans approximately 1.3 million km$^2$ of temperate and subtropical waters and abuts the coastal waters of South Australia and Western Australia.

The main physical features of the region include a narrow continental shelf on the west coast from the subtropics to temperate waters off south-west Western Australia, with a wide continental shelf dominated by sandy carbonate sediments of marine origin (i.e. crushed shells from snails and other small animals and calcareous algae) in the Great Australian Bight. There is high wave energy on the continental shelf around the whole region.

Depths vary throughout the Region, with islands and reefs in both subtropical (Houtman Abrolhos Islands) and temperate waters (e.g. Recherche Archipelago), and a steep, muddy continental slope which include many canyons; the most significant being the Perth Canyon, the Albany canyon group and the canyons near Kangaroo Island. Deeper waters can be found, including large tracts of poorly understood abyssal plains at depths greater than 4,000 m, the Diamantina Fracture Zone, a rugged area of steep mountains and troughs off south-west Australia at depths greater than 4,000 m, and the Naturaliste Plateau, an extension of Australia's continental mass that provides deep-water habitat at depths of 2,000–5,000 m.

By global standards, the marine environment of the SWMR has high biodiversity and large numbers of species native to the region (known as endemism). Particular hotspots for biodiversity are the Houtman Abrolhos Islands, the overlap between tropical and temperate fauna along the west coast, the Recherche Archipelago and the soft sediment ecosystems in the Great Australian Bight.

##### 5.2.2.1 Central Western Province

The EMBA and Hydrocarbon Exposure Area are located within the Central Western Transition provincial bioregion.

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 4,000 m, with the maximum water depth in the bioregion recorded at 5,330 m, 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.

##### 5.2.2.2 Southwest Shelf Transition

The EMBA is located within the Southwest Shelf Transition provincial bioregion.

The Southwest Shelf Transition is a nearshore bioregion that covers the area of continental shelf from Perth to Kalbarri and extends out to the edge of the shelf. The Commonwealth waters of this bioregion extend from the limit of Western Australian State waters to the shelf-break. The Leeuwin Current has a significant influence on the biodiversity of this bioregion as it pushes subtropical water southward along the western edge of the bioregion. 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.

This bioregion consists of a narrow continental shelf, ranging from approximately 40-80 km wide that is noted for its physical complexity. It includes a series of nearshore ridges and depressions that form inshore lagoons, a smooth inner shelf plain, a series of offshore ridges and a steep, narrow outer shelf. The bioregion contains a diversity of tropical and temperate marine life including a large number of endemic fauna species. The west coast of Western Australia, from Ningaloo Reef down

### 5.2.3 Christmas Island Territory

The EMBA transects the Christmas Island Territory provincial bioregion.

Christmas Island an external territory located in the Indian Ocean, part of the Indian Ocean Territories (IOT). The Island has an area of 137.4 $km^2$ and includes the Christmas Island National Park (135 $km^2$).

The Island's 80 km coastline is an almost continuous sea cliff reaching heights of up to 20 m. The Island is surrounded by a coral reef. There is virtually no coastal shelf and the sea plummets to a depth of about 5000 metres within 200 m of the shore. The climate is tropical and temperatures range from 21 °C to 32 °C. Humidity is around 80–90 per cent and south-east trade winds provide pleasant weather for most of the year. However, during the wet season between November and April, it is common for some storm activity to occur producing a swell in seas around the Island. The average rainfall is approximately 2000 mm per annum.

The Island's close proximity to South-East Asia and the equator has resulted in a diverse range of flora and fauna. There are 411 recorded plant species on Christmas Island and approximately 18 of these are native. The land crabs and sea birds are the most noticeable animals on the island. The island is a focal point for seabirds of various species, with eight species or subspecies of seabirds nesting on the island. The endemic Christmas Island Frigatebird (listed as endangered) has three well-defined nesting areas.

### 5.2.4 Cocos (Keeling) Island Territory

The EMBA transects the Cocos (Keeling) Islands Territory provincial bioregion.

The Cocos (Keeling) Islands is an external territory located in the Indian Ocean, part of the Indian Ocean Territories (IOT). There are 27 coral islands in the group with a total land area of approximately 15.6 square kilometres. Apart from North Keeling Island, which is 30 km from the main group, the Islands form a horseshoe-shaped atoll surrounding a lagoon. North Keeling Island was declared a National Park in 1995.

The Cocos (Keeling) Islands' atolls are horseshoe shaped coral atolls, affected by prevailing winds and oceans. Coral sand beaches are to the seaward and mudflats can be found on the lagoon side. The northern atoll consists of North Keeling Island, where the island and the marine area extending 1.5 km around the Island form the Pulu Keeling National Park. It is an important example of an atoll in its natural state and supports an internationally significant seabird rookery. It is also home to land crabs, turtles, and a range of flora, as well as featuring an intact coral atoll.

The climate is tropical with high humidity. Temperatures range from 23 °C to 30 °C. The average rainfall is 2000 mm per annum falling mainly from January to August. The south-east trade winds blow most of the year producing pleasant weather conditions.

The marine environment supports a wide range of corals, fish, molluscs, crustaceans and other species. Turtles, manta rays, reef sharks and common dolphins are regularly sighted.

### 5.2.5 Outside Australian EEZ

The EMBA transects the area outside of the Australian Exclusive Economic Zone (EEZ).

The section of Australia’s EEZ located offshore Western Australia extends to 200 nautical miles from the territorial sea limit along the mainland and Australia’s Indian Ocean Territories. Australia’s EEZ shares boundaries with:

- International waters, to the west and south of the WA section of the EEZ. International waters are managed under the United Nations Law of the Sea Convention (UNCLOS), administered by the International Maritime Organisation (IMO).

- Timor-Leste EEZ to the north west. as prescribed by the 1982 United Nations Convention on the Law of the Sea.
- Indonesia. This boundary is defined in accordance with the Perth Treaty negotiated with the Republic of Indonesia.

Indonesia has the second longest coastline in the world at 95,181 km and has the greatest coral reef area of any country in the world totalling 51,020 km$^2$.

Central and eastern Indonesia lies within the Coral Triangle, an area of globally significant marine biodiversity. Over 70% of all reef-building coral species are found in Indonesia. Among the threats to Indonesia's reefs are direct human impacts such as overfishing and destructive fishing practices, such as blasting and poisoning, as well as indirect threats from coastal development and pollution from land-based sources.

To manage environmental sensitivities within its waters, Indonesia has established a large network of marine protected areas (MPA). MPAs relevant to the Sasanof-1 Exploration Drilling are listed in Table 5-3.

**Table 5-3: Indonesian Marine Protected Areas Relevant to the Sasanof-1 Exploration Drilling**

| Indonesian MPA | Protection Category / Listing | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| KKP Nusa Penida | IUCN Category VI | X | ✓ |
| KKPD Selat Pantar Dan Perairan Sekitarnya Kabupaten Alor Marine Nature Reserve | IUCN Category IV | X | ✓ |
| KKPD Kabupaten Flores Timur Marine Nature Reserve | IUCN Category IV | X | ✓ |
| Pulau Lembata Marine Protected Areas | IUCN category not reported | X | ✓ |
| KKPN Laut Sawu Marine National Park | IUCN Category II | X | ✓ |

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

## 5.3 PHYSICAL ENVIRONMENT

### 5.3.1 Water Quality

Water quality in the NWMR is regulated by the Indonesian Throughflow (ITF) and is the primary driver of the oceanographic and ecological processes in the region (DEWHA 2008). Water quality in the EMBA is typical of an unpolluted tropical offshore environment. Much of the surface water in this area is nutrient poor, transported from the ITF and has low primary productivity. With variations to this state (e.g. increased turbidity) occurring in more coastal regions that are subject to large tidal ranges, terrestrial run-off or anthropocentric factors (i.e. ports, industrial discharges, etc.).

As per the EMBA, water quality in the Hydrocarbon Exposure Area and Operational Area is typical of an unpolluted tropical offshore environment, being nutrient poor and with low primary productivity. The Operational Area (and Hydrocarbon Exposure Area) is located within the Exmouth Plateau, which is recognised as a Key Ecological Feature (KEF). It is possible that the Exmouth Plateau may modify deep-water flow and contribute to the upwelling of deeper, nutrient-rich waters closer to the surface. While the overall productivity of the plateau is low, sporadic but widespread upwelling events are visible in satellite imagery (Brewer et al. 2007). Seawater surface temperatures in the offshore areas, within vicinity of the Operational Area are usually thermally stratified (SSE 1993). Sea surface temperatures range from approximately 22°C in winter and 30°C in summer (Pearce et al. 2003). The seafloor water temperature tends to remain fairly constant throughout the year at <6°C.

Water profiling and water quality sampling was undertaken during baseline surveys at the Equus Exploration Permit Area WA-390-P (RPS 2012a; ERM 2013). Key results from the baseline surveys include:

- The near-surface environment in the WA-390-P Permit Area is typical of the eastern Indian Ocean;
- A well-mixed surface layer exists (~5 - 100 m water depth) of warm (25 - 30°C) low salinity (34.50 - 34.75 PSU) water;
- Below the mixed layer, water temperatures decrease to a constant 10°C at 400 m depth;
- Petroleum hydrocarbons were not detected in water samples;
- Low concentrations of metals, nutrients and chlorophyll-a (chl a) were detected;
- A well-oxygenated surface layer was present (40 - 80 m deep) with dissolved oxygen decreasing with depth; and
- Total suspended solid concentrations were generally low (<2 mg/L).

### 5.3.2 Sediment Quality

Marine sediment quality within the North West region is expected to be representative of the 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, industrial discharges, etc.).

Approximately 80% of the North West (NW) Province bioregion occurs, is in depths of between 1,000 and 3,000 m. The lower slopes contain seven types of geomorphic features including plateaus, deeps/holes/valleys, terraces, trenches/troughs and canyons. The Exmouth Plateau covers approximately 28% of this bioregion and has been shown to have relatively homogeneous sedimentology of mud and sands (Baker et al., 2008).

Seabed sediments of the continental slope in the North West Shelf (NWS) Province are generally dominated by carbonate silts and muds, with sand and gravel fractions increasing closer to the shelf break (Baker et al., 2008). The NWS is primarily covered by carbonate sediments of mostly skeletal origin, overlying a thick carbonate wedge (Brewer et al., 2007).

The EMBA covers multiple bioregions and so is expected to include sediments from these bioregions as detailed in Section 5.2. Sediment quality within the vicinity of the EMBA will be typical of the offshore marine environment on the NWS, which is characterised by high sediment quality with low background concentrations of trace metals and organic chemicals, and little anthropocentric influence. Exceptions may occur in close proximity to ports where elevated concentrations of metals and hydrocarbons may be present (DEC, 2006).

The HEA is located wholly in Commonwealth waters, ~155 km north of Exmouth, WA within the Northern Carnarvon Basin (NCB) geological region. The Operations Area is situated in the Montebello Trough west of the continental slope of the NWS. This area is dominated by fine grained sediments (Jones 1973 cited in Baker et al. 2008) with thicker accumulations of carbonate deposits at the shelf edge. Carbonate mud constitutes a major component of the sediment and contains modern pelagic ooze and aragonitic needle-rich micrite (Dix et al. 2005 cited in Baker et al 2008).

Previous box coring, pre-drilling ROV surveys, sediment grab sampling and seismic and sonar surveys have been undertaken by Hess Corporation throughout Permit WA-390-P (now subdivided into WA-70-R and adjacent to WA-519-P) (SKM, 2006; RPS, 2012b). Given the proximity of WA-390-P to the exploration area (WA-519-P) the similarity of water depths and absence of any known seabed features, it is assumed that seabed geomorphological attributes at these permit areas would be consistent across the Operational Area.

A sediment and infauna field surveys conducted within WA-390-P (SKM, 2006; RPS, 2012b) found that sediments across were dominated by olive/grey silty clay and medium fine sands. No Polycyclic Aromatic Hydrocarbons (PAHs) were detected in any of the samples, with only two of the samples showing very low levels of Total Petroleum Hydrocarbons (TPHs).

### 5.3.3 Air Quality

Air quality data within the NWMR is limited. However, the Operational Area is expected to be of high air quality due to the remote offshore locations. Whilst anthropogenic sources, such as industry developments and shipping, would contribute to local variations in air quality, previous monitoring within the NWMR region suggests that the concentration of air quality parameters remains low.

### 5.3.4 Climate

The NWMR is characterised by complex weather cycles with very hot summers and mild winters with rainfall typically greatest during the summer period due to tropical lows and tropical cyclone activity (Sudmeyer 2016, CSIRO, 2011). The prevailing summer winds are from the northwest and southwest, swinging around to dry south-easterlies over winter. However, in coastal areas local sea breezes often dominate the daily patterns. (Semeniuk et al. 1982; Hamilton, 1997) with strong land/sea breezes of up to 10 m/s super imposed on the synoptic pattern (Pearce et al 2003). During the summer period, tropical cyclones form between northern Australia and Indonesia. An average of two to three a year follow a south-westerly course parallel to the NWS before swinging south and crossing the Pilbara coast. The Pilbara is the most tropical cyclone prone coast in Australia and on average are more severe than elsewhere in Australia (CSIRO 2011).

### 5.3.5 Ambient Light

The Operational Area is remote from urban or industrial areas and therefore ambient light levels in the Operational Area are expected to be low.

Ambient light within the Operational Area is expected to predominantly be from solar and lunar luminance. However, artificial light sources associated with anthropogenic activities also exist, including both permanent and temporary (e.g. local vessel traffic) light sources.

### 5.3.6 Ambient Noise

The majority of the offshore NWMR is relatively remote and therefore ambient noise levels in the Operational Area are expected to be low. Background noise levels within the NWMR and offshore Pilbara regions are expected to represent the typical range for calm to windy conditions, though heavy rain can result in higher noise levels in the area. Underwater broadband ambient noise spectrum levels range from 45-60 dB re 1 µPa in quiet regions (light shipping and calm seas) to 80-100 dB re 1 µPa for more typical conditions and over 120 dB re 1 µPa during periods of high winds, rain (INPEX, 2009). Ambient noise may also be generated by biological sources (e.g. echo-location and communication noises generated by cetaceans and fish).

Commercial shipping and fishing are likely to occur within the vicinity of the Operational Area. A main shipping fairway traverses through the western side of the Operational Area (Section 5.5.4). Occasional anthropogenic low frequency ambient noise is also likely, generated by mid to large vessels such as tankers (~184 dB re 1 µPa RMS).

## 5.4 ECOLOGICAL ENVIRONMENT

### 5.4.1 Benthic Habitats and Communities

The Hydrocarbon Exposure Area and wider EMBA extends across multiple NWMR and SWMR bioregions, while Operational Area exist wholly within the Northwest Province. Benthic substrates within these regions varies from calcareous gravel, sands and silts along the shallower shelf area, to areas of slope and deep ocean floor dominated by sands and muds.

Unvegetated soft sediments are a widespread habitat in both intertidal and subtidal areas, particularly in areas beyond the photic zone. The biodiversity and productivity can vary depending upon depth, light, temperature and the type of sediment present. Infauna is documented to occur in coastal waters to depths of approximately 200 m and are widely distributed through subtropical and tropical waters of WA (Jones and Morgan 1994).

Invertebrate communities (which can include corals, sponges, filter feeders etc.) are common along the coast of the NWMR, particularly on the hard substrate between Dampier and Port Hedland, which has been described as a hotspot for sponge biodiversity (DEWHA 2008). The shallower waters of the region also contain an extensive array of small barrier and fringing reefs, including important sites such as Ningaloo, which is thought to be the one of the richest areas of marine biodiversity in Western Australia. Coastal seagrasses and algal mats also provide important habitat for fish and dugongs through the length of the bioregion, especially surrounding the offshore Barrow and Montebello islands (DEWHA 2008).

Within the Operational Area benthic communities are expected to comprise primarily of scavengers, detrital feeders and filter feeding organisms (DEWHA, 2008) with percentage cover of epibenthic communities typically less than that of shallower regions (Fulton et al.,2006). The Operational Area lies within an area of deep water (~1,000 m), with a homogenous seafloor, therefore, it is unlikely that sensitive benthic habitats will be encountered. The water depths at the Operational Area will preclude the formation of light-dependent taxa such as coral, seagrass or macroalgal assemblages (Woodside 2005, Woodside 2006).

Surveys within the NW Provence from similar depths to the Operational Area report that the benthic environment is dominated by soft, bare, unconsolidated sediments (SKM 2006, Gardline 2009). Video footage of these sediments showed sparse bioturbation which RPS (2012b) suggests is evidence of burrowing polychaete worms, crustaceans and bivalve molluscs. Deposit feeders such as sea cucumbers and sea urchins were also observed during the video footage but infrequently (RPS 2012b)

A study by RPS (2012b) of permit area WA-390-P (adjacent to WA-519-P) showed that the majority of infauna sampled were crustaceans (gammarid amphipods, consisting of 30% of individuals identified) and polychaetes (consisting of 28% of individuals identified). The survey showed a low diversity of infauna within the sampling sites, which is typical of deep-water sediments (Rowe et al 1982). The RPS (2012b) survey showed no evidence of exposed substrate across the 18 sampling stations within the permit area.

No BIAs for benthic assemblages are present within the Operational Area. The EPBC PMST did not identify any threatened benthic species/ecological communities. The WA-519-P permits overlap the Exmouth Plateau KEF. 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 ~1,000 m (DEE 2019b).

#### 5.4.1.1 Coral

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 cited in GLE 2019). 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 cited in GLE 2019).

Within the shallow waters of the EMBA is an extensive array of small barrier and fringing coral reefs. Situated within the EMBA is the Ningaloo Reef which is the largest fringing coral reef in Australia, is over 300 km in length and forms a discontinuous barrier enclosing a lagoon. The lagoon varies in width from 200 m to about 7 km, with an average of about 2.5 km (DPAW 2016). The Ningaloo Reef is characterised by a high diversity of hard corals with at least 217 species representing 54 genera of hermatypic (reef building) corals recorded (Veron and Marsh 1988). Corals are also known to occur in shallow areas around some of the Pilbara inshore islands. (Figure 5-1).

Within Hydrocarbon Exposure Area water depths tend to be greater than 80 m depth, as such no zooxanthellate corals are expected to occur. However, occasional soft corals are expected to occur within region. An ROV survey for the Griffin Pipeline (WA-3-PL) area showed a sparse community of sponges in shallow water up to 80 m (Surespek 2008 cited in BHP 2014).

As the Operational Area is situated in water depths of ~1,000 m, no zooxanthellate corals are expected to occur. Occasional soft corals are known to occur within the Exmouth Plateau and have been observed during nearby benthic video surveys (RPS 2005, URS 2010 cited in RPS 2012).

#### 5.4.1.2 Macrophytes

Macrophyte are aquatic plants that grows in or near water and are either emergent, submergent, or floating; and include seagrass and macroalgae.

Seagrasses are marine flowering plants, with about 30 species found in Australian waters (Huisman 2000). Seagrasses generally grow in sediments in intertidal and shallow subtidal waters where there is sufficient light and are common in sheltered coastal areas such as bays, lees of island and fringing coastal reefs (McLeay et al. 2003; Rogers et al. 2013; McClatchie et al. 2006). Seagrass meadows are important in trapping and stabilising sediments, as seagrass leaves baffle wave action and reduce water movement to the extent that fine suspended particles settle out and are trapped (Edyvane 1999). Seagrass meadows also provide habitat and nursery grounds for juvenile fish and invertebrates, enhance biodiversity and promote primary production (Huisman 2000; Rogers et al. 2013; Kirkman 1997).

Known seagrass habitats within the EMBA occurs within the Ningaloo reef area. Eleven seagrass species are known to occur nearby within North West Cape and Exmouth Gulf region (McMahon et al. 2017).

Macroalgae communities are generally found on intertidal and shallow subtidal rocky substrates and can occur throughout Australian nearshore waters. Macroalgae are divided into three groups: Phaeophyceae (brown algae), Rhodophyta (red algae), and Chlorophyta (green algae). Brown algae are typically the most visually dominant and form canopy layers (McClatchie et al. 2006). Macroalgal systems are an important source of food and shelter for many ocean species; including in their unattached drift or wrack forms (McClatchie et al. 2006). Macroalgae habitat is known to occur within the nearshore areas surrounding some of the Pilbara inshore islands, including the Muiron Island.

Habitats able to support significant macrophytes communities such as those described above are not present within EMBA, therefore, macrophytes are not expected to occur.

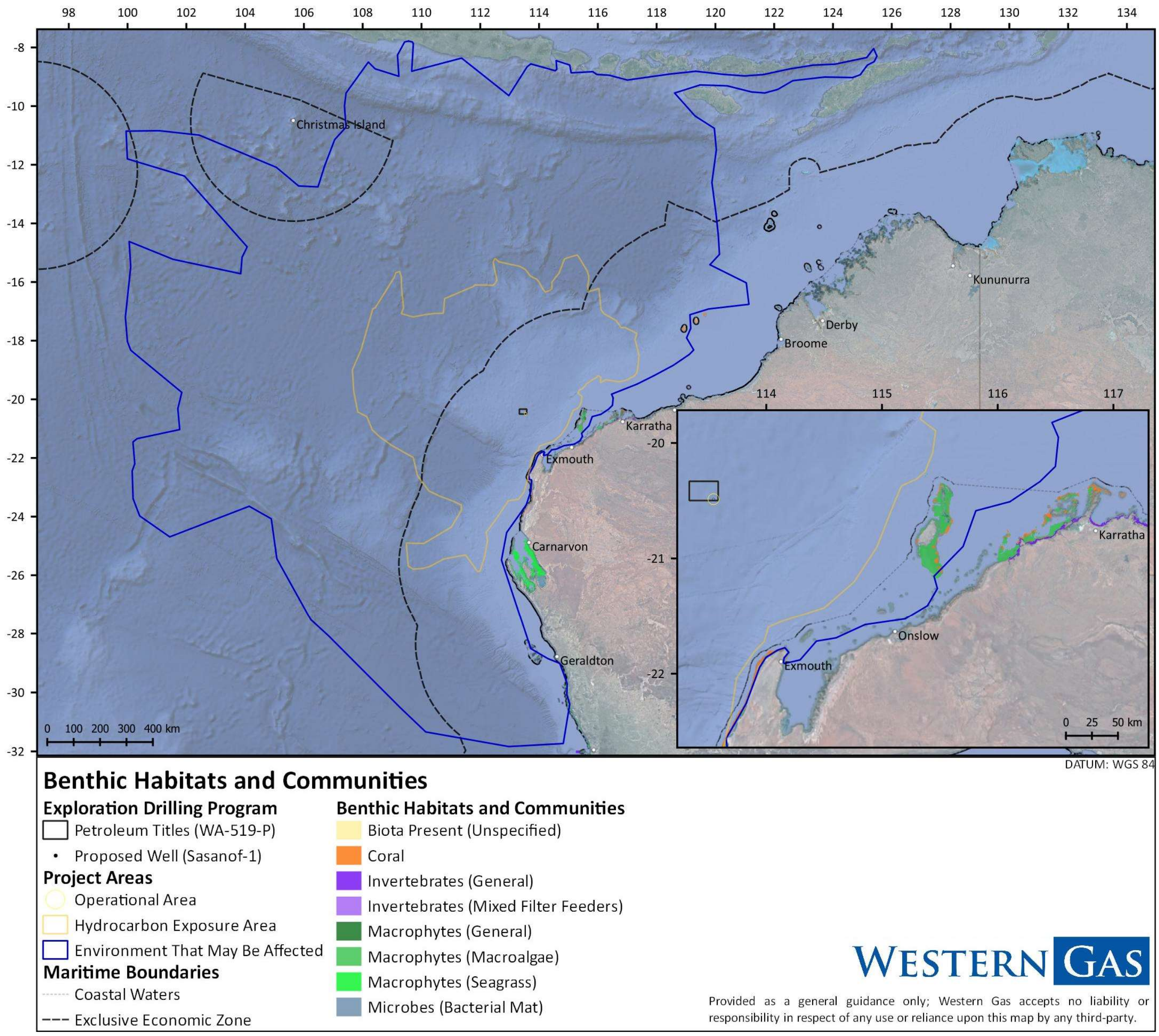



**Figure 5-1 Known benthic habitats within Project Areas**

### 5.4.2 Coastal Habitats and Communities

Coastal habitats are the landforms that coastal communities grow on or in; these are typically considered in terms of shoreline type and can vary from sandy beaches to coastal cliffs. Table 5-4 details shoreline types that may occur in the Project Areas. Coastal communities are biological communities that live within the coastal zone; these communities include wetlands and other intertidal flora/vegetation such as saltmarsh or mangroves. A variety of fauna (e.g. birds) also form a part of these coastal communities (GLE 2019).

The EMBA encompasses coastal habitats and communities within the Northwest Cape and Pilbara inshore island regions (Figure 5-2). The shoreline is dominated by a mixture of tidal flats and sandy beaches, with small areas of rocky coast, particularly around Barrow, Montebello and other inshore islands. The tidal flat regions typically coincide with areas of known saltmarsh and mangrove habitat, within the gulfs, inlets and embayments. There is no marine/coastal wetland habitat designated as internationally (i.e. Ramsar) or nationally important within the EMBA.

**Table 5-4: Shoreline types within the Project Areas**

| Shoreline Type | Description, Values and Sensitivities | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|---|
| Rocky | Hard and soft rocky shores, including bedrock outcrops, platforms, low cliffs (less than five metres), and scarps. Depending on exposure, rocky shores can be host to a diverse range of flora and fauna, including barnacles, mussels, sea anemones, sponges, sea snails, starfish and algae. | X | X | ✓ |
| Tidal flats | This shoreline type can often be associated with mangrove or saltmarsh environments. These typically sheltered habitats can provide a nursery ground for many species of fish and crustacean and provide shelter or nesting areas for birds. | X | X | ✓ |
| Sandy | Beaches dominated by sand-sized (0.063–2 mm) particles; also includes mixed sandy beaches (i.e. sediments may include muds or gravel, but sand is the dominant particle size).<br><br>Sandy beaches are dynamic environments, naturally fluctuating in response to external forcing factors (e.g. waves, currents etc). Sandy beaches can support a variety of infauna and provide nesting habitat to birds and turtles. Sand particles vary in size, structure and mineral content; this in turn affects the shape, colour and inhabitants, of the beach. | X | X | ✓ |
| Artificial | Man-made structures along the coast, including breakwaters, piers, jetties. This is a common feature in urban areas, although does not typically extend for long stretches of coast. | X | X | X |

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

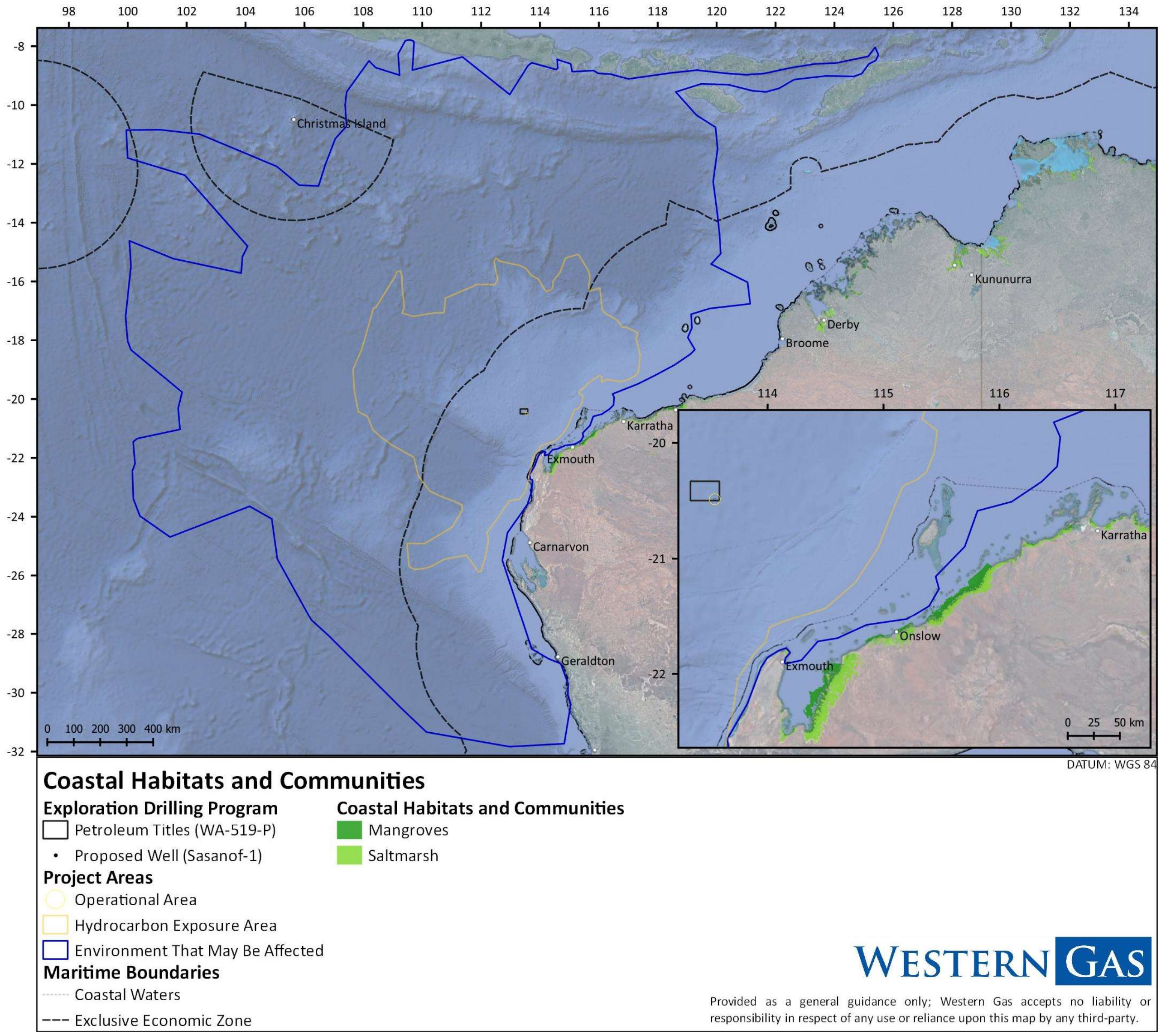



**Figure 5-2 Known coastal habitats and shoreline types within Project Areas**

### 5.4.3 Plankton

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 tend to largely comprise 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. Seasonal variation in phytoplankton (via chlorophyll-a (chl a) concentrations) has been demonstrated in Australian waters from the analysis for MODIS-Aqua sensor imagery (Figure 5-3). Offshore phytoplankton communities in the region are characterised by smaller taxa (e.g. cyanobacteria), while shelf waters are dominated by larger taxa such as diatoms (Hanson et al. 2007).

Zooplankton cover a diverse range of drifting planktonic animals, some of which spend their entire lives in the plankton (holoplankton) and some which are planktonic only in their larval stages (meroplankton). Most marine invertebrate taxa include zooplanktonic representatives. Zooplankton includes species that will drift with currents and also those that are motile (DWER 2006).

Primary productivity of the NWMR 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).

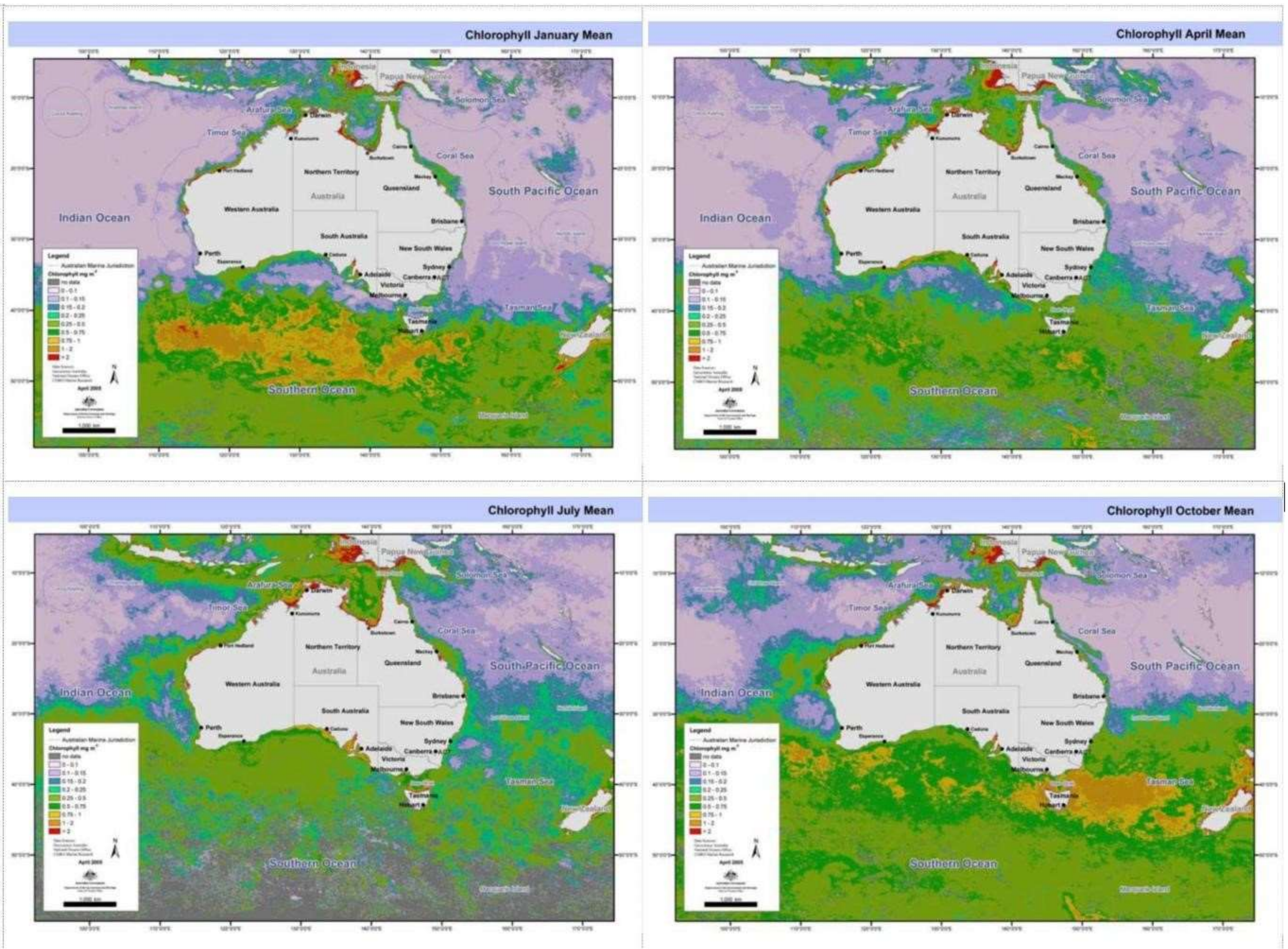



**Figure 5-3 Seasonal phytoplankton growth from MODIS ocean colour composites (Source: McClatchie et al 2006)**

### 5.4.4 Birds

Birds in the marine environment can include both seabirds and shorebirds. Seabirds is a general term used to collectively describe any species of bird which spends a substantial part of its life foraging and breeding in the marine environment (DEE 2019) which includes both coastal and pelagic environments. Seabirds include such species as pelicans, gannets, cormorants, albatrosses and petrels (GLE 2019). Shorebirds (sometimes referred to as wading birds) refers to those species of bird commonly found along sandy or rocky shorelines, mudflats, and shallow waters; shorebirds include such species as plovers and sandpipers (GLE 2019).

Migratory shorebirds may be present in or can be found to be flying through the EMBA, Hydrocarbon Exposure Area and Operations Area between July and December and again between March and April as they migrate between Australia and offshore locations (Bamford et al. 2008 cited in Woodside 2019).

There are multiple species (or species habitat) of seabirds and shorebirds that may occur within the EMBA (Appendix B: EPBC Protected Matters Search Tool Results). The presence of most species, particularly within the Hydrocarbon Exposure Area, are expected to be of a transitory nature only. However, the type of presence for some species within the EMBA and Hydrocarbon Exposure Area were identified as having important behaviours (e.g. breeding, resting, foraging). A total of 83 seabirds or shorebirds were identified in a PMST search as potentially occurring within the EMBA. Four of these EPBC listed species were listed as Critically Endangered (Curlew Sandpiper, Northern Siberian Bar-tailed Godwit, Eastern Curlew and Round Island Petrel) with 10 listed as Endangered and 17 listed as Vulnerable. Within the Hydrocarbon Exposure Area 37 species were identified within PMST report, of which three are Critically Endangered, five Endangered and 8 Vulnerable. Within Operations Area 7 species were identified within PMST report, of which 2 are Endangered. (Refer to Appendix B: EPBC Protected Matters Search Tool Results).

A total of 15 BIAs has also been identified for some bird species within the EMBA, five bird species BIAs within the Hydrocarbon Exposure Area and none within Operations Area (Table 5-5). These include breeding BIAs for the Wedge-tailed Shearwater, Lesser Frigatebird, Lesser Crested Tern, Roseate Tern, Fairy Tern and the White-tailed Tropicbird and within the Pilbara region. The BIAs for these birds occurs along the Pilbara coast in both State and Commonwealth waters, specifically around the Muiron Islands, Barrow Island and the Montebello Islands. Breeding for each species occurs at various times throughout the year.

Breeding for the Caspian Tern, Silver Gull, Pacific Gull, Bridled Tern, Osprey, Sooty Tern, Little Tern, Australian Fairy Tern and Crested Tern is also known to occur in the Pilbara region, however, no aggregation areas have been identified within the EMBA (DEWHA 2008).

No breeding BIAs exist within the Operational Area, with the closest breeding BIAs being the wedge-tailed shearwater located ~49 km at its closest point to the Operational Area (Figure 5-4), There are several important habitats for seabirds and migratory shorebirds including key breeding, nesting and roosting areas plus foraging and resting areas within the NWMR (Figure 5-4).

**Table 5-5 Biologically Important Areas for seabird and shorebird species within the Project Areas**

| Scientific Name | Common Name | Offshore Project Area | | | Summary Description of BIA |
|---|---|---|---|---|---|
| | | Operational Area | Hydrocarbon Exposure Area | EMBA | |
| *Anous stolidus* | Common Noddy | - | - | f | Foraging grounds around islands used for breeding (e.g. Abrolhos). Presence likely around Abrolhos mid-August to late-April. |
| *Anous tenuirostris melanops* | Australian Lesser Noddy | - | - | f | Foraging grounds around islands used for breeding (e.g. Abrolhos). Presence may occur throughout the year. |

| Scientific Name | Common Name | Offshore Project Area | | | Summary Description of BIA |
|---|---|---|---|---|---|
| | | Operational Area | Hydrocarbon Exposure Area | EMBA | |
| *Ardenna pacifica** | Wedge-tailed Shearwater | - | b, f | b, f | Breeding grounds and buffer area around offshore islands (including, Bedout Island, Montebello and Lowendal Islands). Breeding presence may occur between mid-August to April (Pilbara) or to mid-May (Shark Bay). |
| *Fregata ariel* | Lesser Frigatebird | - | - | b | Breeding grounds and buffer area around offshore islands in Pilbara and Kimberley. Breeding season March to September. |
| *Larus pacificus* | Pacific Gull | - | - | f | Foraging grounds (generally inshore waters) along west coast and around Abrolhos Islands. |
| *Phaethon lepturus* | White-tailed Tropicbird | - | - | b, f | Breeding grounds and buffer area around offshore islands in Pilbara and Kimberley (including Rowley Shoals). Breeding recorded between May and October. |
| *Pterodroma mollis* | Soft-plumaged Petrel | - | - | f | Oceanic foraging grounds on continental shelf waters (not observed inshore). Presence may occur March to late-September. |
| *Puffinus assimilis* | Little Shearwater | - | - | f | Oceanic foraging grounds (4–200 km off coast) between Kalbarri and Eucla, with high usage around Abrolhos Islands. Presence mainly occurs April to November. |
| *Sterna anaethetus** | Bridled Tern | - | - | f | Oceanic foraging grounds. Presences is generally driven by breeding season, late-September to late-February/early-May. |
| *Sterna caspia** | Caspian Tern | - | - | f | Oceanic foraging grounds. |
| Sterna dougallii | Roseate Tern | - | b | b, f | Breeding grounds and buffer area around offshore islands in Gascoyne, Pilbara and Kimberley. Breeding presence may occur mid-March to July. |
| *Sterna fuscata** | Sooty Tern | - | f | f | Oceanic foraging grounds on west coast and round Abrolhos Islands. |
| *Sterna nereis* | Fairy Tern | - | b | b, f | Oceanic foraging grounds; common in Abrolhos area but in small numbers. Presence associated with breeding season from late-August to early-May. |
| *Sternula albifrons** | Little Tern | - | - | r | Breeding grounds and buffer area around offshore islands in Gascoyne and Pilbara, of which resting behaviors in the NW are associated. Breeding may occur late-July to September. |

| Scientific Name | Common Name | Offshore Project Area | | | Summary Description of BIA |
|---|---|---|---|---|---|
| | | Operational Area | Hydrocarbon Exposure Area | EMBA | |
| *Thalasseus bengalensis* | Lesser Crested Tern | - | b | b | Breeding grounds and buffer area and resting areas, around offshore islands in Pilbara and Kimberley. Breeding has been recorded June to October. |

*Biologically Important Area*

| | |
|---|---|
| *a* | *Aggregation* |
| *b* | *Breeding* |
| *f* | *Foraging* |
| *r* | *Resting* |

**Species listed with multiple scientific names*

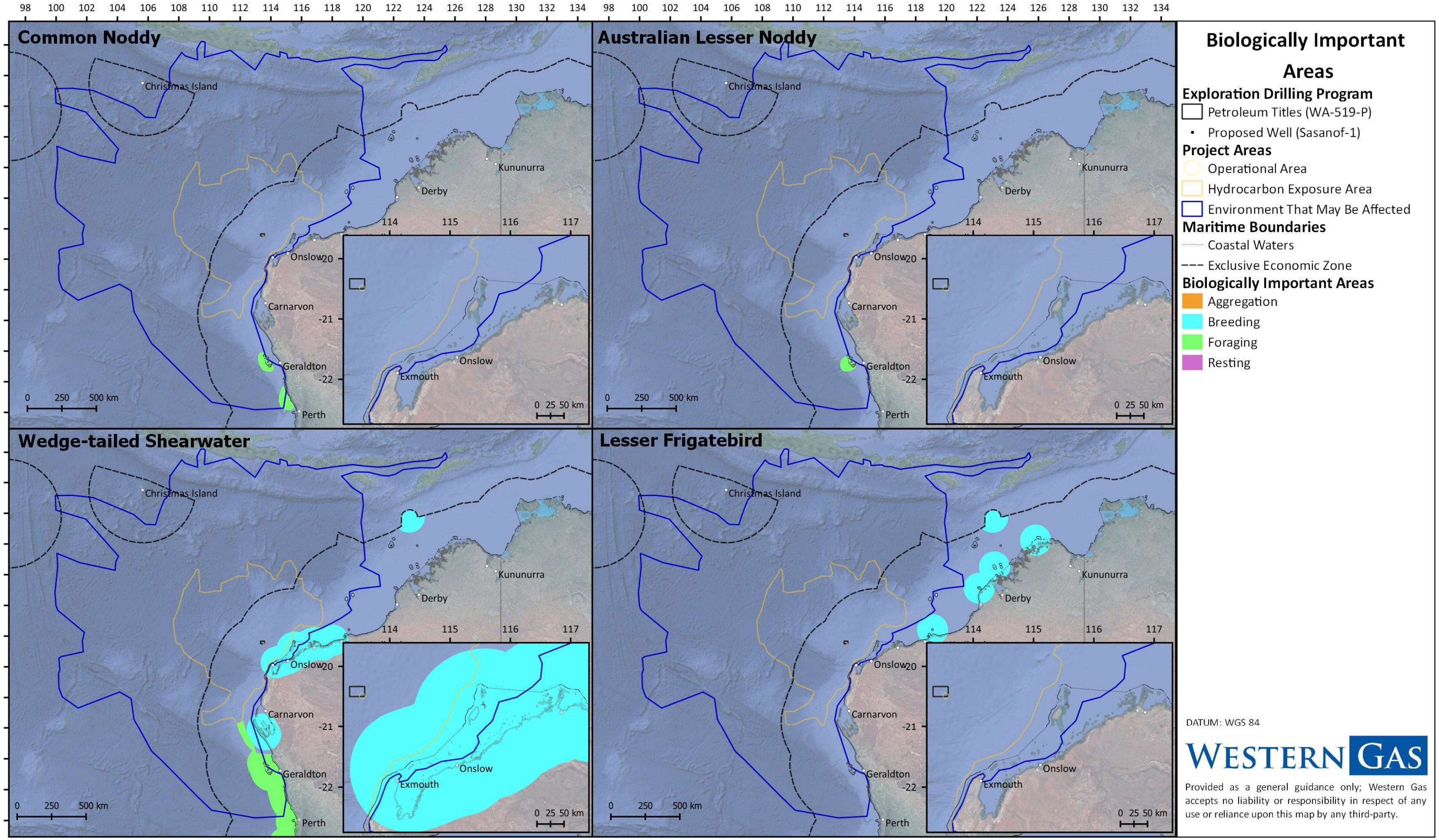



**Figure 5-4 Bird (Common Noddy, Australian Lesser Noddy, Wedge-tailed Shearwater, Lesser Frigatebird) BIAs within the Project Areas**

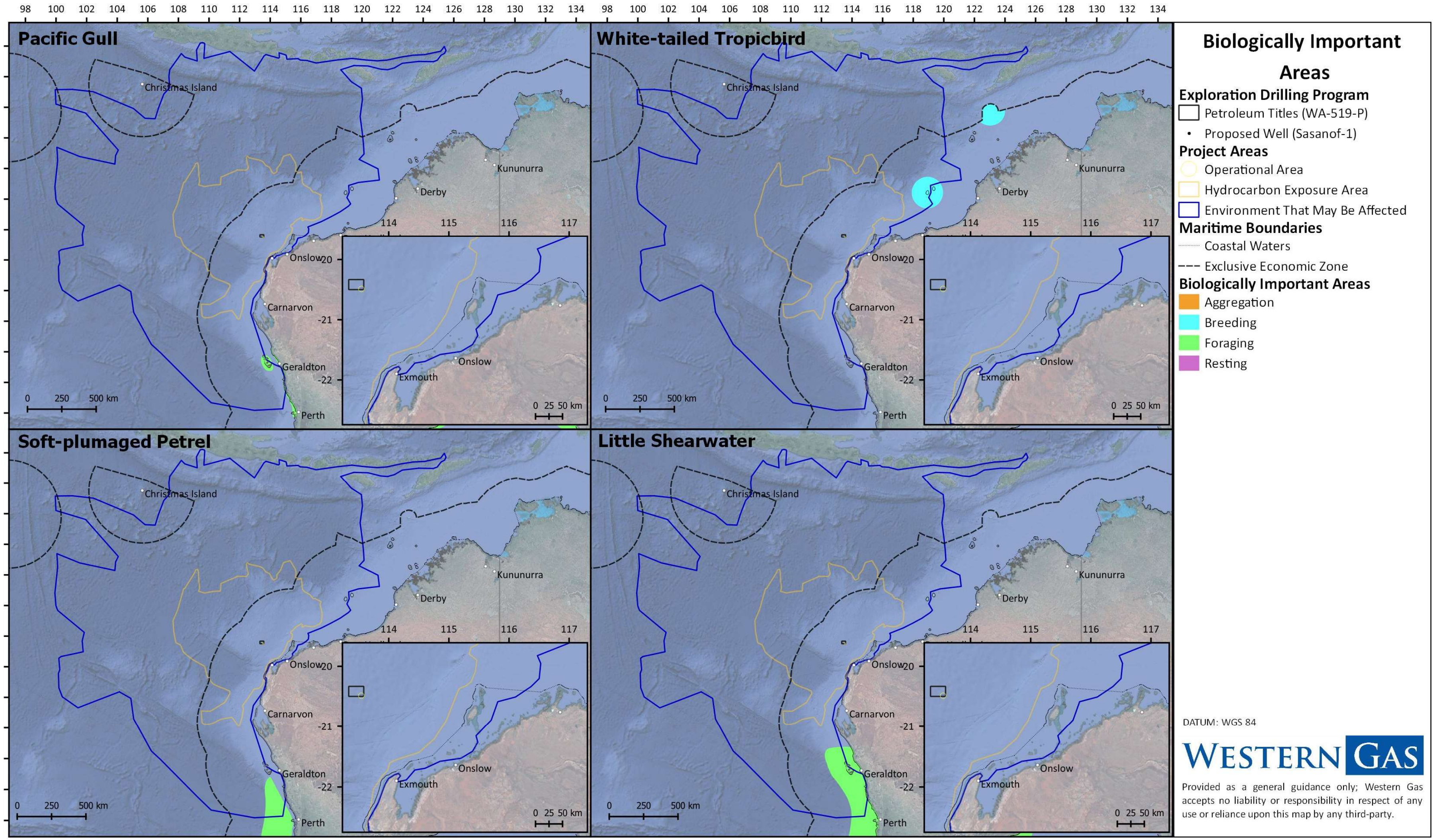



**Figure 5-5 Bird (Pacific Gull, White-tailed Tropicbird, Soft-plumaged Petrel, Little Shearwater) BIAs within the Project Areas**

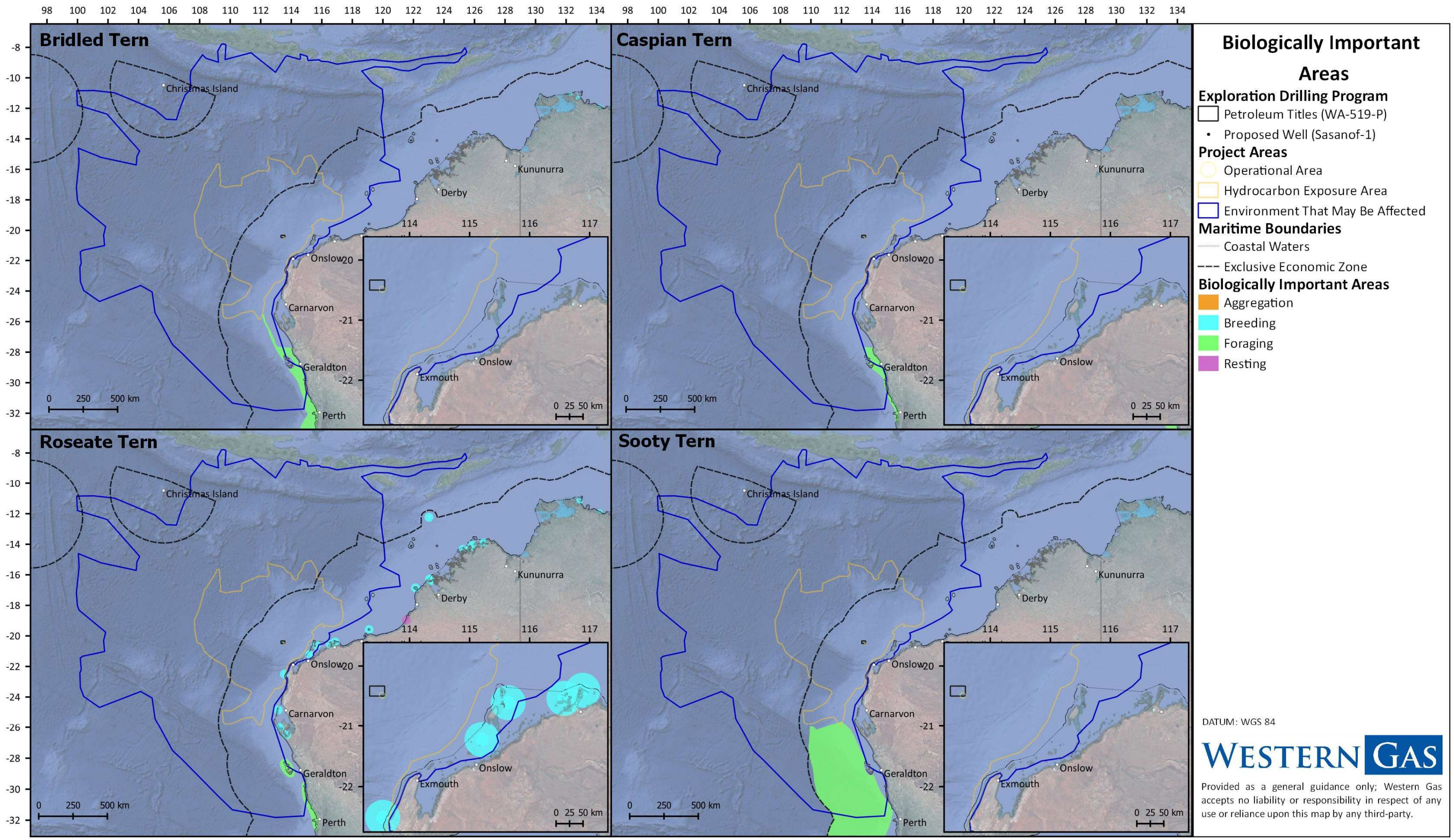



**Figure 5-6 Bird (Bridled, Caspian, Roseate and Sooty Terns) BIAs within the Project Areas**

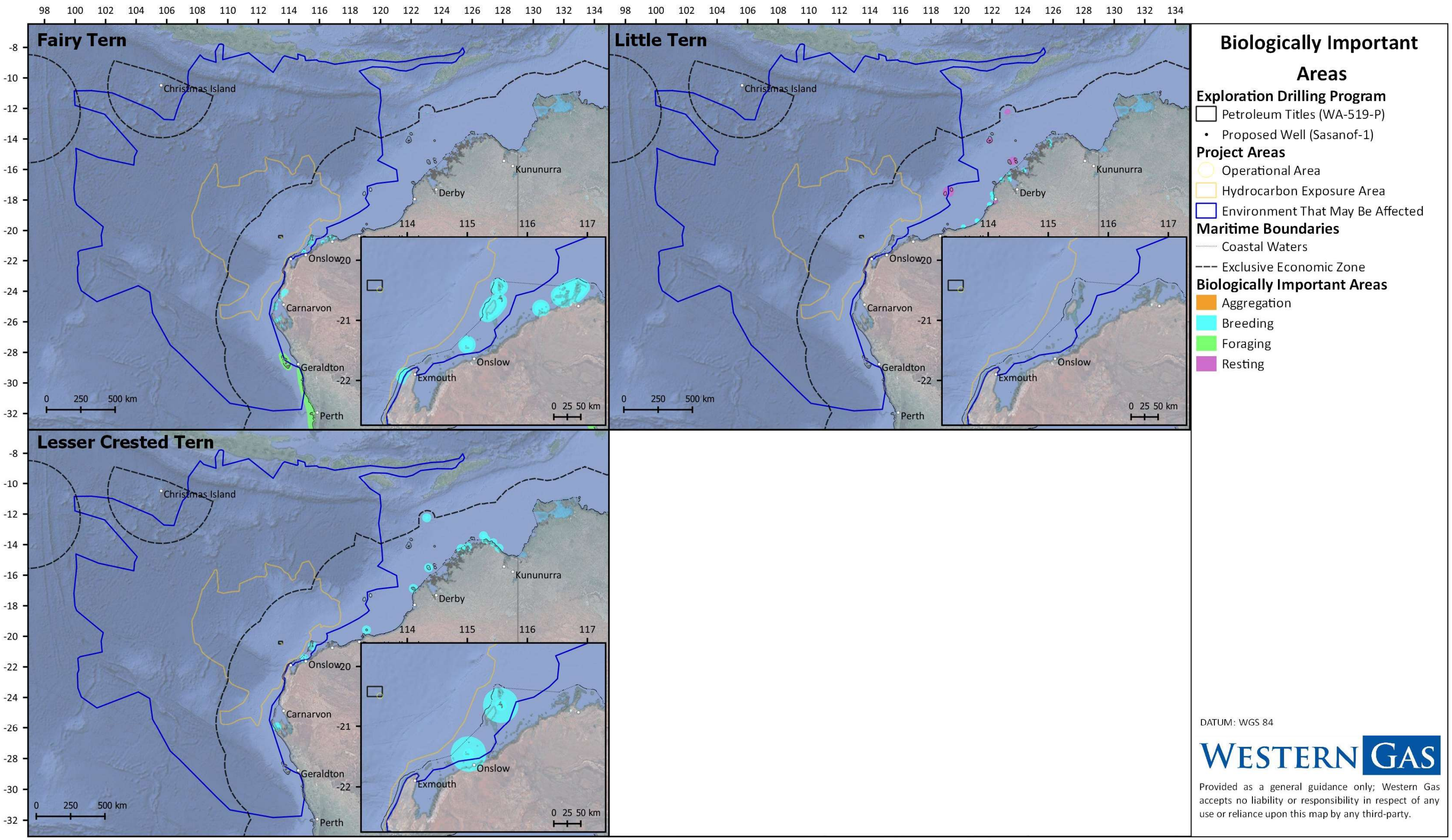



**Figure 5-7 Bird (Fairy, Little and Lesser Crested Terns) BIAs within the Project Areas**

### 5.4.5 Fish and Sharks

There are multiple species (or species habitat) of protected syngnathids, solenostomids, sharks and rays that may occur within the EMBA (Appendix B: EPBC Protected Matters Search Tool Results).

The NWMR supports a diverse array of pelagic and demersal fish species and species habitats including those from the class Chondrichthyes (a diverse group of cartilaginous fishes that includes the sharks, skates, rays) plus from the family Syngnathidae (a large and diverse group of pipefishes, seahorses, seadragons and pipehorses). There are multiple species (or species habitats) of fish that may occur within the EMBA (Appendix B: EPBC Protected Matters Search Tool Results). The presence of most species, particularly within the Operations Area, are expected to be transitory. However, the type of presence for some species within the Project Areas were identified as having important behaviours (e.g. foraging, nursing) (Table 5-6).

The Operational Area is located within the Exmouth Plateau, a recognised KEF for its increased productivity (observed from satellite images of chlorophyll concentrations, particularly along the northern and southern flanks) (Brewer et al. 2007). These areas have been shown to support high catch rates of pelagic and demersal commercial fish, although evidence suggests these high production events are sporadic (Brewer et al. 2007).

A total of 69 EPBC listed fish and shark species were identified in a PMST search as potentially occurring within the EMBA (Appendix B: EPBC Protected Matters Search Tool Results). Seven of these EPBC listed species were listed as Vulnerable. Within Hydrocarbon Exposure Area, 47 fish and sharks were identified as potentially occurring, of which five are Vulnerable. Within the Operational Area, five fish and sharks were identified as potentially occurring, of which one, the great white shark, is listed as Vulnerable.

Two BIAs have been identified for fish species within the EMBA and Hydrocarbon Exposure Area (Table 5-6). This includes the foraging BIAs for the whale shark and the white shark (Figure 5-8).

**Table 5-6 Fish and Shark BIAs within the Project Areas**

| Scientific Name | Common Name | Project Areas | | | Summary Description of BIA |
|---|---|---|---|---|---|
| | | EMBA | Hydrocarbon Exposure Area | Operational Area | |
| *Carcharodon carcharias* | White Shark | f | | | Foraging grounds along west coast and Abrolhos Islands; foraging is associated with sea lion colonies in the area providing a food source. |
| *Rhincodon typus* | Whale Shark | f | f | | Oceanica foraging grounds; whale sharks known to travel along the 200 m depth contour. Presence may occur during spring. |

The whale shark (*Rhincodon typus*) 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 (DEE 2017c). The foraging Biologically important area (BIA) extends north from the Ningaloo region (a known aggregation area for the species); and presence is typically expected during spring (GLE 2019).

Whale sharks have been reported from oceanic and coastal waters across the NWS region (Wilson et al. 2006) with seasonal aggregations around Ningaloo Reef, between March and June. In the Ningaloo area, whale sharks spend daylight hours near the surface and descend to depths of 30–80 m at night. In oceanic waters, they routinely move between the sea surface and deeper depths and in the outer NWS, they spend much of their time swimming near the seafloor and make dives to over 1000 m depth (DSEWPC 2012a).

The white shark (*Carcharodon Carcharias*) has been sighted in all coastal areas within Australia except for the Northern territory. The species is typically found from close inshore habitats (e.g. rocky reefs and shallow coastal bays) to the outer continental shelf and slope areas. Within Australian waters, the majority of recorded great white shark movements occur between the coast and the 100 m depth contour however both adults and juveniles have been recorded diving to depths of 1000 m (Bruce et al. 2006; Bruce and Bradford 2008). Within the EMBA the foraging BIA is located around sealion colonies in the vicinity of the Wallabi Islands and the Jurien marine Park near Geraldton.

The benthic and pelagic fish communities of the NWS Province are strongly depth-related, indicative of a close association between fish communities and benthic habitats (Brewer et al. 2007). The fish communities are also highly diverse with a number of fish biodiversity hotspots identified between Port Hedland and North West Cape (Fox and Beckley 2005). Fish species of the inner shelf include lizardfish, goatfish, trevally, anglefish and tuskfish. Deep goatfish, deep lizardfish, ponyfish, deep threadfin bream, adult trevally, billfish and tuna are found in areas with water depths of between 100–200 m. Spanish mackerel are known to spawn in this area between August and November (DNP 2013).

The Glomar Shoals occurs outside of the EMBA but appears to be a particularly important site for fish species within the bioregion, probably because of increased biological productivity associated with localised upwelling at this location (Brewer et al. 2007).

The canyons in the NW Provence (Section 5.2.1.4) may channel currents onto the Exmouth plateau, driving upwelling in the canyon heads. These are associated with aggregations of baitfish, which in turn attract larger pelagic species such as billfish and tuna. Pelagic species occurring above the plateau, slope and canyons are likely to include nekton and small pelagic fish, attracted to seasonal upwellings, as well as larger predators such as billfish (DEWHA 2008).

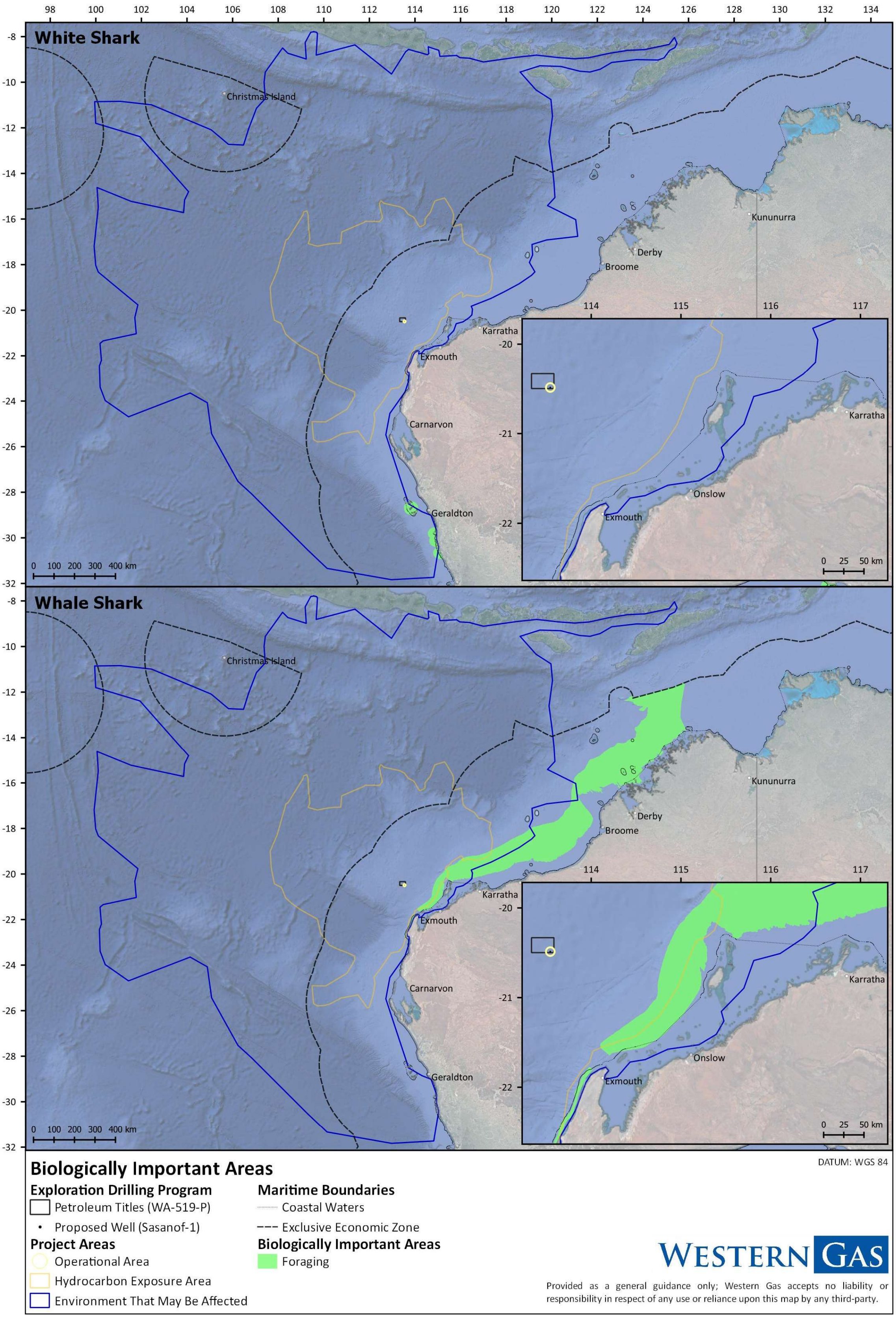



**Figure 5-8 Shark BIAs within the Project Areas**

### 5.4.6 Marine Mammals

There are multiple species (or species habitat) of marine mammals, including cetacean, pinniped and dugong, that may occur within the NWMR region (Appendix B: EPBC Protected Matters Search

Tool Results). The type of presence for some species within the EMBA were identified as having important behaviours (e.g. breeding, foraging, calving) (Table 5-7).

Cetaceans found in the NWMR include truly pelagic species that spend most of their time in the Commonwealth waters of the region plus species that are found predominantly in shallow coastal waters (DSEWPC 2012c). The NWMR is also thought to be an important migratory pathway between feeding grounds in the Southern Ocean and breeding grounds in tropical waters for several cetacean species (DSEWPC 2012c).

A total of 43 marine mammals were identified in a PMST search as potentially occurring within the EMBA, 32 potentially within Hydrocarbon Exposure Area and 24 potentially within Operations Area (Appendix B: EPBC Protected Matters Search Tool Results). Within the Operational Area, listed threatened species include sei whale (Vulnerable), blue whale (Endangered), fin whale (Vulnerable) and humpback whale (Vulnerable), whilst the Hydrocarbon Exposure Area supports two species listed as Endangered and three species listed as Vulnerable, and the EMBA supports two species listed as Endangered and four listed as Vulnerable.

BIAs have also been identified for five marine mammals within the EMBA (Table 5-7, Figure 5-9 which include the blue and pygmy blue, humpback and sperm whales, dugong and Australian sea lion, whilst the Operational Area overlaps with breeding and migration BIAs for pygmy blue whale only.

The blue whale (*Balaenoptera musculus*) is known to migrate through the Pilbara region from September to December for the pygmy subspecies, or from March to April for the Antarctic subspecies. The BIAs for distribution, foraging and migration exist for the pygmy subspecies of blue whale and stretch along the coast of the Pilbara region, out to the EEZ (DEE 2015). Foraging is thought to occur primarily off the coast of the Cape Range Peninsula, where feeding on krill is done through a mix of lunge feeding at or near the surface and diving up to depths of 500 m (DEE 2019a). The migratory path for the pygmy blue whales is in deeper waters, typically 500–1,000 m. Reliable estimates of blue whale population size in Australian waters are poor with little known about the population size of the pygmy blue whale especially (DEE 2019a).

Humpback whales (*Megaptera novaeangliae*) migrate north from their Antarctic feeding grounds around May each year, reaching the waters of the NWMR in early June. During the northerly migration they swim approximately 100 km offshore, following the edge of the continental shelf passing to the west of the Muiron, Barrow and Montebello Islands (Jenner et al. 2001). Immature individuals and lactating females arrive first to the breeding and calving grounds between Broome and north Camden Sound, followed by non-pregnant mature females and adult males with pregnant females arriving last (DSEWPC 2012c). Breeding and calving takes place between August and September when the southern migration starts. Females with calves are the last to leave the breeding grounds, stopping to rest in Exmouth Gulf, Shark Bay and onto Geographe Bay (DSEWPC 2012c). The southerly migration of the humpback whale extends parallel to the coast on ~20–30 m depth contour (Jenner et al. 2001, DEWHA 2008). Absolute abundance estimates for humpback whale breeding stock are difficult to derive due to results bias from north and southbound milling whales overlapping in their migration paths plus other surveys challenges (Bejder et al. 2016). However, Hedley et al. (2006) reported 11,500 whales in 2006 and 33,850 whales in 2008 with an aerial survey by Salgado-Kent et al. (2008) reporting 26,100 whales.

Sperm whales (*Physeter macrocephalus*) tend to inhabit offshore areas with a water depth of 600 m or more and are uncommon in waters less than 300 m deep (NOAA 2006). Female sperm whales are generally found in deep waters (at least 1,000 m). Female and young male sperm whales appear to be restricted to warmer waters north of about 45° S in the Southern Hemisphere, while adult males travel to and from colder waters of Antarctica (Bannister, Kemper and Warneke 1996). Concentrations of sperm whales are found where the seabed rises steeply from great depth and are probably associated with concentrations of major food in areas of upwelling (Bannister, Kemper and Warneke 1996). In the South-west Marine Region, it is thought the species is likely to forage along the shelf-break. They have been observed foraging in waters over the Perth Canyon and Albany canyons (DSEWPC 2012c).

Dugongs (*Dugong dugon*) occur in coastal and inland waters from Shark Bay in Western Australia (25° S) across the northern coastline of WA into the NT and Queensland (Marsh et al. 2002, 2011). Dugongs spend most of their time in the neritic zone, especially near tidal and subtidal seagrass meadows (DEE 2019c). Surveys undertaken in the Shark Bay (2007; 13,000 $km^2$) and Exmouth (1999, 3180 $km^2$) areas report dugong populations as 9347 (±1204) and 704 (±354) respectively. Dugongs are long-lived and slow breeding and is known to occur in the Pilbara region and within the Exmouth Gulf. Dugongs are diffusely seasonal breeders and the seasonality of breeding is more marked in the sub-tropics (mostly spring, early summer calving) than in the tropics (DoE 2020).

Australian sea lions (*Neophoca cinereal*) occur in coastal habitats, waters and islands offshore from SA and WA. The species is almost entirely confined to the SWMR and adjacent state waters, islands and coastal areas (DSEWPC 2012b). Although its range extends to the Houtman Abrolhos Islands in WA, most of the population is found in South Australia. Australian sea lions have an estimated population of approximately 14,700 individuals (DEWHA 2010) and based on pup numbers 14% are within WA. Australian sea lions feed on the continental shelf in the region, most commonly in depths of 20–100 m (Shaughnessy 1999).

**Table 5-7 Biologically Important Areas for marine mammal species within the Project Areas**

| Scientific Name | Common Name | Project Area | | | Summary Description of BIA |
|---|---|---|---|---|---|
| | | Operational Area | Hydrocarbon Exposure Area | EMBA | |
| *Balaenoptera musculus* | Blue Whale, Pygmy Blue Whale | d, m | d, f, m | d, f, m | Offshore migration corridor, typically along shelf-edge at depths 500–1,000 m; this occurs close to the coast around Exmouth. Presence during northern migration past Exmouth area may occur April to August (whereas January to May past Perth Canyon area). Southern migration presence may occur October to late-December. |
| *Megaptera novaeangliae* | Humpback Whale | - | m | m, r | Migration corridor extends out to ~50–100 km from the coast. Presence during the northern migration may occur late-July to September. |
| *Physeter macrocephalus* | Sperm Whale | - | - | f | Oceanica foraging grounds at western end of Perth Canyon. Presence may occur during summer. |
| *Dugong dugon* | Dugong | - | c, b, f, n | c, b, f, n | Breeding, calving, nursing and foraging grounds within the Exmouth Gulf and North West Cape regions. May be present throughout the year.<br>Presence in Shark Bay BIAs may be more seasonal, between April and November. |
| *Neophoca cinerea* | Australian Sea Lion | - | - | f | Oceanic foraging grounds along west coast and around Abrolhos Islands for resident populations. Presence may occur throughout the year. |

*Biologically Important Area*

| | |
|---|---|
| *c* | *Calving and/or nursing* |
| *b* | *Breeding* |
| *d* | *Distribution* |
| *f* | *Foraging* |
| *m* | *Migration* |
| *n* | *Nursing* |
| *r* | *Resting* |

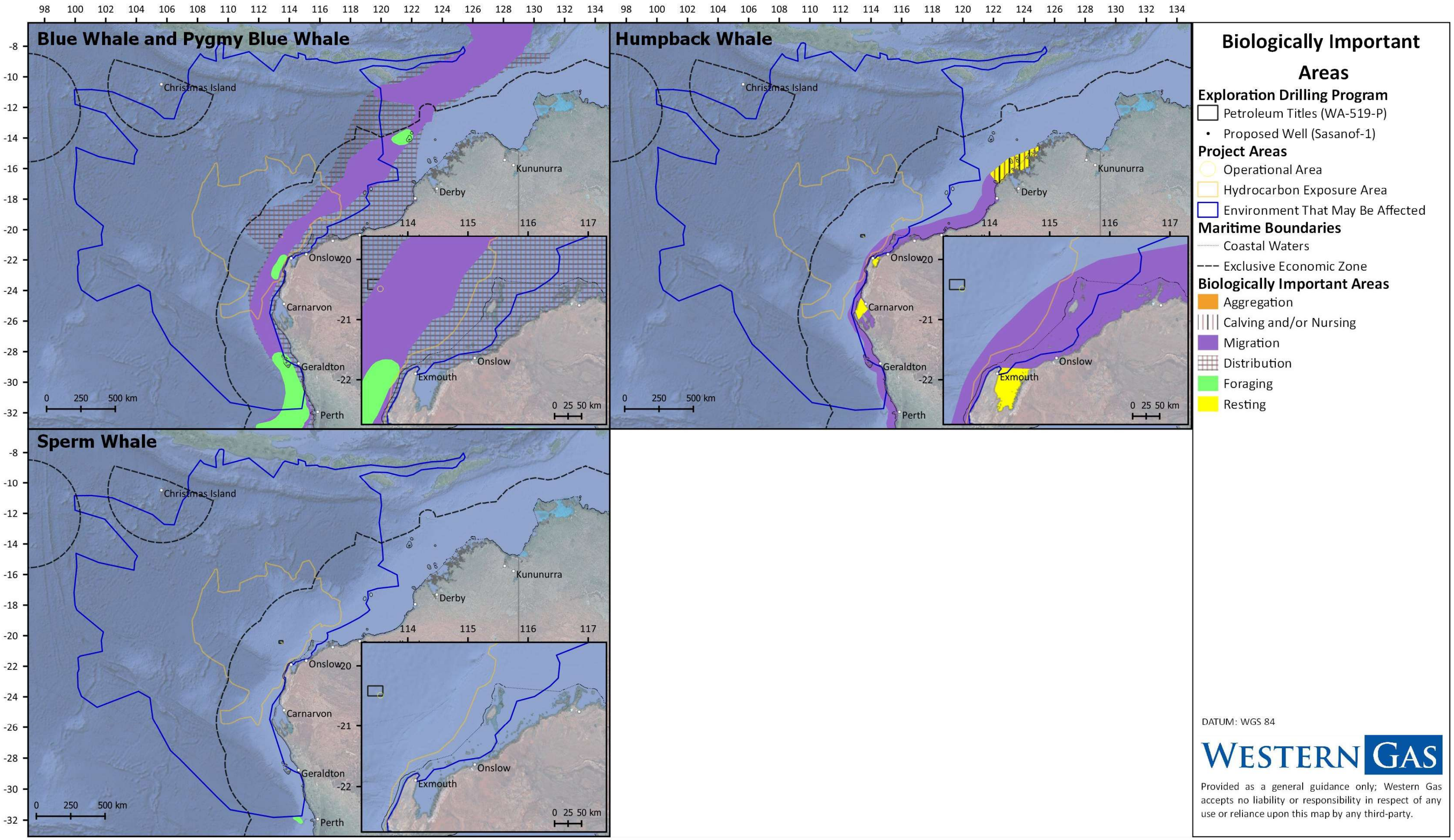



**Figure 5-9 Marine Mammal (Blue, Pygmy Blue, Humpback and Sperm Whales) BIAS within the Project Areas**

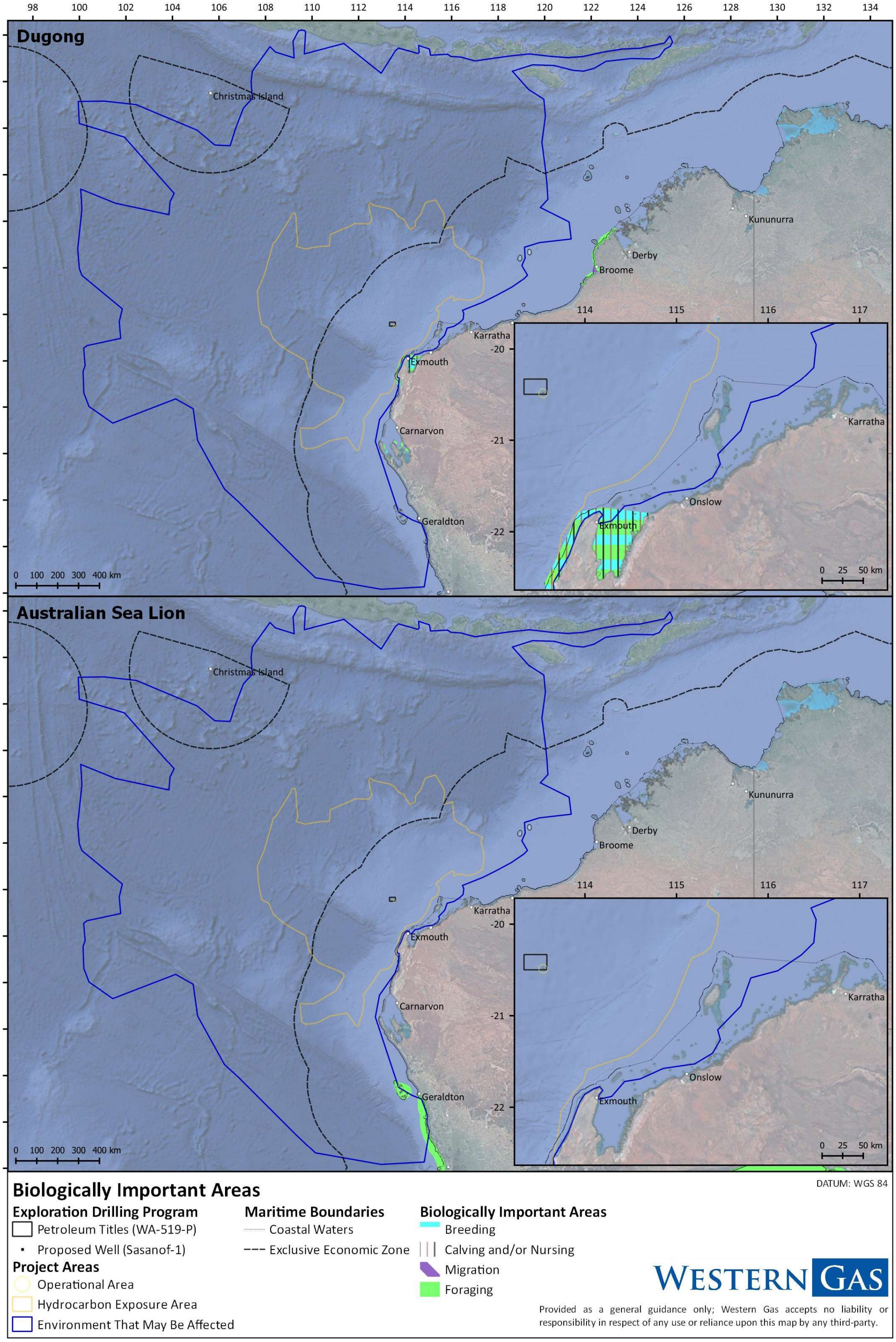



**Figure 5-10 Marine Mammal (Dugong, Australian Sea Lion) BIAs within the Project Areas**

### 5.4.7 Marine Reptiles

There are multiple species (or species habitat) of marine reptiles that may occur within the EMBA (Appendix B: EPBC Protected Matters Search Tool Results). The presence of most species is expected to be of a transitory nature within the majority of the Project Areas. However, the type of presence for some species within the Project Areas were identified as having important behaviours (e.g. foraging, nesting) (Table 5-9 and Figure 5-11).

A total of six turtle species, and 20 seasnakes were identified in a PMST search as potentially occurring within the EMBA (Appendix B: EPBC Protected Matters Search Tool Results). Two of these EPBC listed species are listed as Critically Endangered (short-nosed seasnake, leaf-scaled seasnake), with three listed as Endangered (loggerhead, leatherback and Olive Ridley and three as Vulnerable (green, hawksbill and flatback turtles). PMST identified five turtles and 16 seasnakes potentially occurring within Hydrocarbon Exposure Area, of which two seasnakes are listed as Critically Endangered, two turtles as Endangered and three turtles as Vulnerable. While within Operation Area the PMST identified five turtles and three seasnakes, of which two turtles are Endangered and three turtles are Vulnerable EPBC listed.

BIAs for marine reptiles have been identified within the EMBA and Hydrocarbon Exposure Area (Table 5-8). No BIAs overlap with the Operational Area. Within the EMBA and Hydrocarbon Exposure Area are a number of important turtle nesting beaches and Critical Habitats occur (Table 5-8 and Table 5-9).

Loggerhead turtles (*Caretta caretta*) are known to nest in the NWMR, within the Exmouth Gulf and Ningaloo Coast from November to May, with a peak in late December/early January. The annual nesting population in the region is thought to be several thousand females (Limpus 2008a).

The green turtle (*Chelonia mydas*) is also known to nest within the Exmouth Gulf and near the Montebello and Barrow Islands between November and March. Green turtles are the most common marine turtle breeding in the NWMR with WA supporting one of the largest remaining green turtle populations in the world, estimated to be in the tens of thousands of adult turtles (DSEWPC 2012b).

Nesting of the hawksbill turtle (*Eretmochelys imbricate*) occurs from Cape Preston to mouth of Exmouth Gulf, including the Montebello and Lowendal Islands, all year round with a peak between October and February.

The flatback turtle (*Natator depressus*) nests in the NWMR, north from the mouth of Exmouth Gulf to Port Hedland, around all beaches and coastal islands, including Barrow Island and the Montebello Islands (GLE 2019). However, little is known about their non-nesting habitat preferences, foraging biology or regional abundance and distribution (DSEWPC 2012b). Flatback turtles differ from other marine turtles in that they do not have a pelagic phase to their lifecycle. Instead, hatchlings grow to maturity in shallow coastal waters thought to be close to their natal beaches (DSEWPC 2012b).

The leatherback turtle (*Dermochelys coriacea*) feeds primarily on gelatinous organisms such as jellyfish, salps and squid and their foraging and distribution is largely determined by location of this prey. Foraging is known to occur in the NWMR, however no known aggregation sites occur in the EMBA. The leatherback turtle rarely breeds in Australia and is suspected to have migrated from the larger nesting populations in Indonesia, Papua New Guinea and Solomon Islands, or from populations in the Americas or India (Limpus 2009b).

**Table 5-8 Important breeding, feeding and resting areas for turtle species listed as threatened or migratory under the EPBC Act occurring within Project Areas**

| Location | Description | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|---|
| Ningaloo Reef – North West Cap | Major green turtle nesting area<br>Important nesting area for loggerhead turtles. | X | ✓ | ✓ |
| Exmouth Gulf (Muiron Islands) | Muiron Islands: critical nesting and internesting habitat for loggerhead turtles<br>Area major green turtle rookery. | X | X | ✓ |
| Serrurier Island | Area major nesting area for green turtles and possible foraging area. | X | X | ✓ |
| Thevenard Island | Feeding area for green turtles. | X | X | ✓ |
| Montebello, Lowendal/ Varanus and Barrow islands | Green, hawksbill and flatback turtles nesting plus occasional nesting by loggerhead turtles<br>Montebello Islands: critical nesting/internesting habitat for flatback and hawksbill turtles.<br>Lowendal/ Varanus Island: critical nesting and internesting habitat for hawksbill turtles, supports flatback turtle rookery.<br>Barrow Island: critical nesting and internesting habitat for green turtles and supports flatback turtle rookery. | X | X | ✓ |

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

**Table 5-9 Biologically Important Areas and Critical Habitat areas for reptile species within Project Areas**

| Scientific Name | Common Name | Project Areas | | | Summary Description of BIA |
|---|---|---|---|---|---|
| | | Operational Area | Hydrocarbon Exposure Area | EMBA | |
| *Caretta caretta* | Loggerhead Turtle | - | i, n | i, n, | Nesting and internesting areas around rookeries, including Ningaloo Coast, Muiron, Lowendal and Montebello Islands and Dampier Archipelago. Presence may occur during spring and early summer. |

| Scientific Name | Common Name | Project Areas | | | Summary Description of BIA |
|---|---|---|---|---|---|
| | | Operational Area | Hydrocarbon Exposure Area | EMBA | |
| *Chelonia mydas* | Green Turtle | - | i | a, b, f, i n, m | Nesting and internesting areas around rookeries, including North West Cape, Barrow and Montebello Islands. Presence may occur during summer.<br>Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and b De Grey River and Bedout Island. |
| *Eretmochelys imbricate* | Hawksbill Turtle | - | i, n | f, i, n, m | Nesting and internesting areas around rookeries, including Ningaloo Coast, Thevenard, Barrow, Montebello and Lowendal Islands.<br>Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout Island. |
| *Natator depressus* | Flatback Turtle | - | i | a, i, n, f, m | Nesting and internesting areas around rookeries, including Thevenard (and other Pilbara inshore islands), Barrow and Montebello Islands. Presence may occur during summer.<br>Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout Island. |

*Biologically Important Areas:*

*f = Foraging*

*i = Interesting*

*n = Nesting*

*m = Mating*

*Critical Habitat:*

*a = Aggregation*

*b = Basking*

*M = Migration*

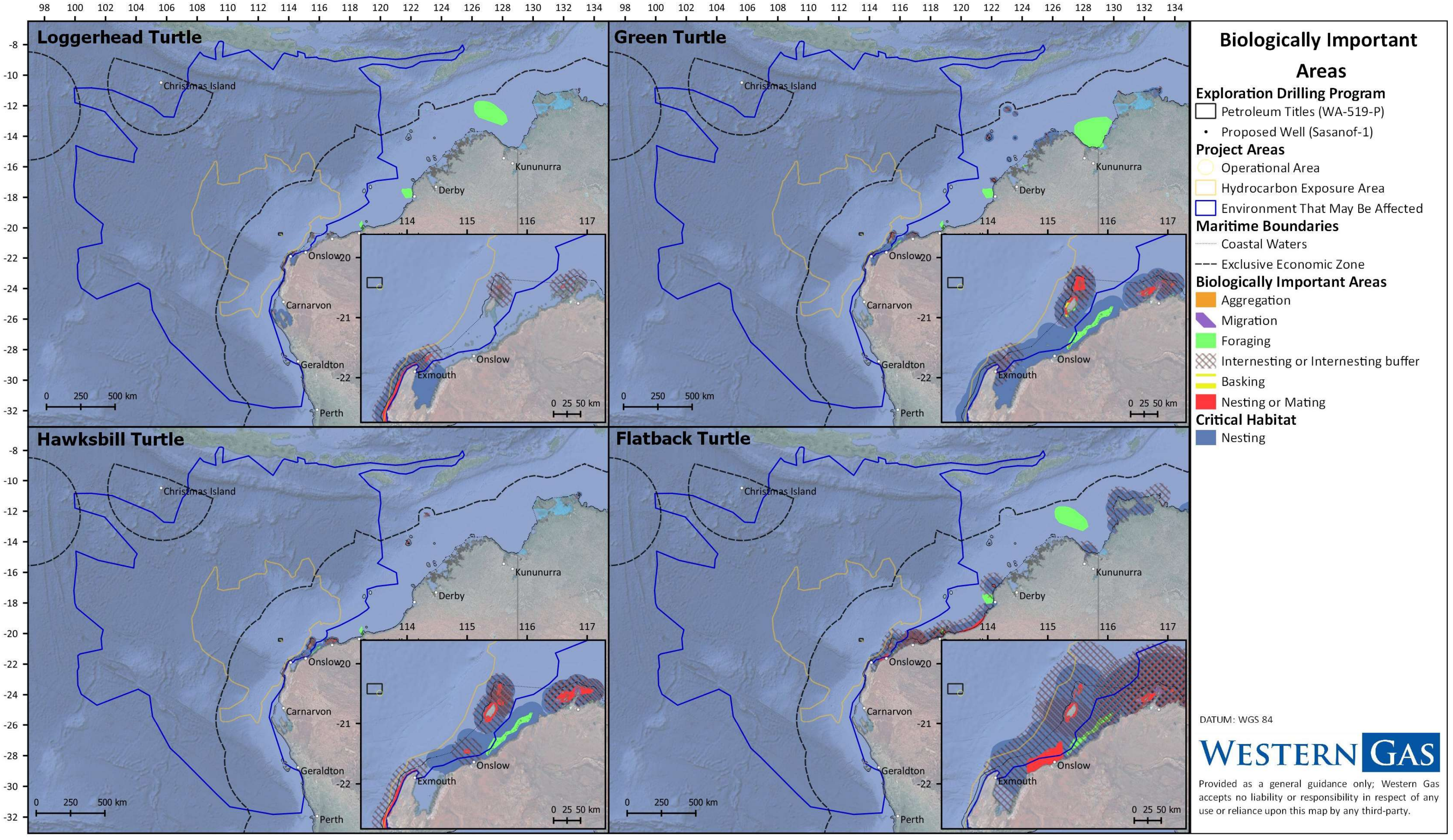



**Figure 5-11 Marine Reptiles BIAs and Critical Habitat within Project Areas**

## 5.5 SOCIO-ECONOMIC ENVIRONMENT

### 5.5.1 Commonwealth Marine Area

The Commonwealth marine environment is a Matter of National Ecological Significance (MNES) under the EPBC Act. The EMBA extends across two bioregions:

- The NWMR comprises Commonwealth waters from the Western Australian – Northern Territory border to Kalbarri, south of Shark Bay. It covers some 1.07 million km$^2$ of tropical and sub-tropical waters.
- The SWMR comprises Commonwealth waters from Kangaroo Island in South Australia to Shark Bay in Western Australia. The region spans approximately 1.3 million km$^2$ of temperate and subtropical waters.

Regional descriptions relevant to the Project Areas as are provided in Section 5.2.

Conservation values of the Commonwealth marine area include:

- Protected species and/or their habitat (Section 5.4)
- Protected places including Australian Marine Parks (Section 5.5.1.1) and heritage places (Section 5.5.6)
- Key ecological features (Section 5.5.1.2).

#### 5.5.1.1 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.

There are no AMPs located within the Operational Area. The closest AMP to the Operational Area is the Gascoyne Marine Park, ~ 22 km. The EMBA overlaps a total of 11 AMPs, 8 within the NWMR, and three within the SWMR. The Hydrocarbon Exposure Area overlaps a total of six AMPs; five within the NWMR and one within SWMR.

AMPs relevant to the Project Areas are listed in Table 5-10.

**Table 5-10 AMPs relevant to the Project Areas**

| Australian Marine Park | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| **North-west Marine Region** | | | |
| Kimberley Marine Park | X | X | ✓ |
| Argo-Rowley Terrace Marine Park | X | ✓ | ✓ |
| Mermaid Reef Marine Park | X | X | ✓ |
| Montebello Marine Park | X | ✓ | ✓ |
| Ningaloo Marine Park | X | ✓ | ✓ |
| Gascoyne Marine Park | X | ✓ | ✓ |
| Carnarvon Canyon Marine Park | X | ✓ | ✓ |
| Shark Bay Marine Park | X | X | ✓ |

| Australian Marine Park | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| **South-west Marine Region** | | | |
| Abrolhos Marine Park | X | ✓ | ✓ |
| Jurien Marine Park | X | X | ✓ |
| Perth Canyon Marine Park | X | X | ✓ |

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

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 5-11:

- 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; and
- Socio-economic values, as the benefits for people, businesses and/or the economy.

**Table 5-11 Significance and Values of AMPs within the EMBA**

| North-west Marine Region |
|---|
| **Kimberley Marine Park** |
| The Kimberley Marine Park is located ~ 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).<br><br>**Statement of significance**<br><br>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.<br><br>**Natural values**<br><br>• Examples of ecosystems representative of the:<br>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.<br>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. |

- 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.
- 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 km$^2$ 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:
  - Cultural tradition of the Wanjina Wunggurr people incorporates many sea country cultural sites;
  - Log-raft maritime tradition, which involved using tides and currents to access warrurru (reefs) far offshore to fish;
  - Interactions with Makassan traders around sea foods over hundreds of years; and
  - 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.

**Social and economic values**

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

**Argo-Rowley Terrace Marine Park**

The Argo–Rowley Terrace Marine Park is located ~ 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:

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|---|
| - 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.<br>- 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.<br>• Contains two KEFs: Canyons linking the Argo Abyssal Plain with the Scott Plateau, and Mermaid Reef and Commonwealth waters surrounding Rowley Shoals.<br>• Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.<br>• BIAs within the Marine Park include resting and breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.<br>**Cultural values**<br>• 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.<br>**Heritage values**<br>• No international, Commonwealth or national heritage listings apply to the Marine Park.<br>• The Marine Park contains two known historic shipwrecks: Alfred (1908) and Pelsart (1908).<br>**Social and economic values**<br>• Commercial fishing and mining are important activities in the Marine Park. |
| **Mermaid Reef Marine Park** |
| The Mermaid Reef Marine Park is located ~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).<br>**Statement of significance**<br>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.<br>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.<br>**Natural values**<br>• 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.<br>• Contains one KEF: Mermaid Reef and Commonwealth waters surrounding Rowley Shoals.<br>• Ecosystems are associated with emergent reef flat, deep reef flat, lagoon, and submerged sand habitats.<br>• Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.<br>• BIAs within the Marine Park include breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.<br>**Cultural values** |

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|---|
| • 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.<br>**Heritage values**<br>• No international or national heritage listings apply to the Marine Park.<br>• The Marine Park surrounds the Mermaid Reef – Rowley Shoals Commonwealth Heritage Place.<br>• The Marine Park contains one known historic shipwreck: Lively (1810).<br>**Social and economic values**<br>• Tourism, recreation, and scientific research 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).<br>**Statement of significance**<br>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. 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.<br>**Natural values**<br>• 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.<br>• Contains one KEF: the ancient coastline at the 125-m depth contour.<br>• Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.<br>• 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.<br>**Cultural values**<br>• 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.<br>**Heritage values**<br>• No international, Commonwealth or national heritage listings apply to the Marine Park.<br>• The Marine Park contains two known historic shipwrecks: *Trial* (1622) and *Tanami* (unknown date).<br>**Social and economic values**<br>• Tourism, commercial fishing, mining and recreation are important activities in the Marine Park. |
| **Ningaloo Marine Park** |
| The Ningaloo Marine Park stretches ~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.
- The Marine Park contains over 15 known historic shipwrecks.

**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 ~ 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.
- 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.
- The Marine Park contains over 5 known historic shipwrecks.

**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 ~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**

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|---|
| 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.<br>**Natural values**<br>• 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.<br>• The Carnarvon Canyon is a single-channel canyon covering the entire depth range of the Marine Park.<br>• Ecosystems are influenced by tropical and temperate currents, deep-water environments and proximity to the continental slope and shelf.<br>• 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).<br>• Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.<br>**Cultural values**<br>• 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.<br>**Heritage values**<br>• No international, Commonwealth or national heritage listings apply to the Marine Park.<br>**Social and economic values**<br>• Commercial fishing is an important activity in the Marine Park. |
| **Shark Bay Marine Park** |
| The Shark Bay Marine Park is located ~ 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).<br>**Statement of significance**<br>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.<br>**Natural values**<br>• Examples of ecosystems representative of the:<br>  o 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.<br>  o 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.<br>• Ecosystems are influenced by the Leeuwin, Ningaloo and Capes currents.<br>• Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.<br>• BIAs within the Marine Park include breeding habitat for seabirds, inter-nesting 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.

**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 ~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:
  - 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.
  - 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.
  - 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.
  - 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

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|---|
| break, and other west-coast canyons, Western rock lobster, Ancient coastline between 90 m and 120 m depth, and the Wallaby Saddle.<br>• Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.<br>• 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.<br>• The Marine Park is adjacent to the northernmost Australian sea lion breeding colony in Australia on the Houtman Abrolhos Islands.<br>**Cultural values**<br>• 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.<br>**Heritage values**<br>• No international, Commonwealth or national heritage listings apply to the Marine Park.<br>• The Marine Park contains 11 known historic shipwrecks.<br>**Social and economic values**<br>• Tourism, commercial fishing, mining, recreation including fishing, are important activities in the Marine Park. |
| **Jurien Marine Park** |
| The Jurien Marine Park is located ~ 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).<br>**Statement of significance**<br>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.<br>**Natural values**<br>• Examples of ecosystems representative of the:<br>  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.<br>  o Central Western Province characterised by a narrow continental slope and influenced by the Leeuwin Current.<br>• 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.<br>• Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.<br>• 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.<br>**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.

**Perth Canyon Marine Park**

The Perth Canyon Marine Park is located ~ 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.

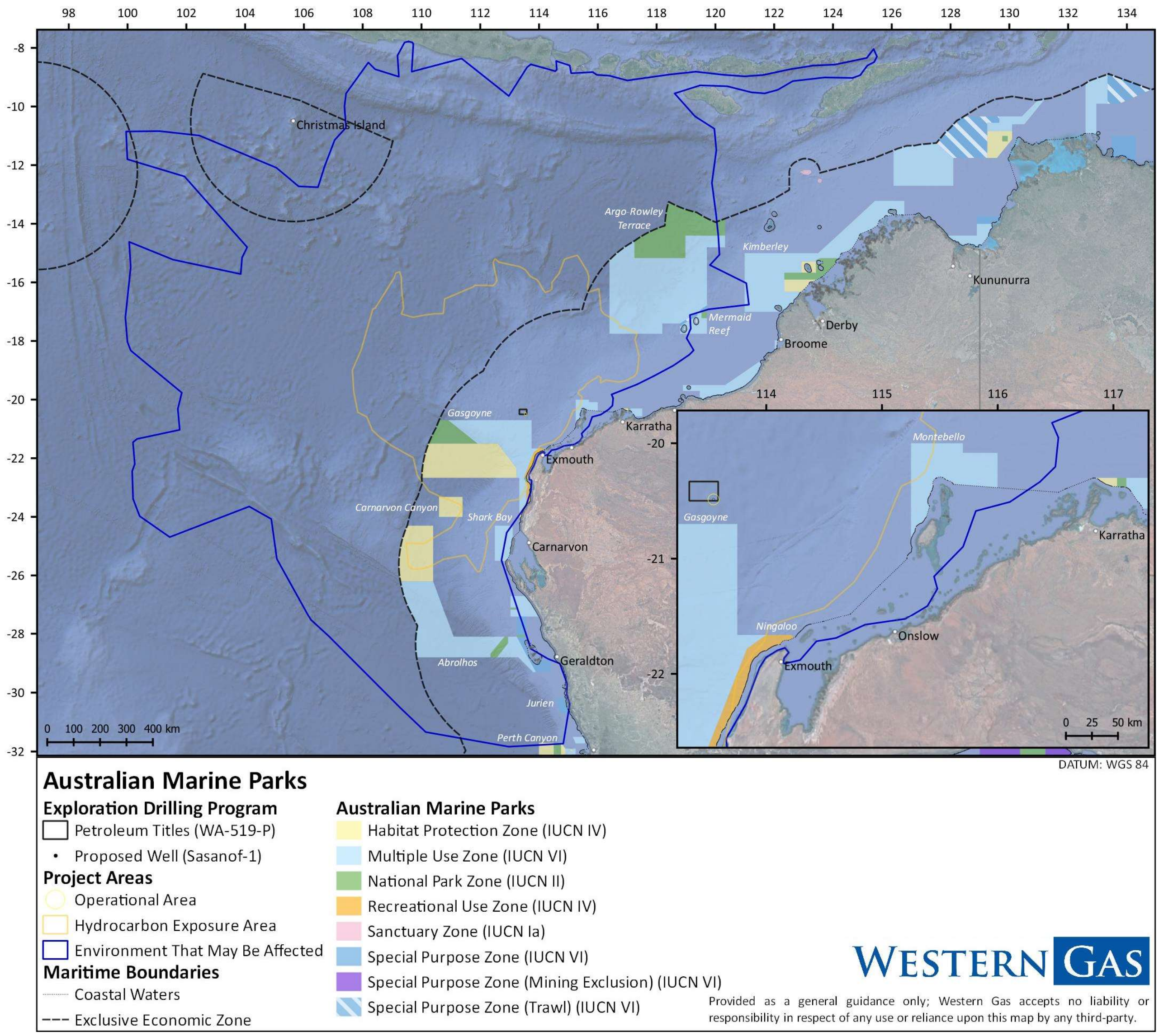


**Figure 5-12 Australian Marine Parks within the EMBA**

#### 5.5.1.2 Key Ecological Features

KEFs are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. KEFs are not MNES and have no legal status in their own right; however, they may be considered as components of the Commonwealth marine area.

The Operational Area is located entirely within the Exmouth Plateau KEF (Figure 5-13). The Exmouth Plateau KEF has a total area of 49,314 $km^2$, of which the Operational Area covers ~392.5 $km^2$ which is equal to 0.64%. The Hydrocarbon Exposure Area transects a total of 8 KEFs; 6 within the NWMR and 2 within the SWMR. While the EMBA transect a total of 16 KEFs; nine within the NWMR, and seven within the SWMR (Table 5-12).

**Table 5-12: KEFs relevant to the Project Areas**

| Key Ecological Feature | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| **North-west Marine Region** | | | |
| Ancient coastline at 125 m depth contour | X | ✓ | ✓ |
| Canyons linking the Argo Abyssal Plain with the Scott Plateau | X | X | ✓ |
| Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula | X | ✓ | ✓ |
| Commonwealth waters adjacent to Ningaloo Reef | X | ✓ | ✓ |
| Continental slope demersal fish communities | X | ✓ | ✓ |
| Exmouth Plateau | ✓ | ✓ | ✓ |
| Glomar Shoals | X | X | ✓ |
| Mermaid Reef and Commonwealth waters surrounding Rowley Shoals | X | X | ✓ |
| Wallaby Saddle | X | ✓ | ✓ |
| **South-west marine region** | | | |
| Ancient coastline at 90–120 m depth | X | X | ✓ |
| Commonwealth marine environment surrounding the Houtman Abrolhos Islands | X | X | ✓ |
| Commonwealth marine environment within and adjacent to the west coast inshore lagoons | X | X | ✓ |
| Meso-scale eddies[1] | X | ✓ | ✓ |
| Perth Canyon and adjacent shelf break, and other west coast canyons | X | X | ✓ |
| Western demersal slope and associated fish communities | X | ✓ | ✓ |
| Western rock lobster | X | X | ✓ |

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

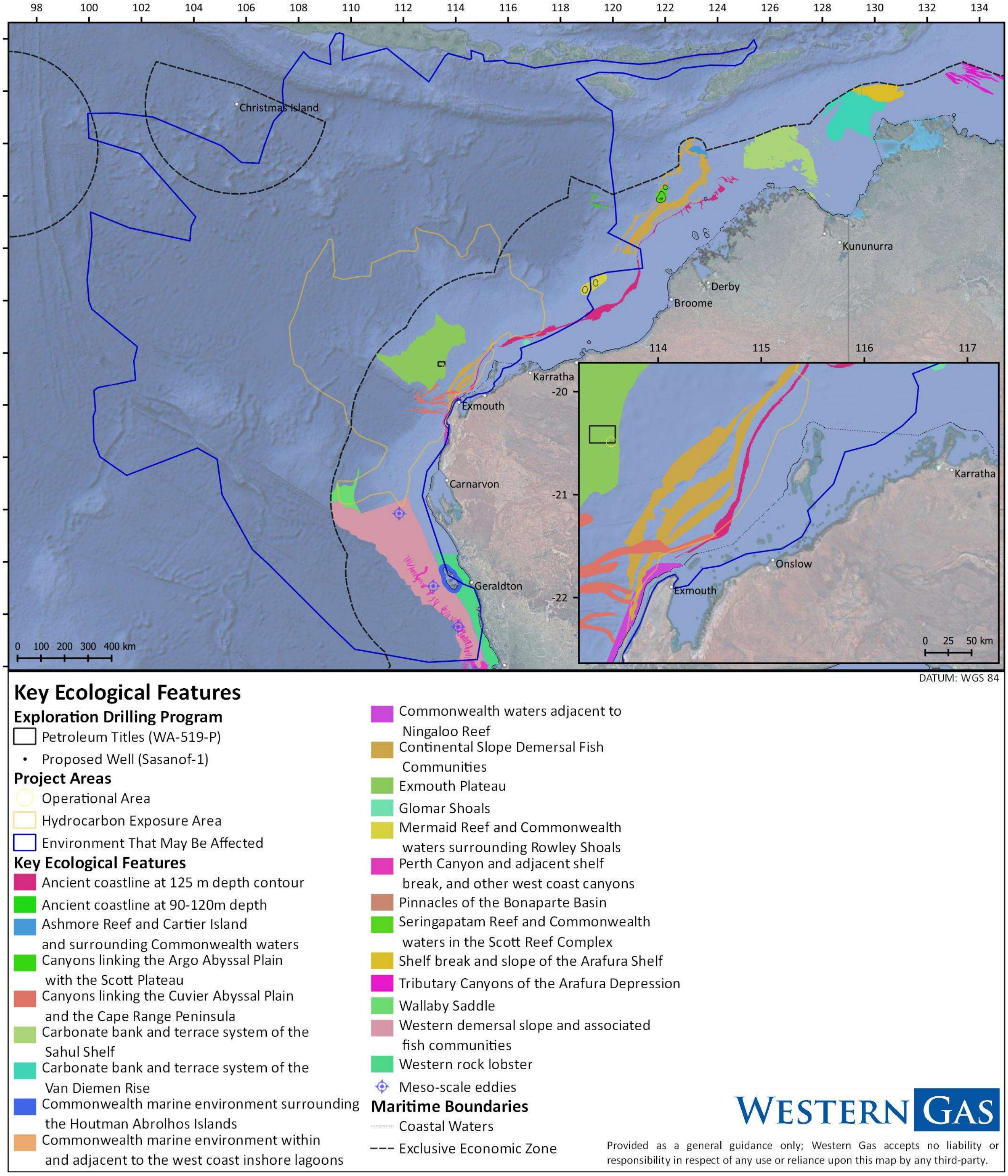


**Figure 5-13 Key Ecological Features within the Project Areas**

The importance and values of the KEFs which overlap with the Project Areas are described in the SPRAT database (DEE 2019b) and summarised in Table 5-13.

Table 5-13 Importance and Values of Key Ecological Features

| **North-west Marine Region** |
|---|
| **Ancient coastline at 125 m depth contour** |
| **National and/or regional importance**<br>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.<br>**Location**<br>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.<br>**Description and values**<br>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.<br>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.<br>Humpback Whales appear to migrate along the ancient coastline, using it as a guide to move through the region. |
| **Canyons linking the Argo Abyssal Plain with the Scott Plateau** |
| **National and/or regional importance**<br>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.<br>**Location**<br>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.<br>**Description and values**<br>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 ~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.<br>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 (~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, seasnakes, 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.

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| 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**<br>This species assemblage is recognised as a key ecological feature because of its biodiversity values, including high levels of endemism.<br>**Location**<br>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.<br>**Description and values**<br>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.<br>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.<br>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**<br>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.<br>**Location**<br>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.<br>**Description and values**<br>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.<br>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.<br>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 |

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| 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.<br><br>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**<br><br>The Glomar Shoals are defined as a KEF for their high productivity and aggregations of marine life.<br><br>**Location**<br><br>The Glomar Shoals are a submerged littoral feature located ~150 km north of Dampier on the Rowley Shelf at depths of 33–77 m.<br><br>**Description and values**<br><br>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.<br><br>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 seafloor 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**<br><br>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.<br><br>**Location**<br><br>The Rowley Shoals are a collection of three atoll reefs (Clerke, Imperieuse and Mermaid), which are located ~300 km northwest of Broome. The KEF encompasses Mermaid Reef MP as well as waters from 3–6 nm surrounding Clerke and Imperieuse reefs.<br><br>Mermaid Reef lies ~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.<br><br>**Description and values**<br><br>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, ~530 species of fish, 264 species of molluscs and 82 species of echinoderms; no sea snakes are known to occur.<br><br>The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the north-west. 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. |

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| 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. |
| **Wallaby Saddle** |
| **National and/or regional importance**<br>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.<br>**Location**<br>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.<br>**Description and values**<br>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.<br>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**<br>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.<br>**Location**<br>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 ~90–120 m.<br>**Description and values**<br>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.<br>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.<br>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** |

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| 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.<br><br>**Location**<br><br>The Houtman Abrolhos Islands are a complex of 122 islands and reefs located at the edge of the continental shelf, ~60 km offshore from the Mid-West coast of WA.<br><br>**Description and values**<br><br>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.<br><br>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 ~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 Western 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**<br><br>The Commonwealth marine environment within and adjacent to the west-coast inshore lagoons is defined as a key ecological feature for its high productivity and aggregations of marine life. Both benthic and pelagic habitats within the feature are of conservation value.<br><br>**Location**<br><br>A chain of inshore lagoons extends along the Western Australian 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. These inshore lagoons extend in places into the Commonwealth marine environment of the South-west Marine Region.<br><br>**Description and values**<br><br>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. These inshore lagoons extend in places into the Commonwealth marine environment of the South-west Marine Region. Although macroalgae and seagrass appear to be the primary source of production, scientists suggest that groundwater enrichment may supplement the supply of nutrients to the lagoons.<br><br>Seagrass meadows occur in more sheltered areas and in the inter-reef lagoons along exposed sections of the coast while emergent reefs and small islands create a diverse topography. The mix of sheltered and exposed seabeds form a complex mosaic of habitats. The inshore lagoons are important areas for the recruitment of the commercially and recreationally important western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone and many other reef species. |
| **Mesoscale eddies** |
| **National and/or regional importance** |

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| Mesoscale eddies are defined as pelagic KEF for their high productivity and aggregations of marine life.<br>**Location**<br>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.<br>**Description and values**<br>Driven by interactions between currents and bathymetry, persistent mesoscale 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.<br>Mesoscale 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. Mesoscale eddies and seasonal upwellings have a significant impact on the regional production patterns.<br>The mesoscale 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**<br>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.<br>**Location**<br>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.<br>**Description and values**<br>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.<br>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.<br>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** |

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| The demersal slope and associated fish communities are recognised as a KEF for their high levels of biodiversity and endemism.<br>**Location**<br>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.<br>**Description and values**<br>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.<br>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**<br>The Western Rock Lobster is defined as a KEF due to its presumed ecological role on the west coast continental shelf.<br>**Location**<br>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.<br>**Description and values**<br>Western Rock Lobster (*Panulirus cygnus*) is the dominant large benthic invertebrate in this bioregion. 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.<br>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. |

### 5.5.2 State Protected Areas

#### 5.5.2.1 Marine

The Operational Area does not coincide with any State marine protected areas, while the Hydrocarbon Exposure Area transects only one Marine State Protected Area; Ningaloo Marine Park. The EMBA transects 15 Marine State Protected Area; nine of which occur within the NWMR and six within the SWMR. (Table 5-14)

The Ningaloo Marine Park is managed under the Management Plan for the Ningaloo Marine Park (CALM 2005). The Ningaloo Marine Park is located off the North West Cape of WA and cover approximately 263,343 ha.

The Ningaloo Marine Park is valued for high terrestrial species endemism, marine species diversity and abundance, and the interconnectedness of large-scale marine, coastal and terrestrial environments (DNP 2018). The area connects the limestone karst system and fossil reefs of the ancient Cape Range to the nearshore reef system of Ningaloo Reef. The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act, and a number of biologically important areas for seabirds, marine turtles and marine mammals (as detailed in Section 5.4). The area is also significant for Aboriginal heritage (Section 5.5.6) and recreational purposes, supporting a wide variety of nature-based tourism activities (Section 5.5.5).

**Table 5-14 State Marine Protected Areas within the Project Areas**

| State Marine Protected Area | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| **North-west Marine Region** | | | |
| Barrow Island Marine Park | X | X | ✓ |
| Great Sandy Island Nature Reserve | X | X | ✓ |
| Ningaloo Marine Park | X | ✓ | ✓ |
| Rowley Shoals Marine Park | X | X | ✓ |
| Montebello Islands Marine Park | X | X | ✓ |
| Muiron Islands Marine Management Area | X | X | ✓ |
| Barrow Island Marine Park | X | X | ✓ |
| Barrow Island Marine Management Area | X | X | ✓ |
| Thevenard Island Nature Reserve | X | X | ✓ |
| **South-west Marine Region** | | | |
| Beagle Island Nature Reserve | X | X | ✓ |
| Essex Rocks Nature Reserve | X | X | ✓ |
| Fisherman Islands Nature Reserve | X | X | ✓ |
| Outer Rocks Nature Reserve | X | X | ✓ |
| Jurien Bay Marine Park | X | X | ✓ |
| Sandland Island Nature Reserve | X | X | ✓ |

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

Table 5-15 provides a summary of the description and values of Ningaloo Marine Park.

**Table 5-15: State Marine Protected Areas relevant to the Operational Area**

| Name | Key Features |
|---|---|
| **Ningaloo Marine Park** | • 263,343 ha.<br>• Ningaloo Reef is the largest fringing coral reef in Australia.<br>• Temperate and tropical currents converge in the Ningaloo region resulting in highly diverse marine life.<br>• Species with special conservation significance such as turtles, whale sharks, dugongs, whales and dolphins.<br>• Diverse marine communities including mangroves, algae and filter-feeding communities and high-water quality.<br>• Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, and annual mass spawning of coral.<br>• Regarded as the State's premier marine conservation icon. |

### 5.5.2.2 Terrestrial

No State Terrestrial Protected Areas occur within the Hydrocarbon Exposure Area or Operational Area. The closest State terrestrial protected area to the Operational Area is the Jurabi Coastal Park which are located ~156 km away but situated outside of the EMBA. The closest State terrestrial protected areas to the Operational Area with in the EMBA are the Murion Islands Nature Reserve located ~145 km away.

State Terrestrial Protected Areas that intersect with the EMBA are detailed in Table 5-16.

**Table 5-16 State Terrestrial Protected Areas within the Project Areas**

| State Terrestrial Protected Area | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| Airlie Island Nature Reserve | X | X | ✓ |
| Barrow Island Nature Reserve | X | X | ✓ |
| Bessieres Island Nature Reserve | X | X | ✓ |
| Boodie, Double Middle Islands Nature Reserve | X | X | ✓ |
| Boullanger, Whitlock, Favourite, Tern and Osprey Islands Nature Reserves | X | X | ✓ |
| Cape Range National Park | X | X | ✓ |
| Escape Island Nature Reserve | X | X | ✓ |
| Houtman Abrolhos Islands National Park | X | X | ✓ |
| Locker Island Nature Reserve | X | X | ✓ |
| Lowendal Islands Nature Reserve | X | X | ✓ |
| Montebello Islands Conservation Park | X | X | ✓ |

| State Terrestrial Protected Area | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| Muiron Islands Nature Reserve | X | X | ✓ |
| Pilbara Inshore Islands Nature Reserve | X | X | ✓ |
| Round Island Nature Reserve | X | X | ✓ |
| Serrurier Island Nature Reserve | X | X | ✓ |
| Turquoise Coast Island Nature Reserves | X | X | ✓ |
| Victor Island Nature Reserve | X | X | ✓ |

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

### 5.5.3 Commercial Fisheries and Aquaculture

#### 5.5.3.1 Commonwealth Fisheries

Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA) under the Fisheries Management Act 1991, with the fisheries typically operating within 3 nm to 200 nm offshore (i.e. to the extent of the Australian Fishing Zone [AFZ]).

Five Commonwealth managed commercial fisheries have boundaries that intersect with the Hydrocarbon Exposure Area and/or EMBA (Table 5-17), while four Commonwealth managed commercial fishery boundaries intersect the Operational Area. Not all the fisheries are active within the full extents of the boundaries. Based on current and historical fishing effort data (ABARES 2019) and consultation with relevant stakeholders:

- North West Slope Trawl Fishery (NWSTF) is likely to be active in waters >200 m off the Pilbara and Kimberley coasts (Figure 5-14);
- 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 5-15);
- Western Deepwater Trawl Fishery (WDTF) is likely to be active in waters >200 m off the Gascoyne coast (Figure 5-16);
- 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 5-17).

Based on previous fishing effort data, the only Commonwealth fisheries expected to be potentially active within the Hydrocarbon Area is the NWSTF, WDTF and WTBF, and within the Operational Area only the WDTF is expected. A summary of the three fisheries that may be active within the EMBA are summarised in Table 5-18.

**Table 5-17: Commonwealth-managed Fisheries potentially relevant to the Project Areas**

| Fishery | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| North West Slope Trawl Fishery (NWSTF) | X | ✓ | ✓ |

| | | | |
|---|---|---|---|
| Southern Bluefin Tuna Fishery (SBTF) | X | X | X |
| Western Deepwater Trawl Fishery (WDTF) | ✓ | ✓ | ✓ |
| Western Skipjack Tuna Fishery (WSTF) | X | X | X |
| Western Tuna and Billfish Fishery (WTBF) | X | ✓ | ✓ |

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

**Table 5-18: Commonwealth Managed Fisheries with active fishing effort relevant to the EMBA**

| Fishery | Method | Target Species | Permits / Vessels | Effort | Main Landing Port |
|---|---|---|---|---|---|
| NWSTF | Demersal Trawl | Scampi (*Metanephrops australiensis, M. boschmai, M. velutinus*) | 2017 – 2018: six permits, four active vessels | 2017 – 2018: 219 days | Darwin (NT)<br>Point Samson (WA) |
| WDTF | Demersal Trawl | Deepwater Bugs (*Ibacus* spp.)<br>Ruby Snapper (*Etelis carbunculus, Etelis* spp.) | 2017 – 2018: seven permits, three active vessels | 2017 – 2018: 100 days | Carnarvon (WA) |
| WTBF | Pelagic longline, minor-line, purse seine | Striped marlin (*Kajikia audux*)<br>Swordfish (*Xiphias gladius*)<br>Albacore (*Thunnus alalunga*)<br>Bigeye Tuna (*Thunnus obesus*)<br>Yellowfin Tuna (*T. albacares*) | 2018:95 boat SFRs, two active pelagic longline vessels, one active minor line vessel | 2018:<br>404,880 hooks | Fremantle (WA)<br>Geraldton (WA) |

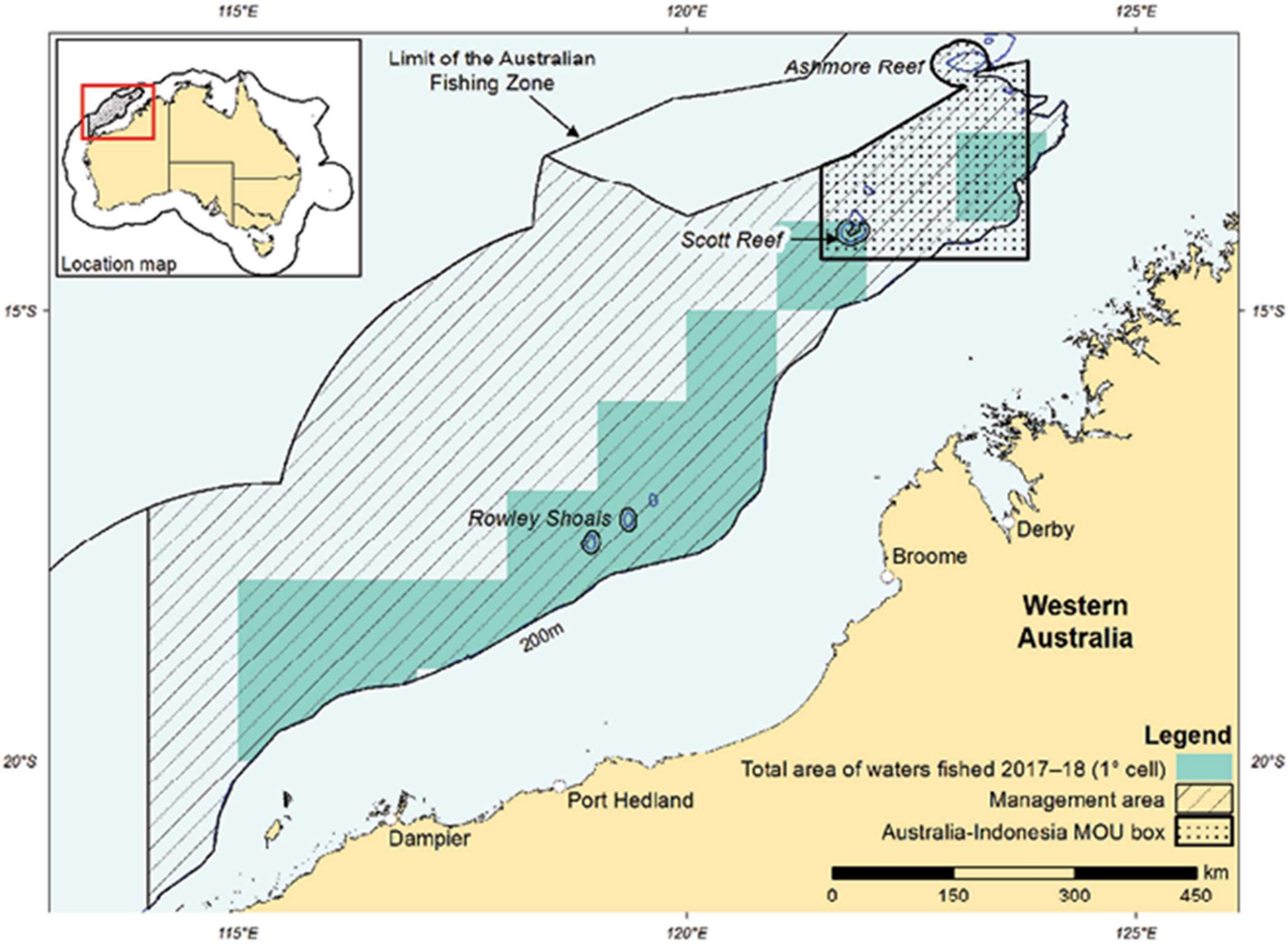


**Figure 5-14 North West Slope Trawl Fishery Management Area and Fishing Effort 2017-2018 (Source: ABARES 2019)**

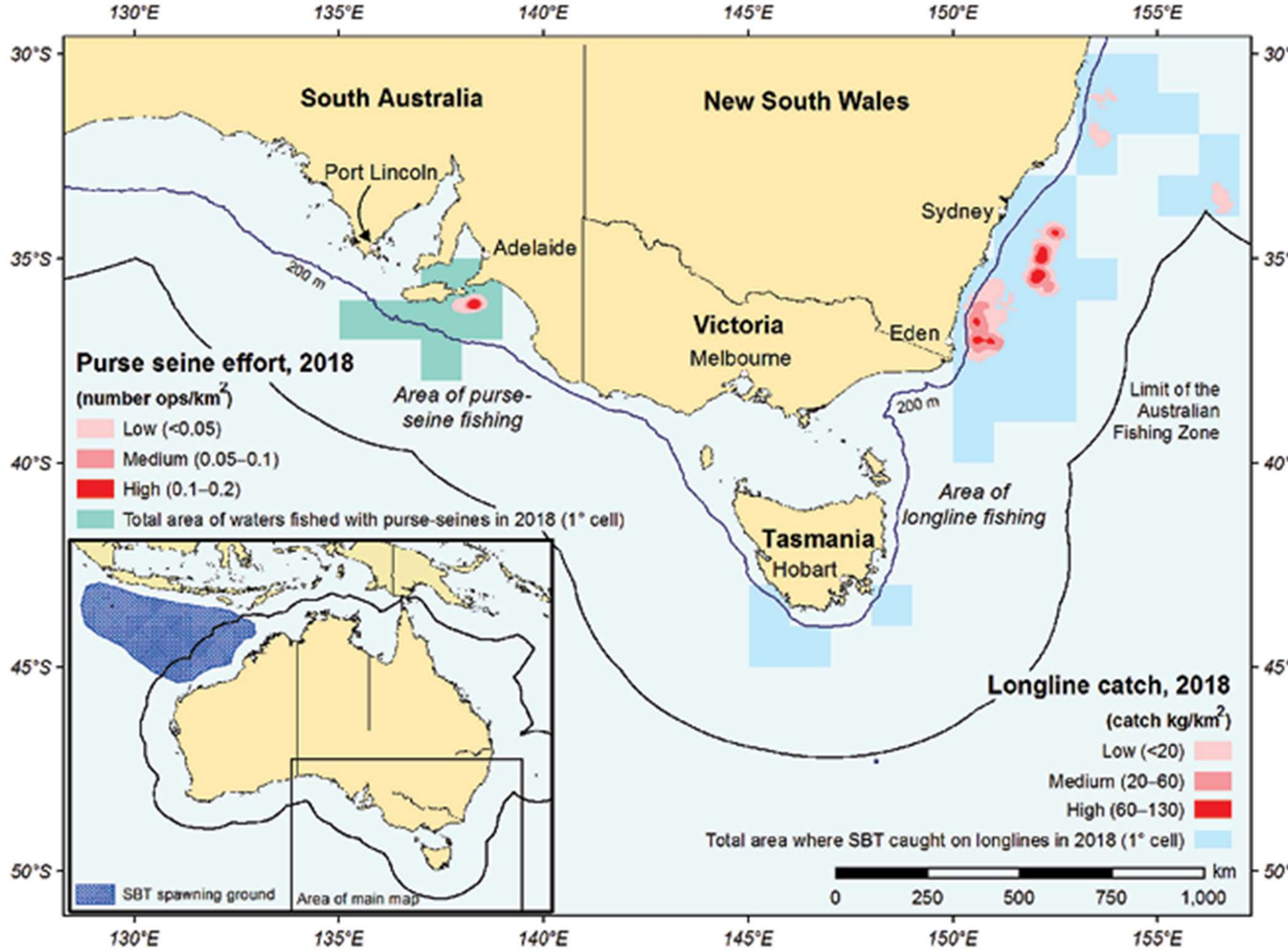


**Figure 5-15 Southern Bluefin Tuna Fishery Management Area and Fishing Effort 2017-2018 (Source: ABARES 2019)**

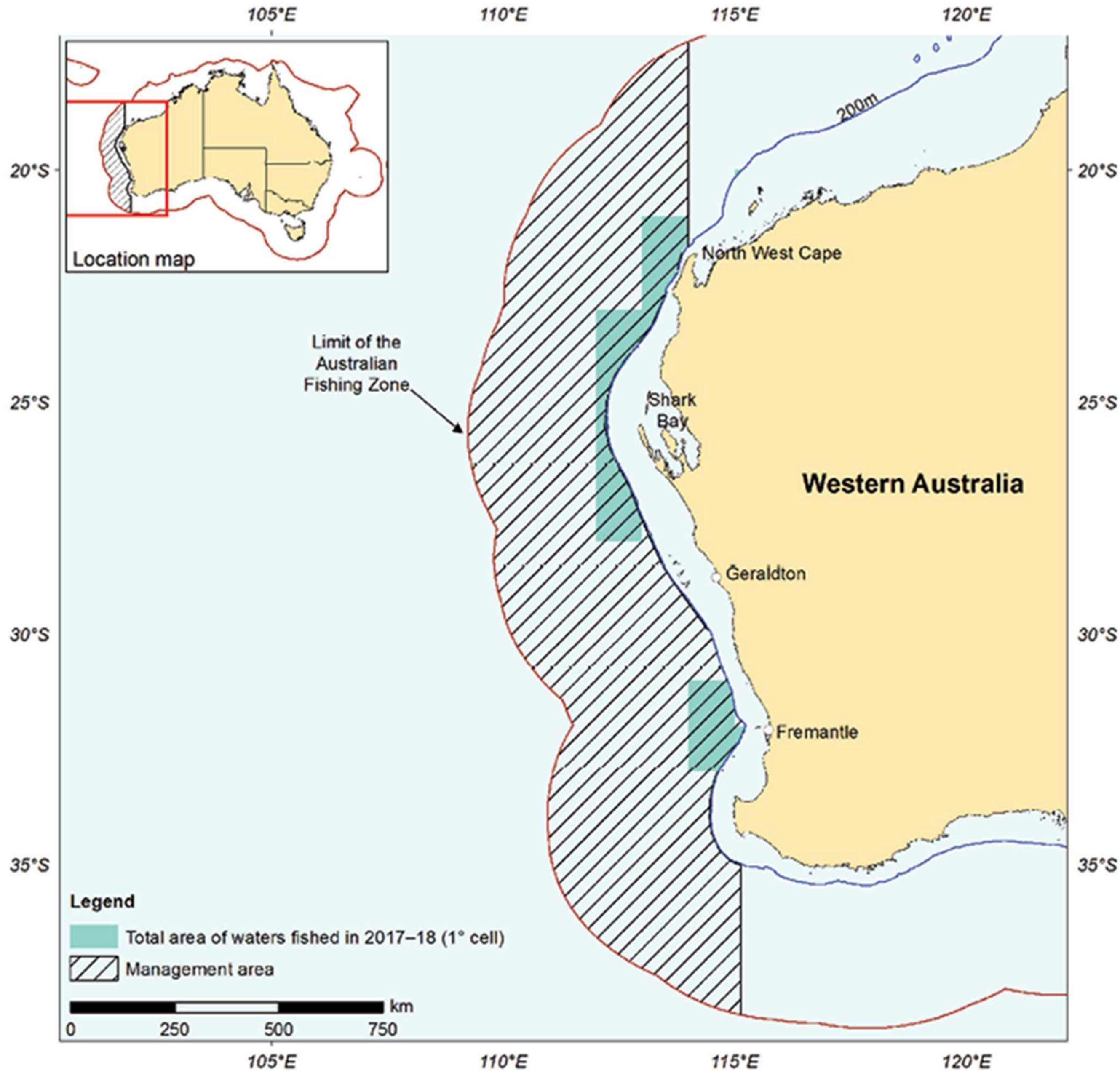


**Figure 5-16 Western Deepwater Trawl Fishery Management Area and Fishing Effort 2017-2018 (Source: ABARES 2019)**

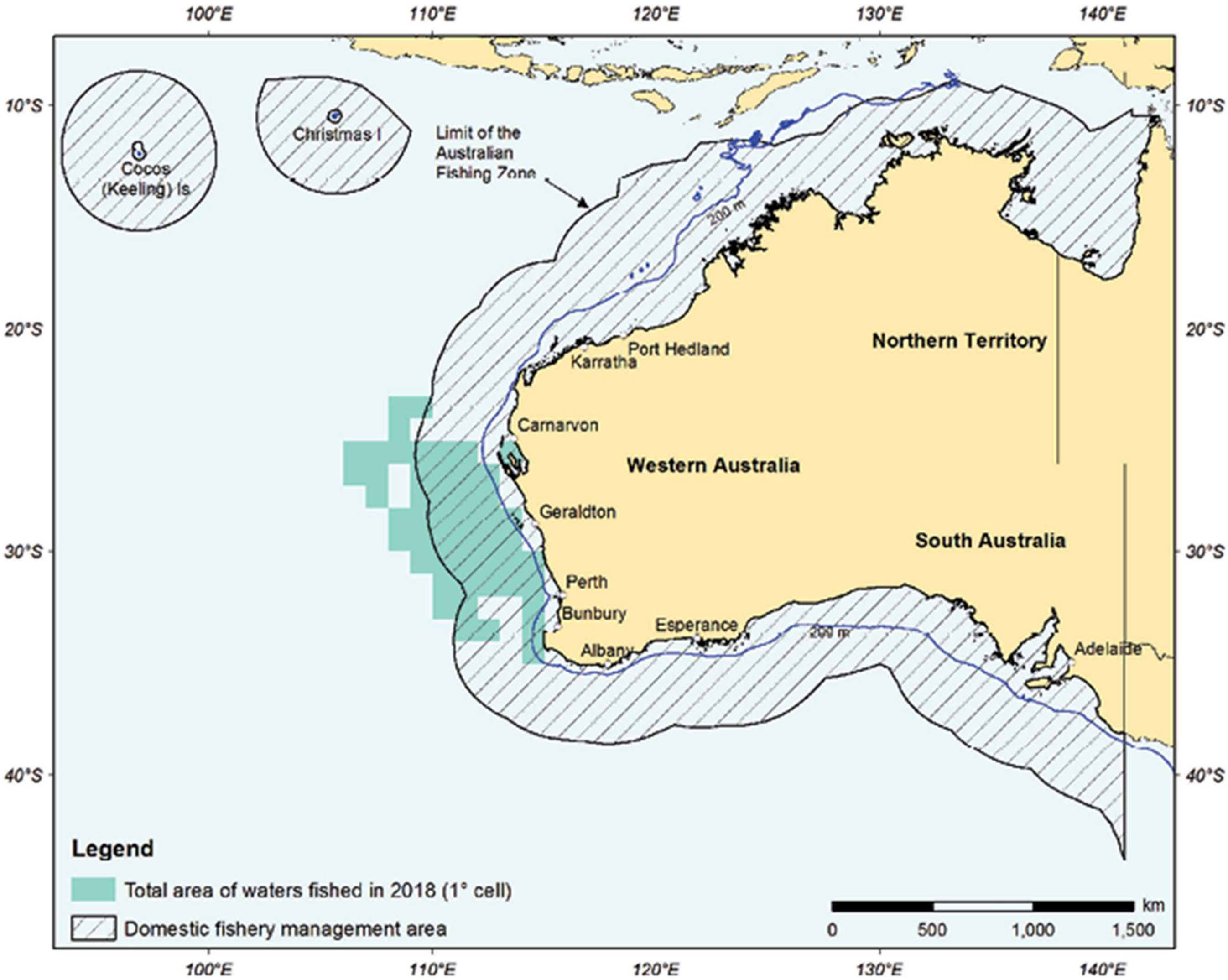


**Figure 5-17: Western Tuna and Billfish Fishery Management Area and Fishing Effort 2018 (Source: ABARES 2019)**

#### 5.5.3.2 State Managed Fisheries

State commercial fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD) under the Fish Resources Management Act 1994 (WA) and the Pearling Act 1990 (WA). The Aquatic Resources Management Act 2016 will become the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in Western Australia, however commencement has been delayed due to an amendment to the Act (DPIRD 2019a). The Offshore Constitutional Settlement (OCS) allows for some individual fisheries to be managed under relevant State government, with fishing areas extending into both Commonwealth and State waters.

Consultation with DPIRD and the FishCube database (DPIRD 2019b) indicates that eight State fisheries may be active within the Project Areas (DPIRD 2019b):

- Exmouth Gulf Prawn Managed Fishery;
- Exmouth Gulf Beach Seine and Mesh Net Managed Fishery;
- Mackerel Managed Fishery;
- Pilbara Line Fishery;
- Pilbara Trap Managed Fishery;

- Hermit Crab Fishery;
- Marine Aquarium Fish Managed Fishery; and
- Specimen Shell Managed Fishery.

The presence of these fisheries within the Project Areas is described below and outlined in Table 5-19.

- The Exmouth Gulf Prawn Managed Fishery is the state fishery with the highest catch and fishing days within the Project Areas (e.g. 499 fishing days and a catch of 297,429 kg for 2018); however, this fishery is focused within Exmouth Gulf and therefore activity does not intersect with the Operational Area.
- The Exmouth Gulf Beach Seine and Mesh Net Managed Fishery operates in shallow, nearshore environments and therefore activity does not intersect with the Operational Area.
- There has been no effort recorded for the Mackerel Managed Fishery in the Project Areas since 2016. The fishery focusses coastal areas around reefs, shoals and headlands; therefore, no fishing effort is expected to occur within the Operational Area.
- Activity for the Pilbara Line Fishery varied between less than three to four vessels, and annual catches of 17.952–27,235 kg during the five-year period. While situated at the southern extent of this fishery, active fishing within the Project Areas is possible. The Pilbara Line Fishery is managed under the Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006 with the exemption of nine fishing vessels for any nominated five-month block period within the year.
- No activity for the Pilbara Trap Managed Fishery was recorded during the last five years, therefore no activity is expected within the Project Areas.
- The State-wide Collector Fisheries (Hermit Crab Fishery, Marine Aquarium Fish Managed Fishery and the Specimen Shell Managed Fishery) occur within State waters only, and therefore no activity would occur within the Operational Area as it is beyond the fisheries' management area boundaries.

However, it is noted that not all the fisheries are active within the full extents of their management areas. In consultation with WAFIC, it was confirmed that there was no active commercial fishing for state managed fisheries over 1,000 metres water depth. Therefore, based on management boundaries and the previous reported fishing effort, minimal State commercial fishing activity is expected to occur within the Project Areas.

**Table 5-19 State-managed Active Fisheries relevant to the Project Areas**

| Fishery | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| **North Coast Bioregion** | | | |
| Kimberley Developing Mud Crab Fishery | X | X | ✓ |
| Beche-De-Mer (Sea Cucumber) Fishery | X | ✓ | ✓ |
| Pearl Oyster Fishery | X | ✓ | ✓ |
| Pilbara Fish Trawl (Interim) Managed Fishery | X | ✓ | ✓ |
| Onslow Prawn Managed Fishery (OPMF) | X | ✓ | ✓ |

| Fishery | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| Nickol Bay Prawn Managed Fishery (NBPMF) | X | ✓ | ✓ |
| Broome Prawn Managed Fishery (BPMF) | X | X | ✓ |
| Kimberley Prawn Managed Fishery | X | X | ✓ |
| Kimberley Gillnet and Barramundi Fishery | X | X | ✓ |
| Mackerel Managed Fishery | X | X | ✓ |
| Pilbara Line Fishery | X | X | ✓ |
| Pilbara Trap Managed Fishery | X | ✓ | ✓ |
| **Gascoyne Coast Bioregion** | | | |
| Gascoyne Demersal Scalefish Fishery | X | ✓ | ✓ |
| Exmouth Gulf Prawn Fishery | X | X | ✓ |
| Shark Bay Prawn and Scallop Managed Fisheries | X | X | ✓ |
| **West Coast Bioregion** | | | |
| Octopus Fishery | X | X | ✓ |
| West Coast Demersal Scalefish Fishery | X | X | ✓ |
| West Coast Purse Seine Fishery | X | X | ✓ |
| Abrolhos Island and Mid-West, South West Trawl Fishery | X | X | ✓ |
| Roe’s Abalone Fishery | X | ✓ | ✓ |
| West Coast Rock Lobster Fishery | X | ✓ | ✓ |
| West Coast Deep Sea Crustacean Fishery | ✓ | ✓ | ✓ |
| **State-wide Bioregion** | | | |
| Marine Aquarium Fish Managed Fishery | ✓ | ✓ | ✓ |
| Specimen Shell Managed Fishery | X | ✓ | ✓ |
| Hermit Crab Fishery | X | ✓ | ✓ |
| **Pearling and Aquaculture** | | | |
| Pearling Leases | X | X | ✓ |
| Aquaculture Leases | X | ✓ | ✓ |

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

#### 5.5.3.3 Traditional Indonesian Fishing

In 1974, a Memorandum of Understanding (MoU) was signed between the Australian and Indonesian governments that 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. Fishers target a range of animals, including sea cucumbers, trochus, reef fish and sharks. 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 Reserves. These areas do not occur within the EMBA. 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). Of these, only Browse Island occurs within the EMBA.

### 5.5.4 Marine and Coastal Industry

There are a number of industries or users that may be present within the Project Areas (Table 5-20). Commercial fisheries, tourism and recreation have been detailed in previous sections (Section 5.5.3 and 5.5.5 respectively).

**Table 5-20 Marine and Coastal Industries within the Project Areas**

| Industry or User | Operational Areas | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| Petroleum exploration and production | X | ✓ | ✓ |
| Ports | X | ✓ | ✓ |
| Commercial shipping | ✓ | ✓ | ✓ |
| Defence | ✓ | ✓ | ✓ |
| Submarine telecommunication cables | X | ✓ | ✓ |

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

#### 5.5.4.1 Petroleum exploration and production

The Project Areas are within the Northern Carnarvon Basin, which is one of the most heavily explored in Australia and is regarded as the premier hydrocarbon basin of Australia. The basin lies mainly offshore, extending north from the Pilbara Craton to the continental–oceanic crust boundary, and covers about 500,000 km$^2$ (DMIRS 2019). The Carnarvon Basin supports >95% WA oil and gas production and accounts for 63% of Australia's total production of crude oil, condensate and LNG. It is also the most heavily explored, with almost 80 per cent of the oil and gas wells drilled in WA (DEWHA 2008).

The closest active petroleum activities to the Operational Area is the Chevron Jansz-Io field development (subsea wells/infrastructure/pipeline) located approximately 106 km to the east. (Figure 5-18).

Western Gas also has five suspended exploration wells within their adjacent permits (Figure 5-18).

There are a number of submerged pipelines within the EMBA. Many of these are associated with connecting the NWS Venture petroleum fields with the onshore gas plants. These include Woodsides' WA-10-PL, and Chevron's Wheatstone Pipeline WA-25-PL (Figure 5-18).

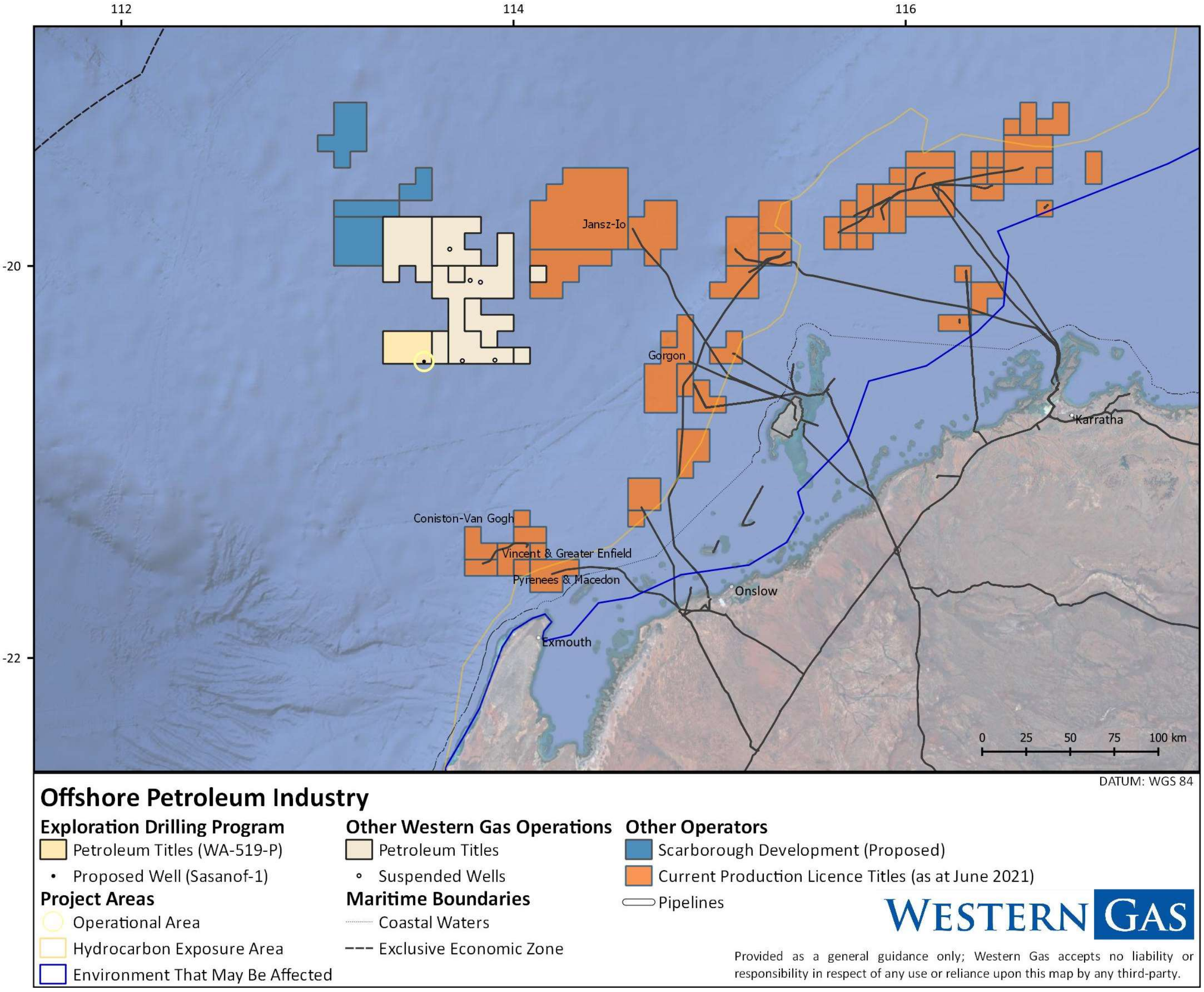


**Figure 5-18 Petroleum industry facilities within the Project Areas**

#### 5.5.4.2 Ports

The seabed and water areas of the Port of Ashburton and Port of Onslow transect the Project EMBA (Figure 5-19). The Port of Ashburton is managed by the Pilbara Port Authority. It is multi-user port and accommodates LNG and other hydrocarbon based processing and natural gas processing for Western Australia’s domestic gas supply. Port of Onslow is located alongside the Port of Ashburton and is managed and operated by the Department of Transport (DoT). The main commodities managed by the port is salt and oil and gas product.

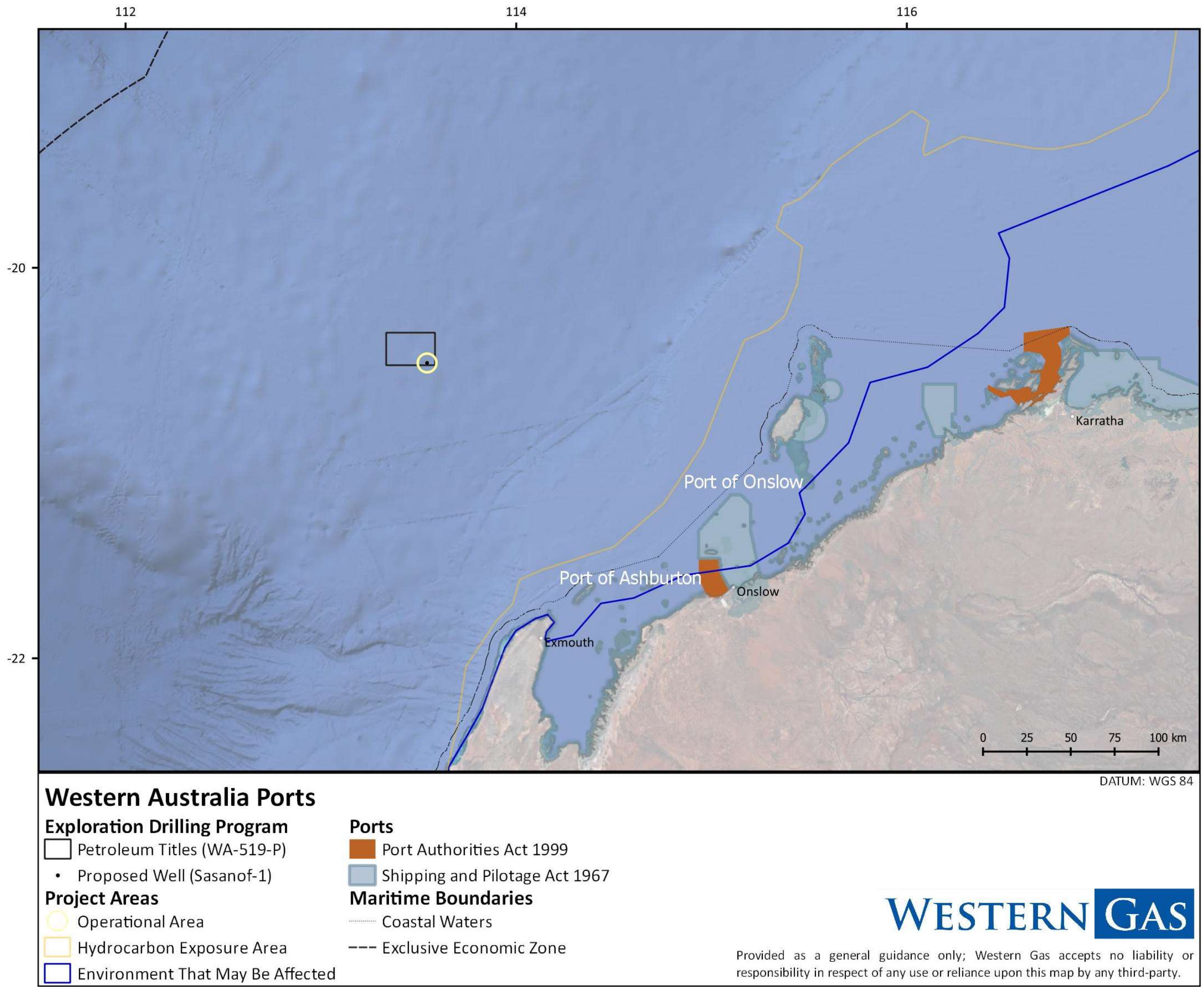


**Figure 5-19 Major Port Facilities within the Project Areas**

### 5.5.4.3 Shipping

Sea transport is an important activity, with international transit routes and shipping lanes occurring within the northwest of WA. Vessels operating within the region are generally linked with resource industry and Dampier receives the highest number of vessel visits in WA (Figure 5-20).

The region is subject to a high degree of shipping traffic as it is intersected by two AMSA Shipping Fairways plus a high degree of commercial traffic to the southern end the Project Areas moving from the established shipping fairways to the ports along the adjacent coastline (Figure 5-20). However, shipping volumes within the Operational Area are expected to be low.

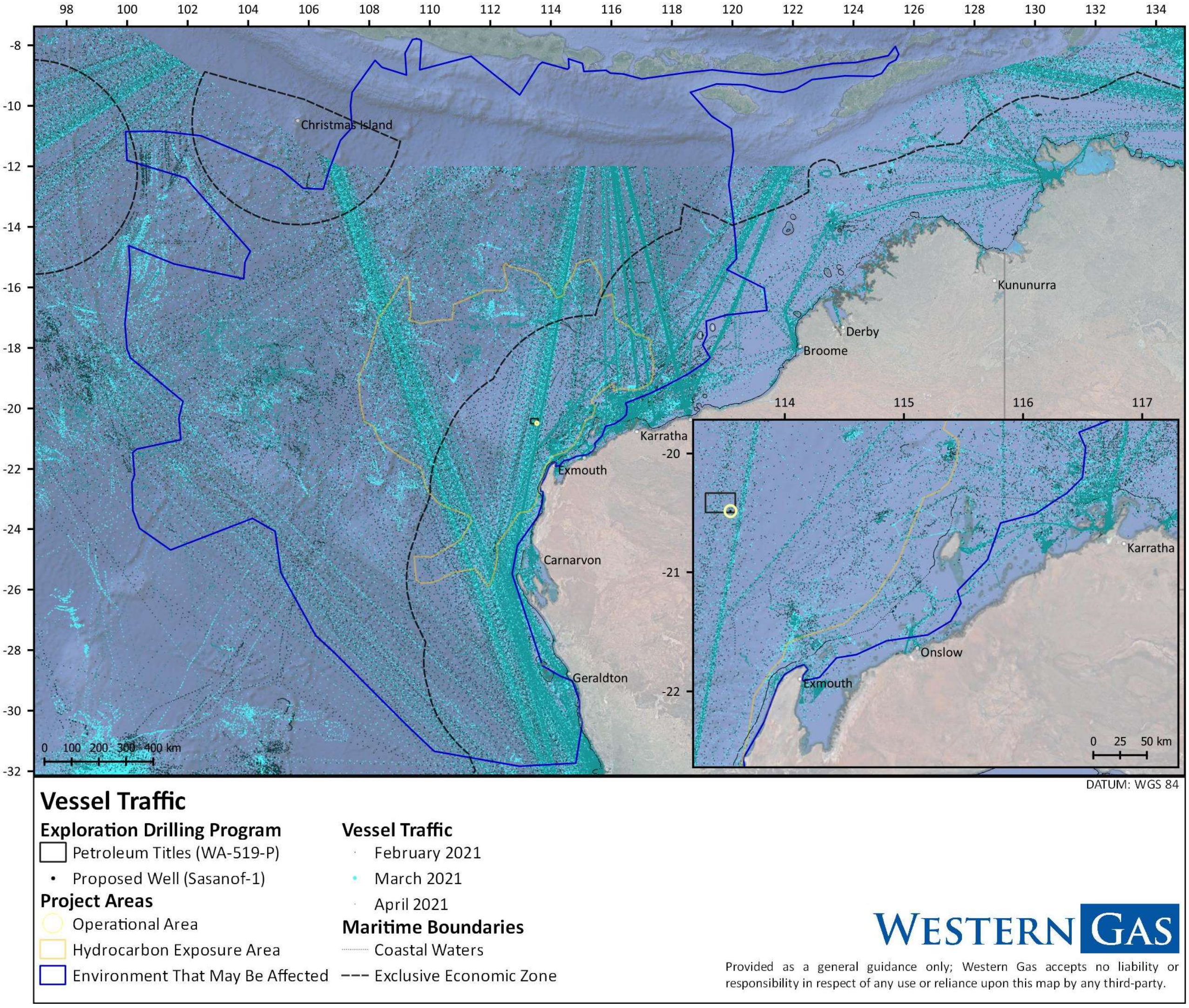


**Figure 5-20: Recorded vessel traffic within the Project Areas**

#### 5.5.4.4 Defence

The Royal Australian Air Force (RAAF) Base Learmonth is located south of Exmouth. The RAAF maintains the Commonwealth Heritage listed Learmonth Air Weapons Range Facility, which is located onshore between Ningaloo Station and the Cape Range National Park. This facility is used for military exercises and as a bombing range. The Naval Communications Station Harold E. Holt is also located at North West Cape north of Exmouth. The main role of the station is to communicate at very low frequencies with Australian and United States submarines in the Indian Ocean and the western Pacific.

The Operational Area transects a marine Defence Training Area (Figure 5-21), while the Hydrocarbon Exposure Area and EMBA both transect a marine Defence Training Area and a Defence Practice Area.

#### 5.5.4.5 Submarine telecommunications cables

The SEA-ME-WE3, Australia-Singapore and Indigo-West cables are three submarine telecommunications cables of international significance currently in service in the region. The previous JASURAUS cable was decommissioned in 2012. The EMBA and Hydrocarbon Exposure

Area intersect within these submarine telecommunications cables, however there are no submarine telecommunications cables located in the Operational Area (Figure 5-21).

Under the *Telecommunications and* Other *Legislation Amendment Act 2005* protection zones can be declared to cover the cables to prohibit and/or restrict activities that may damage them. The protection zones are generally the area within 1.8 km (1 nm) either side of the cable and include both the waters and seabed within the area. The Perth Protection Zone extends approximately 112 km (60 nm) offshore from City Beach to water depths of 2,000 m, and 1 nm each side of the SEA-ME-WE3 cable.

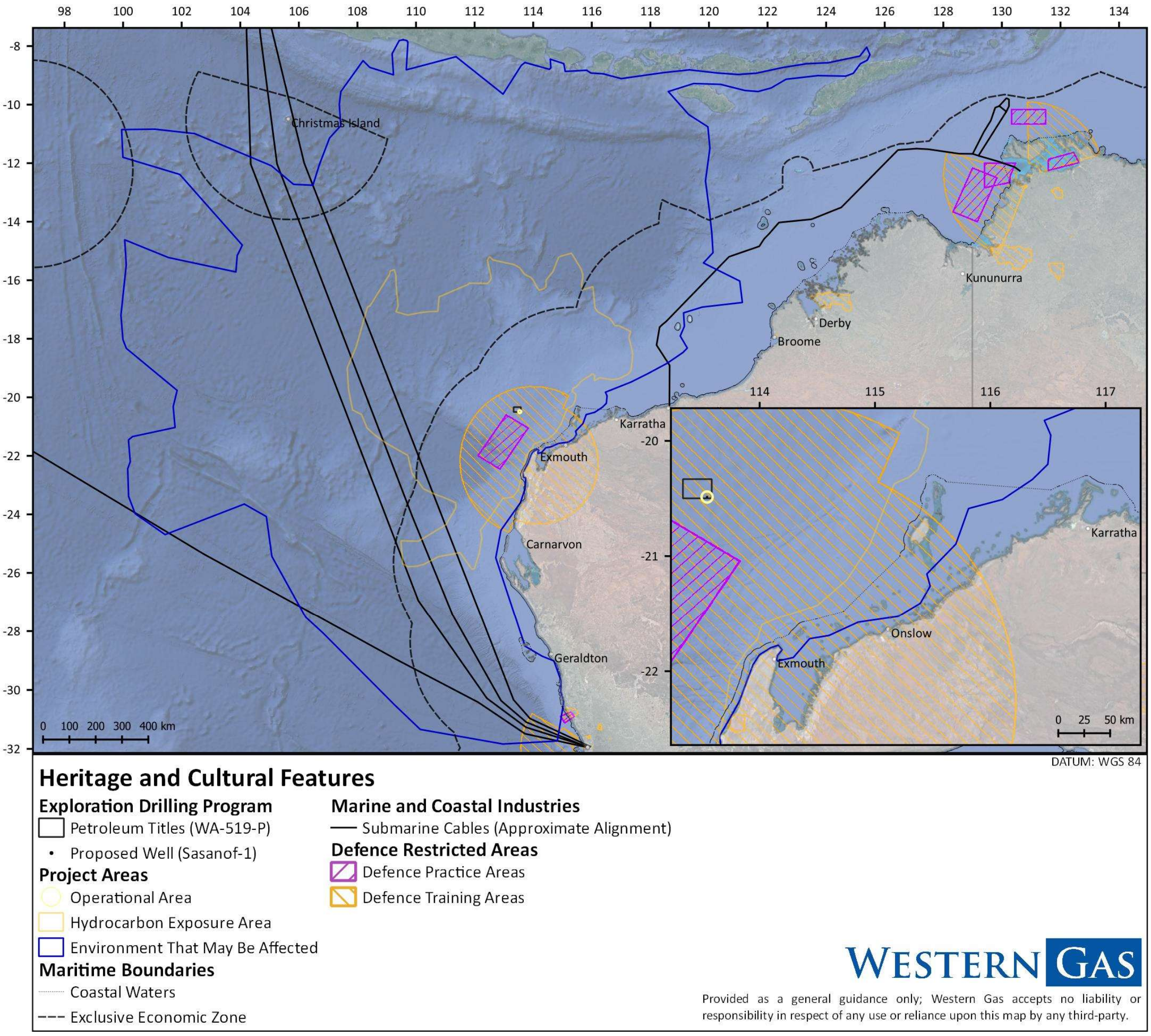


**Figure 5-21: Defence areas and Submarine Cables within Project Areas**

### 5.5.5 Tourism and Recreation

Charter fishing, diving, snorkelling, whale, marine turtle and dolphin watching and cruising are the main commercial tourism activities within the EMBA (Table 5-21). With the exception of offshore charter fishing, most marine tourism activities occur in state waters. Charter fishing is a popular tourist activity in the Pilbara region with most tours operate out of Exmouth. Whale watching is a popular tourist activity, particularly in the Exmouth Gulf during the southward migration of Humpback Whales from September to late November (DEWHA 2008). The area also offers encounters with whale sharks which is an important source of tourism income within the area. The majority of tourism occurs around the Ningaloo Reef (over 140 km from Operational Area) and Cape Range National Park (over 140 km from Operational Area) and are concentrated in the vicinity of the population centres such as Exmouth, Dampier, Onslow, Point Samson (~160 km, ~320 km, ~200 km, ~360 km distance from the Operational Area respectively). Cruise ships operate in the EMBA with frequent visits to Exmouth and the occasional visit to Port Hedland, bringing an added value of $0.7 million and $1 million to the areas respectively (Tourism WA 2017). Cruise ships are expected to operate within standard shipping lanes and state waters.

Tourism and recreation activities are not expected to occur within the Operational Area due to the water depths and distance offshore. Some tourism and recreation activities may occur in areas of the Hydrocarbon Exposure Area and EMBA that occur nearshore but is expected to be limited to passing vessels and the occasional offshore charter fishing.

**Table 5-21: Marine Tourism and Recreation within the Project Areas**

| Activity | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| Recreational fishing | *X* | ✓ | ✓ |
| Charter vessel tours | *X* | ✓ | ✓ |
| Cruises | *X* | ✓ | ✓ |
| Recreational diving, snorkelling, and other nature-based activities | *X* | ✓ | ✓ |

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

### 5.5.6 Heritage and Cultural

The heritage value of places is included as part of the definition of environment as provided in the OPGGS(E) Regulations. World Heritage Properties and National Heritage Places are both matters of national environment significance under the *Environment Protection and Biodiversity Conservation Act 1999*.

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 numerous (>1,500) known shipwreck and historic (>75 years old) shipwreck sites listed to occur within waters offshore WA, as listed in the Australasian Underwater Cultural Heritage Database, including *the Batavia*, wrecked in 1629 offshore from the Houtman Abrolhos Islands, the *HSK Kormoran* and the *HMAS Sydney II*, sunk in 1941. Some historic shipwrecks lie within protected or no-entry zones; these zones cover an area around a wreck site, ensures that a fragile or sensitive historic shipwreck is actively managed (Figure 5-23).

Aboriginal sites are of immense cultural, scientific, educational and historic interest and provide Aboriginal people with an important link to their present and past culture. Within Western Australia, sites of significance are included within the list of Registered Sites under the Aboriginal Heritage Act 1972. Indigenous Protected Areas are a component of Australia's National Reserve System (i.e. the network of formally recognised parks, reserves and protected areas across Australia). As well as protecting biodiversity, Indigenous Protected Areas deliver environmental, cultural, social, health and wellbeing and economic benefits to Indigenous communities.

Heritage and cultural places and values that may be present within the EMBA are detailed in Table 5-22 There are no heritage or cultural features located within the Operational Area

**Table 5-22: Heritage and Cultural Features relevant to Project Areas**

| Feature | Operational Area | Hydrocarbon Exposure Area | EMBA |
|---|---|---|---|
| **World Heritage Properties** | | | |
| The Ningaloo Coast | X | ✓ | ✓ |
| **National Heritage Properties** | | | |
| The Ningaloo Coast | X | ✓ | ✓ |
| Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos | X | X | ✓ |
| *HMAS Sydney II* and *HSK Kormoran* Shipwreck Sites | X | X | ✓ |
| **Commonwealth Heritage Places** | | | |
| Ningaloo Marine Area (Commonwealth waters) | X | ✓ | ✓ |
| *HMAS Sydney II* and *HSK Kormoran* Shipwreck Sites | X | X | ✓ |
| **Aboriginal Heritage Places** | | | |
| Registered Sites | X | X | X |
| **Indigenous Protected Areas** | | | |
| State terrestrial protected areas that are proclaimed as Indigenous Protected Areas | X | X | X |
| **Underwater Cultural Heritage** | | | |
| Historic shipwrecks (>75 years) | X | ✓ | ✓ |
| Shipwrecks | X | ✓ | ✓ |
| Sunken aircraft | X | X | X |
| Insitu artefact | X | X | X |

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

Within the EMBA there is one World and three National heritage places (Table 5-22) and Figure 5-22). The closest World and National heritage areas to the Operational Area is the Ningaloo Coast, which is situated ~139 km away.

There are several known shipwreck and historic (>75 years old) shipwreck sites within the EMBA (Figure 5-22). Some underwater cultural heritage sites are also within a declared protection zone, where entry and/or activities may be restricted; two of these occur within the EMBA and are associated with historic shipwrecks: *HSK Kormoran* and *HMAS Sydney II*.

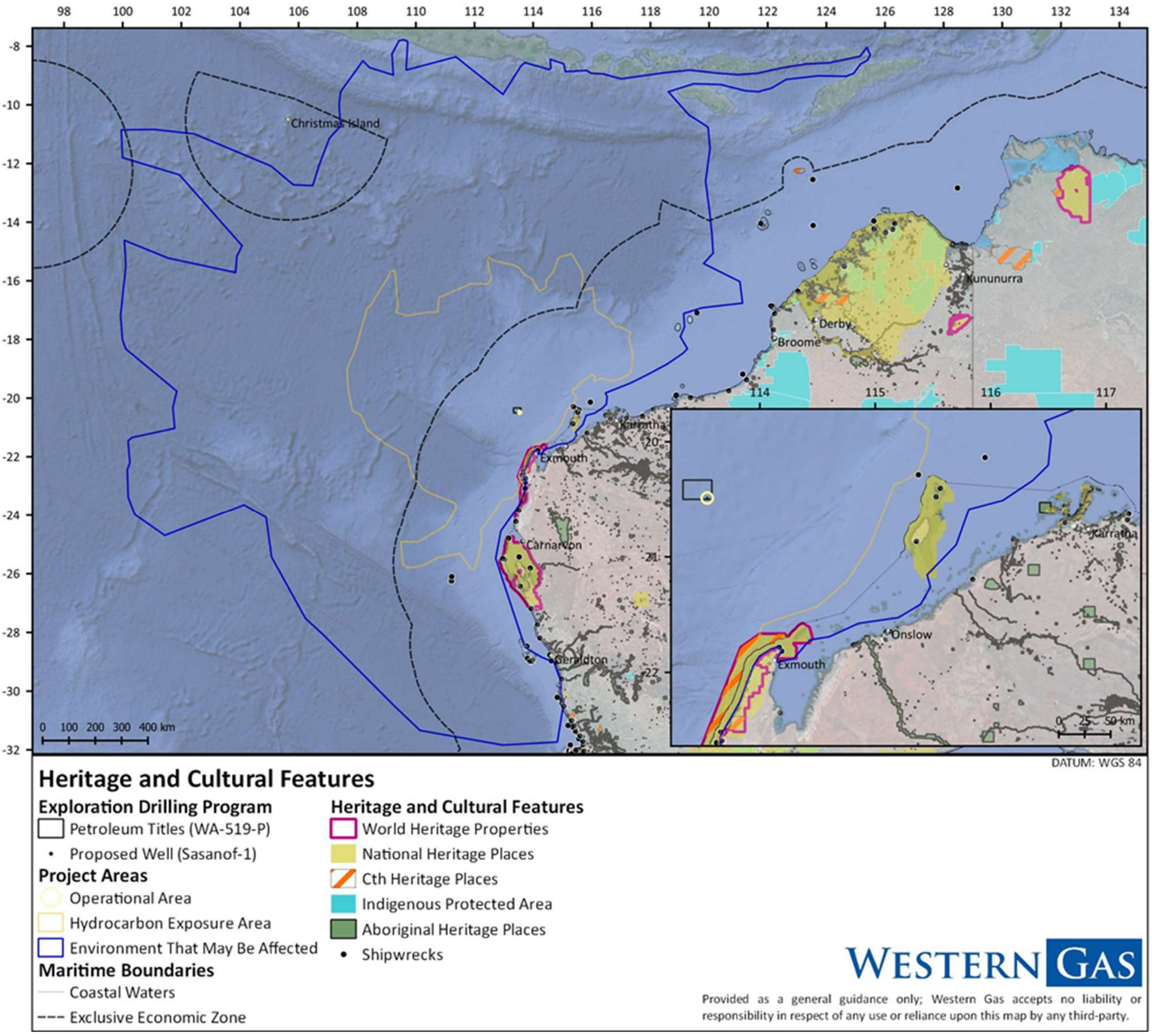


**Figure 5-22 Heritage and cultural features within the Project Area**

### 5.5.6.1 Ningaloo Coast

The Ningaloo Coast is recognised as both a World Heritage Area (WHA) and included on both the National and Commonwealth Heritage lists. The Ningaloo Coast includes both land and State and Commonwealth marine waters (Figure 5-22). The coastal waters host a major near shore reef system and a directly adjacent limestone karst system with associated habitats and species along an arid coastline (DEE 2019d). The area has a high level of terrestrial species endemism and high marine species diversity and abundance. An estimated 300 to 500 whale sharks aggregate annually coinciding with mass coral spawning events and seasonal localized increases in productivity (DEE 2019d). The marine portion of the nomination contains a high diversity of habitats that includes lagoon, reef, open ocean, the continental slope and the continental shelf. Intertidal systems such as rocky shores, sandy beaches, estuaries, and mangroves are also found within the property. The most dominant marine habitat is the Ningaloo reef, which sustains both tropical and temperate marine fauna and flora, including marine reptiles and mammals (UNESCO 2019).

### 5.5.6.2 HMAS Sydney II and HSK Kormoran

The shipwrecks of HMAS Sydney II and HSK Kormoran and associated debris fields are located ~290 km west south west of Carnarvon, off the coast of Western Australia in 2,500 m of water. HMAS Sydney II sank after a battle with the German raider HSK Kormoran off the Western Australian coast on the 19 November 1941. HMAS Sydney II was Australia's most famous warship of the time and this battle has forever linked the stories of these warships to each other.

### 5.5.6.3 Underwater Cultural Heritage Sites

The shipwrecks of Batavia Shipwreck Site and Survivor Camps Area is located in the Houtman Abrolhos Islands, 90km north west of Geraldton, Western Australian. The sites consists of the wreck itself on Morning Reef, the survivors camps and gravesites on Beacon Island, and the enclosures on West Wallabi Island. Wrecked on 4 June 1629, the Batavia is the oldest of the known Verenigde Oost-Indische Compagnie wrecks on the WA coast. It has a unique place in Australian shipwrecks because of its relatively undisturbed nature the archaeological investigation of the wreck itself has revealed a range of objects of considerable value to the artefact specialist and historian. The Batavia and its associated sites hold an important place in the discovery and delineation of the Western Australian coastline.

Some underwater cultural heritage sites are also within a declared protection zone, where entry and/or activities may be restricted; three of these occur within the EMBA and are associated with historic shipwrecks: HSK Kormoran, HMAS Sydney II.

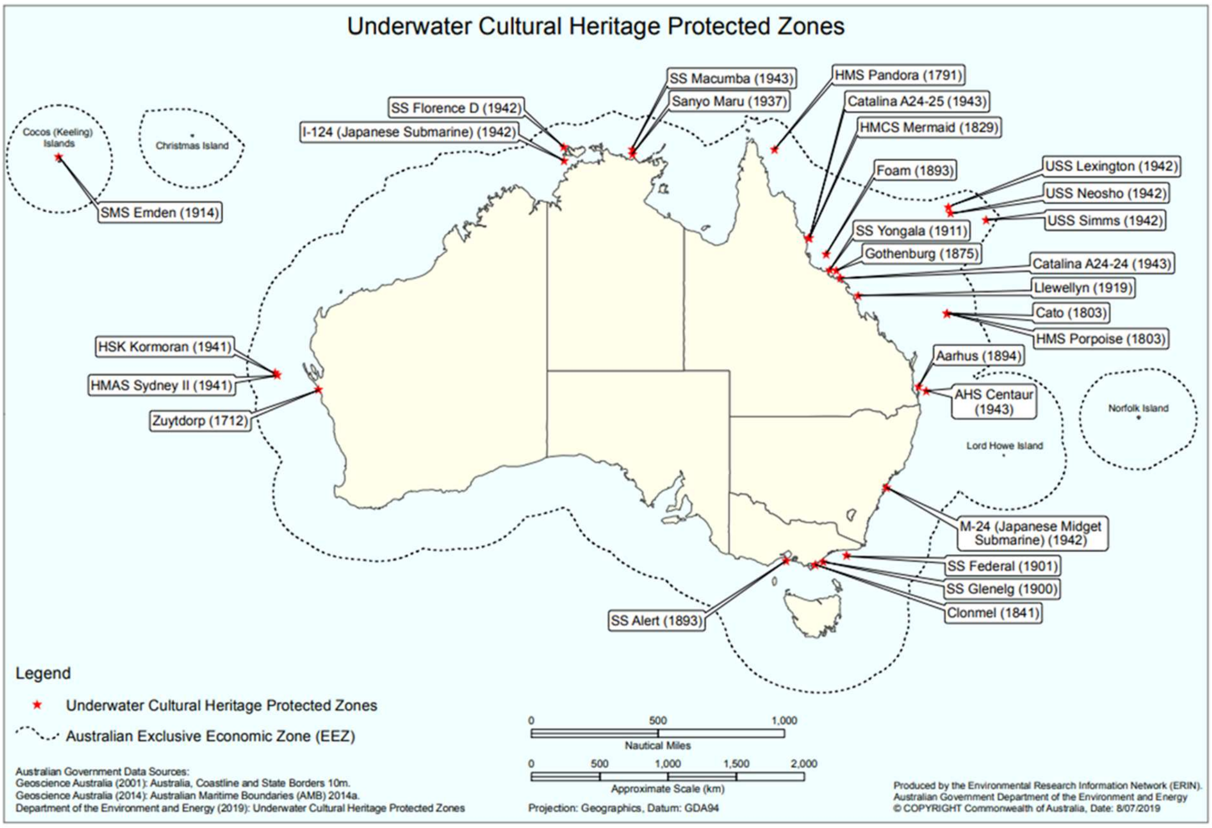


**Figure 5-23 Underwater Cultural Heritage Protected Zones (Source: DEE 2019e)**

# 6 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

## 6.1 OVERVIEW

The purpose of the environmental impact and risk assessment is to ensure that all impacts associated with the petroleum activity are identified and evaluated, and the resulting impacts are demonstrated to be ALARP and Acceptable in accordance with the impact and risk assessment methodology (Section 2).

The assessment of impacts has been undertaken at two levels:

1. Low Order Impact and Risk Assessment (Section 6.2).
2. High order Impact and Risk Evaluation (Section 6.3).

## 6.2 LOW ORDER IMPACTS AND RISKS

The context of the impact and risk assessment has been set through the description of the activity (Section 3) and identification of potential environmental receptors within the Project Areas (Section 5.1). By considering the relationship between environmental aspects and the activity (Table 4-1), Western Gas has identified all impacts and risks to receptors which could potentially occur as a result of the petroleum activity.

An ENVID was held to assist in the identification of environmental impacts and risks associated with the petroleum activity and assign controls to ensure impacts and risks are managed to ALARP and an acceptable level. Impacts and risks were evaluated using the impact assessment methodology (Section 2.2) to determine consequence to receptors and ALARP decision context, and for risks to determine likelihood and residual level of risk. Control measures were identified, and an assessment of acceptability was undertaken against the Western Gas Acceptability Criteria and the defined acceptable levels of environmental performance (Section 2.2.5).

For most impacts identified, the workshop was able to determine that given the scale of the activity, the location and the short-term duration, the adopted controls lowered impacts to ALARP and to an acceptable level. As low order impacts and risks, the environmental assessment and the outcomes are described in Table 6-1 and Table 6-2.

In some cases, it was not possible to finalise the impact evaluation during the workshops. This was due to the need for either modelling outcomes or an in-depth literature review to support the evaluation and assessment of potential impacts to receptors. In these cases, a detailed evaluation has been provided as follows:

- Underwater sound emissions – continuous and impulsive (Section 6.3 and 6.4)
- Accidental Release – Loss of Well Control (Section 6.5); and
- Hydrocarbon Spill Response Options (Section 7).

For all impacts and risks, control measures have been considered as described. Controls are applied where a reduction in the consequence of the impact will occur as a result of their adoption. They may also be required by legislation, or by internal requirements. Where the assessment of the impact identified that there were no suitable Good Practice control measures, and additional controls considered would not lower the impact assessment outcomes, no controls have been adopted. This is identified in the table and assessed as part of the demonstration of acceptability.

Controls are referred to in Table 6-1 and Table 6-2. Environmental Performance Outcomes (EPOs) and standards and measurement criteria relevant to impacts associated with the petroleum activity are provided in Section 6.6. Environmental Performance Outcomes and Standards relevant to impacts and risks for oil spill response strategies are detailed in Section 6.6. The implementation strategy (Section 9) provides the details regarding the management, roles, competency, monitoring, emergency response and reporting.

**Table 6-1: Impact and Risk Assessment – Planned Aspects**

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ALARP Decision Context | Control Measures[2] | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| MODU Operations<br>Vessel Operations | <u>Physical Presence – Interaction with Other Users</u><br>The presence of the Petroleum Activity may lead to interaction with other marine users.<br>Interaction with other users will be restricted to close proximity to the MODU and vessels within the Operational Area, and for the duration of the activity (approximately 25 days). | <u>Change to the functions, interests or activities of other users</u><br>Disruption to commercial activities includes:<br>• Exclusion of commercial vessels to areas around the activity; and<br>• Loss of commercial fish catches. | Commercial Fisheries & Aquaculture | There are four Commonwealth-managed fisheries and three State-managed fisheries which may undertake fishing activities within the Operational Area, although effort data suggests that the only active fisheries in the Operational Area will be the Western Deepwater Trawl Fishery (WDTF) and Western Tuna and Billfish Fishery (WTBF). Fisheries effort data shows that activity is low, and relatively small numbers of vessels are likely to be present in the Operational Area.<br>There are no aquaculture facilities within the Operational Area.<br>The 500 m exclusion zone around the MODU will result in exclusion of commercial fishing vessels from part of the fisheries management area and may result in vessels making minor deviations around the 500 m exclusion zone while transiting through the area. Impacts are limited to the Operational Area.<br>The well will be plugged and abandoned post drilling and well head removed, so the limit of any physical interaction will be for the duration of the activity that is approximately 25 days.<br>Given the extensive operational area utilised by Commonwealth and State fisheries, temporary exclusion from the 500 m exclusion zone during drilling operations will result in localised and temporary impacts to commercial fisheries. Impacts have been assessed as **Slight (1).** | 1 | A | **CM 1:** Pre-start notifications<br>**CM 2:** Ongoing consultation | None identified<br>There are no alternatives to the use of a MODU and support vessels to undertake the activity, and these will result in the requirement of an exclusion zone. With the application of this as a management control as well as communication with relevant organisations, then the risk of interacting with other marine users will have been reduced to ALARP. | ALARP | • Impacts assessed as Slight due to the short term nature of the activity and distance from sensitive features.<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | Acceptable |
| | | | Industry | There are limited activities associated with industry likely to occur within the Operational Area. The closest active petroleum activities to the Operational Area is the Chevron Jansz-Io field development (subsea wells/infrastructure/pipeline) located approximately 106 km to the east. The closest shipping lane is in the vicinity of the Operational Area, located east of the Operational Area. The Operational Area transects a marine interface for a Defence Training Area.<br>The 500 m exclusion zone around the MODU will result in exclusion of other marine users from the area. Vessel presence within the Operational Area is likely to be very low, due to the distance from other industries. | 1 | | | | | | |

[2] Full descriptions of controls, environment performance standards and outcomes are provided in Table 6-12

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Given the low number of vessels expected, the short term nature of the activity (approximately 25 days) and impacts will be restricted to the 500 m exclusion zone, impacts have been assessed as **Slight (1).** | | | | | | | |
| | | | Tourism & Recreation | Tourism and recreation in the region are focused around recreational / charter fishing, whale watching cruises and diving and snorkelling excursions, and typically occur within State waters. The Operational Area is a significant distance from the coast, over 140 km from Ningaloo Reef and Cape Range National Park and is not considered a primary dive location or area of interest for fauna observations.<br><br>The 500 m exclusion zone around the MODU will result in exclusion of other marine users from the area for the duration of the activity (approximately 25 days). However, tourism and recreational vessel presence within the Operational Area is likely to be very low, due to the distance from the coastline.<br><br>Given the low number of vessels expected, the short term nature of the activity and the relatively small extent of the exclusion zone, impacts have been assessed as **Slight (1).** | 1 | | | | | | |
| MODU Operations | Physical Presence – Seabed Disturbance<br><br>Anchoring and drilling operations will result in seabed disturbance.<br><br>Seabed disturbance will be restricted to close proximity to the MODU, within the | Change in water quality<br><br>Seabed disturbance will lead to change in water quality through increased turbidity. | Water quality | Seabed disturbance from anchoring and drilling operations will lead to an increase in turbidity at the seabed. Soft sediments such as those found in the Operational Area are more likely to result in localised suspended particles than hard substrates.<br><br>Disturbance will be limited to the operational area at significant distance from sensitive features and be short term in nature.<br><br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Increases in turbidity will be localised and temporary, with suspended solids expected to settle quickly following disturbance. Impacts are assessed as **Minor (2).** | 2 | A | **CM 3**: API RP 2SK - Mooring analysis<br><br>**CM 4:** Rig move and positioning plan<br><br>**CM 5**: Removal of subsea infrastructure | Selection of DP MODU<br><br>Would reduce seabed disturbance as no contact of MODU with the seabed. Optionality for DP or anchoring has been carried for this assessment, based on limited MODU availability.<br><br>Not adopted. | ALARP | • Impacts assessed as minor due to the short term nature of the activity, and distance to significant features. Impacts are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore | Acceptable |
| | | | KEFs | The Operational Area is within the Exmouth Plateau KEF, which is significant because it is predicted to modify deepwater flow and be associated with the generation of internal tides. Both may | 1 | | | | | | |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Operational Area.<br><br>Maximum area of disturbance is based on the anchoring and mooring spread. | | | contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007).<br><br>Change in water quality is not listed as a pressure in the Marine Bioregional Plan for the North-west Marine Bioregion (DSEWPC, 2012a). Any impacts to the water quality within the Exmouth Plateau KEF from the short term anchoring of the MODU will be localised and temporary and have been assessed as **Slight (1).** | | | | | | practises and benchmarking.<br><br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br><br>• No stakeholder objections or claims have been raised. | |
| | | Injury / mortality to fauna<br><br>A disturbance to the seabed may result in direct physical contact with fauna occupying the benthic and demersal environment and / or result in an increased level of turbidity, resulting in a change in water quality that may result in the injury or death of fauna. | Benthic Habitats & Communities | Increased turbidity in the water column as a result of suspended sediments has the potential to result in a range of impacts to benthic communities. These impacts include:<br>• Inhibiting of breathing and feeding mechanisms of filter feeding species (Parr et al., 1998);<br>• Temporary and highly localised reduction in available oxygen;<br>• Potential for eutrophic conditions as a result of organic rich sediment uplift; and<br>• Toxicological effects to species as a result of contaminated sediment.<br><br>The benthic habitat and communities of the Operational Area is expected to contain low diversity of infauna which is typical of deep-water sediments (RPS 2012b, Rowe et al 1982).<br><br>Given the small area of impact, the temporary nature of the activity and disturbance and anticipated low diversity of benthic assemblages within the Operational Area, impacts will be localised, and recovery is expected to be quick. Impacts are assessed as **Minor (2).** | 2 | | | | | | |
| MODU Operations<br><br>Vessel Operations | Emissions – Atmospheric<br><br>The MODU and vessels will be powered via the use of onboard generators. The operation of | Change in air quality<br><br>The release of combusted hydrocarbons into the atmosphere can lead to a decline in air | Air quality | Other operators have modelled $NO_2$ emissions from MODU power generation for an offshore project (BP 2013). $NO_2$ is considered the main (non-greenhouse) atmospheric pollutant of concern, on account of the larger predicted emission volumes compared to the other pollutants, and the potential for $NO_2$ to impact on human health (as a proxy for environmental receptors). Results of this modelling indicate that on an hourly average, there is the potential for an increase in ambient $NO_2$ concentrations of 0.0005 ppm within 10 km of the source. | 1 | A | **CM 6**: Marine assurance system – vessel contractor pre-qualification assessment.<br><br>**CM 7**: Planned Maintenance System | No incineration during MODU / vessel-based operations activities<br><br>Applying this control would remove all emissions associated with incineration | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br><br>• Activity will be undertaken in a manner consistent with relevant | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | these (fuelled by marine diesel oil [MDO]) will result in combustion emissions.<br><br>Gaseous greenhouse gas (GHG) emissions, such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), along with non-GHG emissions, such as sulphur oxides (SOX) and nitrogen oxides (NOX), will be discharged to the atmosphere. | quality, cause atmospheric pollution and contribute to greenhouse gases (GHG). | | The Australian Ambient Air Quality National Environment Protection Measure (NEPM) Review recommends that exposure to $NO_2$ on an hourly basis is below 0.12 ppm and on an annual average <0.003 ppm. Modelling undertaken by BP indicated that even the highest hourly averages (0.00039 ppm or 0.74 µg/m$^3$) were restricted to within approximately 5 km from the rig (BP 2013).<br><br>Due to the remote, offshore location of the Petroleum Activity, air quality is expected to be high. Impact to air quality will be highly localised to the source and quickly dissipate in the offshore marine environment. Any impacts will be **Slight (1)**. | | | | during the activity. However there are some associated health risks with storing wastes onboard. Based on this and costs associated with transporting waste to shore for landfill or incineration, this control has not been adopted.<br><br>Not adopted. | | legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | |
| | | | Climate | While these emissions add to the GHG load in the atmosphere, they are relatively small on a global scale, and are temporary in nature. The activity is similar to other industrial activities contributing to the accumulation of GHG in the atmosphere, though new engines on the MODU have been designed to maximise the efficiency of fuel combustion.<br><br>Impact to climate will be highly localised to the source and quickly dissipate in the offshore marine environment. Any impacts will be **Slight (1)**. | 1 | | | | | | |
| MODU Operations<br><br>Vessel Operations | <u>Emissions – Light</u><br><br>MODU and vessels require external lighting to facilitate navigation and safe operations at night (*Navigation Act 2012*). Lighting typically consists of bright white (i.e., metal halide, halogen, fluorescent) lights, and are | <u>Change in ambient light</u><br><br>Light emissions will result in a change in ambient light. | Ambient Light | Light emissions from MODU and vessel operations will result in a change in ambient light.<br><br>Woodside (2014) undertook a line of sight assessment to determine the maximum distance that light may be visible (irrespective of the light source intensity). This study focused on lighting from a MODU, which has high light emissions than vessels. This assessment showed that the maximum distance that direct light may be visible extended up to:<br>• 16.6 km for main deck lights;<br>• 21 km for drill floor lights; and<br>• 26.6 km for derrick lights.<br><br>Monitoring was also undertaken by Woodside Energy (2014) and indicated that light density (navigational lighting) attenuated to below 1.00 Lux and 0.03 Lux at distances of 300 m and 1.4 km, respectively, from the source (a MODU). Light densities of 1.00 | 1 | A | None identified | <u>Manage the timing of the activity to avoid sensitive periods at the location (e.g. turtle nesting/hatching).</u><br><br>Given the minimal risk of impacts to listed marine species (e.g. turtles) occurring due to lighting, the financial and environmental costs of extending the activity duration are deemed grossly | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ALARP Decision Context | Control Measures[2] | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | not dissimilar to other offshore activities in the region, including fishing and shipping. | | | and 0.03 Lux are comparable to natural light densities experienced during deep twilight and during a quarter moon.<br>Ambient light within the Operational Area is expected to be low, and typical of the offshore marine environment. Impacts will be highly localised and limited to the Operational Area. Any changes to ambient light will be **Slight (1).** | | | | disproportionate to low environmental benefits.<br>Not adopted | | Western Gas policies, standards and procedures.<br>• Impacts to marine fauna are expected to be restricted to localised attraction and temporary disorientation but with no long-term or residual impact and no decrease in local population size, area of occupancy of species or loss or disruption of critical habitat/ disruption to the breeding cycle.<br>• No stakeholder objections or claims have been raised. | |
| | | Change in fauna behaviour<br>A change in ambient light levels could result in a localised light glow. This can lead to changes in fauna behaviour. | Birds | Many seabirds (including most shearwaters, petrels and albatross species) are active at night; and many nocturnal seabird species are sensitive to the disorientating influences of artificial light (Montevecchi 2006; Rodriguez et al. 2019). Vulnerability to artificial lighting varies between different species and age classes and according to the influence of season, lunar phase and weather conditions. Artificial lights can confuse species, result in attraction, injury or mortality via collision or becoming grounded (Rodriguez et al. 2019; Wiese et al. 2001).<br>In general, young birds (fledglings) are more likely to become disorientated by artificial light sources. Fledglings have been observed being affected by lights up to 15 km away (CoA 2019).<br>There are no BIAs for bird species within the Operational Area, and there are no known nesting sites within 20 km of the activity (the light assessment boundary of 20 km from the source will be used as the extent of light exposure, in accordance with National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020). Red Knot (Endangered) and Southern Giant-Petrel (Endangered) may occur within the area. The Wildlife Conservation Plan for Migratory Shorebirds (DotE 2015b) and the National recovery plan for threatened albatrosses and giant petrels 2011-2016 (DSEWPC 2011) do not list Light Pollution as a threat.<br>Given the limited light footprint expected and the short-term duration of the Petroleum Activity (approximately 25 days), any impacts will be localised and temporary and have been assessed as **Slight (1).** | 1 | | | | | | |
| | | | Fish & Sharks | Fish may move towards light sources as a product of instinctual attraction to light or to prey on other species aggregating at the edges of artificial light halos. Experiments using light traps have found that some fish and zooplankton species are attracted to | 1 | | | | | | |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | light sources (Meekan et al. 2001), with traps drawing catches from up to 90 m (Milicich et al. 1992).<br><br>Exposure to artificial light may alter reproduction in some species (CoA, 2019), however given that there is no benthic habitat within light penetration depths, no impacts to fish spawning are expected.<br><br>There are no BIAs for fish or shark species within the Operational Area. Great White Shark (Vulnerable) may occur within the area. The Recovery Plan for the White Shark (DSEWPC 2013) does not list light emissions as a threat.<br><br>Given the limited light footprint expected and the relatively short-term duration of the Petroleum Activity, any impacts will be localised and temporary and have been assessed as **Slight (1).** | | | | | | | |
| | | | Marine Reptiles | Light pollution can cause disturbance to marine reptiles resulting in a change in behaviour along, or adjacent to, turtle nesting beaches where emerging hatchlings orient to, and head towards, the low light of the horizon unless distracted by other lights which disorient and affect their passage from the beach to the sea (EA 2003).<br><br>There are no BIAs or critical habitats for marine reptiles within 20km of the Operational Area. Five listed threatened species of marine turtle (Loggerhead Turtle [E], Green Turtle [V], Leatherback Turtle [E], Hawksbill Turtle [V] and Flatback Turtle [V]) are likely to be present in the Operational Area. The Recovery Plan for Marine Turtles in Australia 2017-2027 (DEE 2017) lists Light Pollution as a threat, however this is mostly in relation to critical behaviours such as nesting and hatching. Given that critical behaviours are unlikely to occur within the Operational Area, and light will be below detectable levels at the closest nesting site, impacts to listed threatened marine turtles are not expected.<br><br>Given the limited light footprint expected and the relatively short-term duration of the Petroleum Activity, any impacts will be localised and temporary and have been assessed as **Slight (1).** | 1 | | | | | | |
| Well Design & Drilling Operations | Planned Discharge - Drill | Change in water quality | Water quality | Planned discharge of cuttings and adhered fluids from the surface will occur intermittently during drilling. Residual barite and bentonite may also be discharged at the end of drilling as a slurry. | 1 | A | **CM 10:** Chemical Assessment Procedure | Riserless Mud Recovery (RMR) | ALARP | • Impacts assessed as Minor to Slight and | Acceptable |

| | | | | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | ALARP Decision Context | Control Measures[2] | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| Well P&A | Cuttings and Fluids<br>Drill cuttings and fluids are discharged from the surface and at the seabed.<br>Volumes of cuttings and fluids discharged are typical of exploration drilling and are described in Table 3-3.<br>Discharge of residual barite and bentonite at end of drilling (up to 80$m^3$ each). | Discharge of drill cuttings and fluids at the surface and the seabed will result in a change in water quality though:<br>• Increased turbidity<br>• Chemical exposure and oxygen depletion.<br>Impacts will be restricted to the Operational Area. | | Barite and bentonite are components of the drill fluids and are classed as pose little or no risk (PLONOR) to the environment. Discharge of residual barite and bentonite as a slurry is predicted to have the same impact as the discharge of WBM.<br>The intermittent nature of the discharges greatly reduces the extent of a change in water quality (Neff, 2005).<br>Increases in turbidity from drill cutting discharges during riserless drilling (i.e. direct discharge to the seabed) are expected to be highly localised and limited to within a close proximity of the source.<br>Hinwood et al (1994) and Neff (2005) note that within 100 m of the discharge point, a drilling cuttings and fluid plume released at the surface will have diluted by a factor of at least 10,000, while Neff (2005) states that in well-mixed oceans waters (as is likely to be the case within the drilling area), drilling mud is diluted by more than 100-fold within 10 m of the discharge.<br>Based upon the assumptions that fluids only comprise a small percentage of the discharge (expressed as residual synthetic oil on wet cuttings up to 8% by weight), potential concentrations of fluid are expected to be reduced to 700 ppm within 10 m of the MODU and 7 ppm within 100m of the release location.<br>Based upon the requirement that drilling fluid and chemical components will be of low toxicity, it is expected that concentrations will be below acute toxicity thresholds (>100 ppm) 100 m of the MODU.<br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Given the localised impact area and the high energy marine environment, change in water quality will be localised and temporary, and impacts will be **Slight (1)**. | | | **CM 11:** Use of WBM during riserless drilling<br>**CM 12:** No overboard discharge of whole SBM<br>**CM 13:** Solids Control Equipment<br>**CM 14:** Solids Control Equipment Operator – to ensure monitoring of %ROC<br>**CM 44:** Residual Materials Management | Low risk of discharge disproportionate to cost. Not adopted.<br>Slim Hole / Coiling Tube Drilling (World Bank Group, 2015)<br>Not proven, therefore not evaluated.<br>Additional SCE to increase fluid recovery<br>Adopted (**CM 13**).<br>Reinjection / skip and ship of fluids<br>Cost disproportionate to environmental benefit. Not adopted.<br>Limit %ROC<br>Adopted (**CM 14:** Monitor %ROC).<br>Discharge cuttings at surface or at depth below MODU<br>Cost disproportionate to environmental benefit. MODU not yet determined. Not adopted.<br>Onshore treatment and disposal<br>Adopted (**CM 12**).<br>No overboard discharge of residual barite or bentonite. | | are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Additional controls considered and adopted to reduce impacts to ALARP.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | |
| | | Change in habitat<br>Discharges of drill cuttings can smother seabed habitat, flora and | Benthic Habitats and Communities | Studies show that the effects on seabed fauna and flora from the discharge of drilling cuttings with WBM are subtle, although the presence of drill-fluids in the seabed close to the drilling location (<500 m) can usually be detected chemically (e.g. Hyland et al. 1994, Daan & Mulder 1996, Currie & Isaacs 2005, OSPAR 2009, Bakke et al. 2013). | 2 | | | | | | |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
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| | | fauna, resulting in an alteration in seabed substrate (Hinwood et al., 1994).<br>Due to the water depth, a change in habitat will occur during riserless drilling only. Impacts will be restricted to the Operational Area. | | Jones et al. (2006, 2012) compared pre- and post-drilling ROV surveys and documented physical smothering effects from WBM cuttings within 100 m of the well. Outside the area of smothering, fine sediment was visible on the seafloor up to at least 250 m from the well. After three years, there was significant removal of cuttings particularly in the areas with relatively low initial deposition (Jones et al. 2012). The area impacted by complete cuttings cover had reduced from 90 m to 40 m from the drilling location, and faunal density within 100 m of the well had increased considerably and was no longer significantly different from conditions further away.<br>The benthic habitat and communities of the Operational Area is expected to contain low diversity of infauna which is typical of deep-water sediments (RPS 2012b, Rowe et al 1982).<br>Given the small volumes discharged during riserless drilling and anticipated low diversity of benthic assemblages within the Operational Area, any impacts will be localised, and recovery is expected. Impacts are assessed as **Minor (2).** | | | | In the unlikely event residual barite or bentonite leftover from drilling is not required by the next operator, sending it to shore for disposal has a financial cost and increased environmental impacts (GHG, waste) that are disproportionate to environmental gain.<br>Not adopted. | | | |
| | | | KEFs | The Operational Area is within the Exmouth Plateau KEF, which is predicted may modify deepwater flow and be associated with the generation of internal tides. Both may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007). The area is generally considered to have low habitat heterogeneity.<br>Habitat modification is not listed as a pressure in the Marine Bioregional Plan for the North-west Marine Bioregion (DSEWPC, 2012a). Any impacts to the seabed habitat within the Exmouth Plateau KEF will therefore be localised and temporary and have been assessed as **Slight (1).** | 1 | | | | | | |
| | | <u>Injury / mortality to fauna</u><br>A change in water quality or a change in habitat could lead to injury / mortality to fauna. | Plankton | Jenkins and McKinnon (2006) indicate that levels of 100 mg/L are likely to affect the larvae of a number of marine invertebrate species and subsequently indicate that fish eggs and larvae are more vulnerable to suspended sediments than older life stages. Identifiable effects on recruitment would be difficult to discern given the high natural mortality of larvae and dispersive characteristics of the open water environment. | 1 | | | | | | |

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| **Activity** | **Aspect** | **Impact** | **Affected Receptor** | **Consequence Evaluation** | **Severity Level** | **ALARP Decision Context** | **Control Measures[2]** | **Additional Control Measures Considered** | **ALARP Outcome** | **Acceptability Assessment** | **Acceptability Outcome** |
| | | | | Neff (2010) explains that the lack of toxicity and low bioaccumulation potential of the drilling muds means that the effects of the discharges are highly localised and are not expected to spread through the food web. This confirms the evaluation that any potential for impact is limited to the area around the well locations with concentrations rapidly diluted below that known to result in an impact to marine fauna.<br>Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Given the localised and temporary nature of the impact, it has been assessed as **Slight (1).** Impacts to other ecological and social receptors are not expected. | | | | | | | |
| Cementing Operations | Planned Discharge – Cement<br>During riserless drilling, the spacer is displaced by the cement slurry and discharged directly to the seabed at the mudline. | Change in habitat<br>Mixed cement overspilled during spacer displacement will harden in the area surrounding the well (10-50 m), resulting in a change in habitat over an area of 0.007 km$^2$. | Benthic Habitats & Communities | Cement overspill from cementing activities will result in a change in habitat within 10-50 m of each well. Given the low levels of heterogeneity within the Operational Area, and the typically sparse benthic habitats and communities present at this water depth, any impacts will be highly localised and will not affect the long-term success of the ecosystem. Impacts are evaluated as **Slight (1)**. | 1 | A | **CM 10:** Chemical Assessment Procedure<br>**CM 15:** Cementing procedures<br>**CM 44:** Residual Materials Management | No overboard residual cement discharge<br>Cost disproportionate to environmental gain. Storage of cement on MODU is not practical.<br>In the event residual cement from drilling is not required by the next operator, sending it to shore for disposal has a financial cost and increased environmental impacts (GHG, waste) that are disproportionate to the environmental gain.<br>Not adopted. | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | Acceptable |
| | | | KEFs | The Operational Area is within the Exmouth Plateau KEF, which is predicted may modify deepwater flow and be associated with the generation of internal tides. Both may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007). The area is generally considered to have low habitat heterogeneity.<br>Physical habitat modification is listed as a pressure ‘of less concern’ in the Marine Bioregional Plan for the North-west Marine Bioregion (DSEWPC, 2012a). Given the small impact area within the KEF, any impacts to the seabed habitat will not impact adversely on the ecosystem functioning and integrity of the Exmouth Plateau KEF and have been assessed as **Slight (1).** | 1 | | | | | | |
| | | Change in water quality<br>Change in water quality caused by planned discharges | Water quality | Cementing fluids are not routinely discharged to the marine environment at the surface; however, volumes of a cement/water mix may be released in surface waters during equipment washing or at the end of drilling. The cement particles will disperse under action of waves and currents, and eventually settle out of the | 1 | | | | | | |

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| | | of cement can occur through increase in turbidity; and chemical toxicity. | | water column; the initial discharge will generate a downwards plume, increasing the initial mixing of receiving waters.<br><br>Modelling of surface cement discharges (approximately 78 $m^3$ over a one-hour period) (BP 2013) showed that within two hours suspended solid concentrations ranged between 0.005-0.05 $mg/m^3$ within the extent of the plume (approximately 150 m horizontal and 10 m vertical); and by four hours post-discharge, that concentrations were <0.005 $mg/m^3$. These volumes are far greater than the expected cement wash volumes during drilling (Table 3-5), and results are considered conservative. Estimated volumes of residual cement which will be discharged as a slurry are 120 $m^3$. Thus, if residual cement is required to be discharged the extent of the plume may be slightly larger than that modelled by BP (2013) and may remain for a slightly longer period, However, this would not be a significant increase with rapid dilution occurring resulting in changes in water quality being localised and temporary.<br><br>Dry cement mix does not contain chemical additives and is therefore not considered toxic upon discharge, however mixed cement from washdown / equipment washing and discharged at the seabed during displacement will contain chemical additives. Terrens et. al (1998) suggests that once cement has hardened the chemical constituents are locked into the hardened cement. As such the extent of the impact is limited to the subsurface waters directly adjacent to the displaced subsea cement (expected to be in the order of 10-50 m of each well) and pelagic waters within 150 m of each well following the surface discharge of cement slurry from washing the cement unit.<br><br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Given that it is expected that cement will harden within a couple of hours, and exposure to in water concentrations are expected to be limited due to the rapid dispersion and dilution (BP, 2013), changes to water quality will be localised and temporary and are assessed as **Slight (1)**. | | | | | | | |
| | | Injury / mortality to fauna | Plankton | Jenkins and McKinnon (2006) reported that levels of suspended sediments greater than 500 mg/L are likely to produce a | 1 | | | | | | |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
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| | | | | measurable impact upon larvae of most fish species, and that levels of 100 mg/L will affect the larvae of some species if exposed for periods greater than 96 hours. Jenkins and McKinnon (2006) also indicated that levels of 100 mg/L may affect the larvae of several marine invertebrate species and that fish eggs and larvae are more vulnerable to suspended sediments than older life stages.<br><br>Neither the modelling by de Campos et al (2017) or BP (2013) suggest that suspended solids concentrations from a discharge of the cement washing will be at or near levels required to cause an effect on fish or invertebrate larvae, i.e. predicted levels were well below a 96-hr exposure at 100 mg/L, or instantaneous 500 mg/L exposure.<br><br>Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Given the high energy marine environment and naturally high mortality of plankton, any impacts will be localised and temporary and have been assessed as **Slight (1).** Due to the low levels of exposure, impacts to other ecological and socio-economic receptors are not expected. | | | | | | | |
| Wellhead cutting | Planned discharge – metal shavings | Change in sediment quality<br><br>Discharge of metal shavings will lead to a change in sediment quality.<br><br>Impacts will be limited to the well bore. | Sediment quality | A small amount of metal shavings will be produced as a result of mechanical cutting of the wellhead. As the wellhead will be from inside the casing and below the seabed the majority of the metal shavings will be within the remaining hole which will become covered by sediment over time. A small amount of metal shavings may be carried outside of the hole by currents. Any change to sediment quality would be negligible based on the steel being cut is inert and the small amount of metal shavings that would be generated. | 1 | A | None identified | None | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
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| | | | | | | | | | | standards and procedures.<br>• No stakeholder objections or claims have been raised. | |
| Blowout Preventer Installation and Function Testing<br>ROV Operations | <u>Planned Discharge - Hydraulic Fluids and Chemicals</u><br>BOP function testing and ROV operations will lead to small volumes (<10 litres) of hydraulic fluid being intermittently discharged to the marine environment. | <u>Change in water quality</u><br>Discharges of hydraulic fluid will lead to a change in water quality.<br>Impacts will be limited to the Operational Area. | Water quality | Modelling undertaken by BP indicates that the maximum plume and length associated with BOP Function testing to reach dilutions of 3000 times, is in the order of 51 and 81 m respectively, with a maximum displacement of 98 m (BP, 2013). Volumes of hydraulic fluid discharged during ROV operations will be similar to those discharged during BOP function testing, therefore impacts are expected to be limited to 100 m from the discharge point.<br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Given the high energy marine environment, discharges will dissipate rapidly and any change in water quality will be localised and temporary. Impacts are assessed as **Slight (1).** | 1 | A | **CM 10:** Chemical Assessment Procedure | None | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | Acceptable |
| | | | KEFs | The Operational Area is within the Exmouth Plateau KEF, which is predicted may modify deepwater flow and be associated with the generation of internal tides. Both may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007). The area is generally considered to have low habitat heterogeneity.<br>Change in water quality is not listed as a pressure in the Marine Bioregional Plan for the North-west Marine Bioregion (DSEWPC, 2012a). Any impacts to the water quality within the Exmouth Plateau KEF will be localised and temporary and have been assessed as **Slight (1).** | 1 | | | | | | |
| | | <u>Injury / mortality to fauna</u><br>A change in water quality may lead to injury / mortality to fauna. | Plankton | Early life stages of fish (embryos, larvae) and other plankton would be most susceptible to the toxic exposure from chemicals in the hydraulic fluid discharges, as they are less mobile and therefore can become exposed to the plume at the outfall. However, these are expected to rapidly recover once the activity ceases, as they are known to have high levels of natural mortality and a rapid replacement rate (UNEP, 1985). | 1 | | | | | | |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP | | | | Demonstration of Acceptability | |
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| | | | | Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Given the high energy marine environment, discharges will dissipate rapidly and any impacts to plankton will be localised and will not result in significant impacts on population level of organisms that would affect ecological diversity or productivity within Commonwealth marine areas. Rather it is considered to result in an undetectable or limited local degradation of the environment, rapidly returning to original state by natural action. Impacts are assessed as **Slight (1).** Due to the low levels of exposure, impacts to other ecological and socio-economic receptors are not expected. | | | | | | | |
| MODU Operations<br><br>Vessel Operations | Planned Discharge - Sewage and Greywater<br><br>The use of ablution, laundry and galley facilities by crew onboard the MODU and vessels will result in the generation of sewage and grey water, which will be discharged to the marine environment.<br><br>Vessels and MODU typically generate around 5-15 $m^3$ of waste water (consisting of sewage and grey water) per day. Vessel | Change in water quality<br><br>Changes in water quality caused by discharges of sewage and greywater will include:<br>• nutrient loading<br>• chemical exposure<br>• turbidity | Water Quality | Nutrients in sewage and greywater can lead to increased nutrient loads, and subsequent eutrophication. Eutrophication occurs when the addition of nutrients, such as nitrates and phosphates, causes adverse changes to the ecosystem, such as increased growth of primary producers such as phytoplankton and benthic algae and oxygen depletion and can result in changes in biological diversity (reduced species diversity with shifts towards fewer well adapted species).<br><br>Sewage and greywater will include organic and inorganic chemicals. While organics may degrade through bacterial action, oxidation and evaporation, there is the potential for some chemicals to persist, e.g. metals and chlorinated organics. These are likely to be most concentrated in the vicinity of the discharge.<br><br>Sewage and grey water may include some particulate matter which can cause an increase in the turbidity of the receiving waters close to the point of discharge.<br><br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Given the open water, marine environment, and the low volumes of sewage and greywater which will be discharged, water quality changes will be localised and temporary, and any discharges of chemicals or particulates will be rapidly dispersed. Monitoring of sewage discharges has demonstrated that a 10 $m^3$ sewage discharge over 24 hrs from a stationary source in shallow water, reduced to approximately 1% of its original concentration within 50 m of the | 1 | A | **CM 6:** Marine assurance system - vessel contractor pre-qualification assessment.<br><br>**CM 7:** Planned Maintenance System | Storage of all wastes on-board (e.g. oily water and sewage) for disposal onshore.<br><br>Storage space would be required for containment of sewage and greywater and depending on the duration of the activity may involve transfer to vessels. This could result in increased potential impacts and risks (both environment and safety). Increased transfers can result in increased fuel usage, increased safety risks to personnel during transfer, increase in crane movements. | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Control Measures[2] | Additional Control Measures Considered | ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Acceptability Outcome |
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| | operations will typically be short term and discharges made while in transit, whilst MODU discharges will be over the term of the activity (approximately 25 days) and from a stationary discharge location.<br><br>Impacts will be restricted to the Operational Area. | | | discharge location (Woodside, 2008). Therefore, impacts are predicted to be restricted to the Operational Area. | | | | Given the low-level impact of discharge, the costs and risk of onboard storage is not commensurate.<br><br>Not adopted. | | | |
| | | | KEFs | The Operational Area is within the Exmouth Plateau KEF, which is predicted may modify deepwater flow and be associated with the generation of internal tides. Both may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007). The area is generally considered to have low habitat heterogeneity.<br><br>Change in water quality is not listed as a pressure in the Marine Bioregional Plan for the North-west Marine Bioregion (DSEWPC, 2012a) and discharges of sewage at this location will not impact on the values of the KEF. Any impacts to the water quality within the Exmouth Plateau KEF will be localised, at the surface and temporary and have been assessed as **Slight (1).** | 1 | | | | | | |
| | | Injury / mortality to fauna | Plankton | Plankton communities have a naturally patchy distribution in both space and time (ITOPF, 2011). They are known to have naturally high mortality rates (primarily through predation), however in favourable conditions (e.g. supply of nutrients), plankton populations can rapidly increase. Once the favourable conditions cease, plankton populations will collapse and/or return to previous conditions. Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF, 2011). However, any potential change in phytoplankton or zooplankton abundance and composition is expected to be localised, typically returning to background conditions within tens to a few hundred metres of the discharge location (Parnell, 2003). Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Impacts to plankton are evaluated to be **Slight (1).**<br><br>Effects on environmental receptors along the food chain, namely, fish, reptiles, birds and cetaceans are therefore not expected beyond the immediate vicinity of the discharge in deep open waters. | 1 | | | | | | |
| MODU Operations | Planned Discharge - Food Waste | Change in fauna behaviour | Birds<br><br>Fish & Sharks | The introduction of food waste to the marine environment will lead to an increase in scavenging marine fauna such as birds and fish, localised to the discharge location. This can lead to an | 1 | A | **CM 6:** Marine assurance system - vessel contractor | None | ALARP | • Impacts assessed as Slight and are | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP | | | | Demonstration of Acceptability | |
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| Vessel Operations | The MODU and vessels will generate wastes including food wastes (or putrescibles) which are commonly discharged to the marine environment.<br>Volumes vary depending on the POB, with discharges estimated to be in the order of 1-2 kg per person per day. | Planned discharges of food waste will provide a localised and temporary food source to scavenging marine fauna.<br>Impacts will be restricted to the Operational Area. | | increase in predators in the area, resulting in a change in predator / prey dynamics.<br>There are no BIAs for bird species within the Operational Area. Red Knot (Endangered) and Southern Giant-Petrel (Endangered) may occur within the area. The Wildlife Conservation Plan for Migratory Shorebirds (DotE 2015b) and the National recovery plan for threatened albatrosses and giant petrels 2011-2016 (DSEWPC 2011) do not list a change in predator / prey dynamics as a threat.<br>There are no BIAs for fish or shark species within the Operational Area. Great White Shark (Vulnerable) may occur within the area. The Recovery Plan for the White Shark (DSEWPC 2013) does not list change in predatory / prey dynamics as a threat.<br>The rapid consumption of the discharged food waste by scavenging fauna, and physical and microbial breakdown, ensures that the impacts of putrescible waste discharges are insignificant and temporary. Any impacts will be **Slight (1),** with the ecosystem returning to the natural state once the discharge has ceased. | | | pre-qualification assessment.<br>**CM 7:** Planned Maintenance System | | | considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• The activity will not impact the long term survival and<br>• CM recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions.<br>• No stakeholder objections or claims have been raised. | |
| MODU Operations<br>Vessel Operations | <u>Planned Discharge - Deck Drainage and Bilge</u><br>Deck drainage and bilge water can be | <u>Change in water quality</u><br>Discharges of deck drainage and treated bilge water can lead to a | Water Quality | Discharges of deck drainage and bilge will lead to a change in water quality through increased turbidity and chemical toxicity.<br>Deck drainage water and bilge water generally consists of a mixture of fresh water, sea water, oil, sludge, chemicals and various other fluids. Discharges will be highly localised and infrequent with high dilution and dispersion rates due to wave | 1 | A | **CM 6:** Marine assurance system - vessel contractor pre-qualification assessment.<br>**CM 7:** Planned Maintenance System | None | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP | | | | Demonstration of Acceptability | |
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| | contaminated with hydrocarbons, oil, detergents, hydraulic oil, and chemicals.<br><br>Bilge water is treated onboard using an oily water separator (OWS). | change in water quality. | | and ocean currents. Therefore, decreased turbidity is expected to be very short term, hours rather than days.<br><br>Bilge water will be treated prior to discharge via an OWS with a maximum concentration of 15 ppm oil-in-water being achieved prior to discharge. The remaining oil residue will be retained onboard for onshore disposal. Modelling (Shell, 2010) indicates that chemicals and hydrocarbon discharges will disperse rapidly to below the Predicted No Effect Concentration (PNEC) within 70 m, with no long-term impacts expected.<br><br>Impacts will be localised to the discharge location. As discharges will be non-continuous and infrequent, impacts are expected to be short-term with water quality quickly returning to ambient levels. Cumulative impacts are not expected. Any impacts will be **Slight (1)**, and no impacts to ecological or socio-economic receptors are expected. | | | | | | with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | |
| MODU Operations<br><br>Vessel Operations | Planned Discharge – Brine<br><br>Brine is created through the desalination process that creates freshwater for drinking, showers, cooking etc. This is achieved through reverse osmosis (RO) or distillation resulting in the discharge of seawater with a slightly elevated salinity (~10-15% higher than seawater). | Change in water quality<br><br>Planned discharges of brine will lead to a change in water quality through:<br>• Increased salinity<br>• Chemical exposure | Water quality | Changes in salinity can affect the ecophysiology of marine organisms. Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20% to 30% (Walker and McComb, 1990). However, larval stages, which are crucial transition periods for marine species, are known to be more susceptible to impacts of increased salinity (Neuparth, Costa & Costa 2002). Pelagic species are mobile; it is expected that at worst, they would be subjected to slightly elevated salinity levels (~10-15% higher than seawater) for a very short period which they are expected to be able to tolerate. As such, transient species are not expected to experience chronic or acute effects.<br><br>Discharged brine water sinks through the water column where its rapidly mixed with receiving waters and dispersed by ocean currents. As such, any potential impacts are expected to be limited to the source of the discharge where concentrations are highest. This is confirmed by studies that indicate effects from increased salinity on planktonic communities in areas of high mixing and dispersion are generally limited to the point of discharge only (Azis et.al, 2003). Modelling of brine discharges from a vessel (Frick et al., 2001) assuming no ocean current predict salinity levels would return to ambient levels within 4m of the discharge point. | 1 | A | **CM 10:** Chemical Assessment Procedure<br><br>**CM 7:** Planned Maintenance System | None | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | Acceptable |

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| | | | | Scale inhibitors and biocide used in the desalination process to avoid fouling of pipework are inherently safe at the low dosages used; they are usually consumed in the inhibition process, so there is little or no residual chemical concentration remaining upon discharge. Chemicals are used at trace concentrations that would be suitable for human consumption, and no impacts to plankton or marine fauna are expected.<br><br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Given the limited impact area and the high energy marine environment, any impacts will be localised and temporary and are evaluated to be **Slight (1).** Impacts to ecological or socio-economic receptors are not expected. | | | | | | | |
| MODU Operations<br><br>Vessel Operations | <u>Planned Discharge - Cooling Water</u><br><br>Seawater is used as a heat exchange medium for cooling machinery engines and other equipment. Upon discharge, it will be warmer than the ambient water temperature and may contain low concentrations of residual biocide. | <u>Change in water quality</u><br><br>Discharges of cooling water will lead to a change in water quality through:<br>• Increased temperature<br>• Chemical exposure | Water quality | Modelling of continuous wastewater discharges (including cooling water) found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being <1 °C above ambient within 100 m (horizontally) of the discharge point, and 10 m vertically (DHI, 2014).<br><br>Scale inhibitors are typically low molecular weight phosphorous compounds that are water-soluble, and only have acute toxicity to marine organisms about two orders of magnitude higher than typically used in the water phase (Black et al., 1994). The biocides typically used in the industry are highly reactive and degrade rapidly (Black et al., 1994). Scale inhibitors and biocide used in the heat exchange process to avoid fouling of pipework are inherently safe at the low dosages used; they are usually consumed in the inhibition process, so there is little or no residual chemical concentration remaining upon discharge.<br><br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Given the high energy marine environment and the low dosage of chemicals used, any impacts will be localised (within 100 m of the discharge) and temporary. Impacts are assessed as **Slight (1)**. | 1 | A | **CM 10:** Chemical Assessment Procedure<br><br>**CM 7:** Planned Maintenance System | None | ALARP | • Impacts assessed as Slight and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• The activity will not impact the long term | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | ALARP Decision Context | Control Measures[2] | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
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| | | | | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
| | | | KEFs | The Operational Area is within the Exmouth Plateau KEF, which is believed may modify deepwater flow and be associated with the generation of internal tides. Both may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007). The area is generally considered to have low habitat heterogeneity.<br><br>Change in water quality is not listed as a pressure in the Marine Bioregional Plan for the North-west Marine Bioregion (DSEWPC, 2012a). Any impacts to the water quality within the Exmouth Plateau KEF will be localised and temporary and have been assessed as **Slight (1).** | 1 | | | | | survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions.<br>• No stakeholder objections or claims have been raised. | |
| | | <u>Injury / mortality to fauna</u><br><br>A change in temperature or chemical exposure cause by planned discharges of cooling water can lead to injury / mortality to fauna. | Plankton | Early life stages of fish (embryos, larvae) and other plankton would be most susceptible to the change in temperature and toxic exposure from chemicals in the cooling water discharges, as they are less mobile and therefore can become exposed to the plume at the outfall. However, these are expected to rapidly recover once the activity ceases, as they are known to have high levels of natural mortality and a rapid replacement rate (UNEP 1985).<br><br>Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Given the high energy marine environment, discharges will dissipate rapidly and any impacts to plankton will be localised and will not result in significant impacts on population level of organisms that would affect ecological diversity or productivity within Commonwealth marine areas. Impacts are assessed as **Slight (1).** | 1 | | | | | | |
| | | | Fish & Sharks | Fish passing through the area will be able to actively avoid entrainment in any heated plume (Langford, 1990). Acclimation of test organisms at 15, 20 and 25°C allowed them to tolerate temperature increments of 8-9°C without damage (UNEP, 1985).<br><br>There are no BIAs for fish or shark species within the Operational Area. Great White Shark (Vulnerable) may occur within the area. The Recovery Plan for the White Shark (DSEWPC 2013) does not list change in water quality or localised increased temperate as a threat.<br><br>Given the high energy marine environment, any impacts will be localised and temporary and have been assessed as **Slight (1)**. | 1 | | | | | | |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Severity Level | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Control Measures[2] | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
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| | | | Marine Mammals | Marine mammals passing through the area will be able to actively avoid entrainment in any heated plume (Langford, 1990). Acclimation of test organisms at 15, 20 and 25°C allowed them to tolerate temperature increments of 8-9°C without damage (UNEP, 1985).<br><br>The Operational Area is within the migration BIA for Pygmy Blue Whale. Migration route for Blue Whale (E) is known to occur within the area. Fin Whale (V) and Sei Whale (V) are likely to occur, whilst Humpback Whale (V) may occur. Change in water quality or localised increased temperature is not listed as a threat in the Conservation Management Plan for the Blue Whale (DotE 2015a), and the Conservation Advice for Humpback Whale (TSSC 2015a), Sei Whale (TSSC 2015b) or Fin Whale (TSSC 2015c).<br><br>Given the high energy marine environment, any impacts will be localised and temporary and have been assessed as **Slight (1)**. | 1 | | | | | | |
| | | | Marine Reptiles | Marine mammals and fish passing through the area will be able to actively avoid entrainment in any heated plume (Langford, 1990), and reptiles and sharks would be expected to behave similarly. Acclimation of test organisms at 15, 20 and 25°C allowed them to tolerate temperature increments of 8-9°C without damage (UNEP, 1985).<br><br>There are no BIAs or critical habitats for marine reptiles within the Operational Area. Five listed threatened species of marine turtle (Loggerhead Turtle [E], Green Turtle [V], Leatherback Turtle [E], Hawksbill Turtle [V] and Flatback Turtle [V]) are likely to be present in the Operational Area. The Recovery Plan for Marine Turtles in Australia 2017-2027 (DEE 2017) does not list change in water quality or localised increase in temperature as a threat.<br><br>Given the high energy marine environment, any impacts will be localised and temporary and have been assessed as **Slight (1)**. | 1 | | | | | | |

**Table 6-2: Risk Assessment – Unplanned Aspects**

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment: Severity Level | Risk Assessment: Likelihood | Risk Assessment: Risk Rating | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Good Practice Control Measures | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
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| Vessel Operations | Physical Presence - Interaction with Marine Fauna<br>The presence of moving or stationary vessels and/or surface infrastructure in the marine environment may result in interaction with marine fauna. | Injury / mortality to fauna<br>High risk marine fauna includes those which are slow moving / large in size, and which commonly dwell at or near surface waters.<br>Large moving fish species, such as whale shark, are not expected to be present within the Operational Area. | Marine Mammals | Marine mammals are naturally inquisitive marine mammals that are often attracted to offshore vessels and facilities (Richardson et al. 1995).<br>Collisions between vessels and cetaceans occur more frequently where high vessel traffic and cetacean habitat occurs (WDCS, 2006). Vessel strike data identified 109 potential strikes in Australia waters from 1840 to 2015 (Peel et al., 2016).<br>The Operational Area is within the migration BIA for Pygmy Blue Whale. Migration route for Blue Whale (E) is known to occur within the area. Fin Whale (V) and Sei Whale (V) are likely to occur, whilst Humpback Whale (V) may occur. Vessel collision or disturbance is listed as a threat in the Conservation Management Plan for the Blue Whale (DotE 2015a), and the Conservation Advice for Humpback Whale (TSSC 2015a), Sei Whale (TSSC 2015b) or Fin Whale (TSSC 2015c). The Conservation Management Plan for the Blue Whale (DotE 2015a) lists the threat as a moderate concern and a high risk, determining that additional mitigation measures are required.<br>Western Gas will adopt all legislative and best practise controls in order to sufficiently lower the risk of an impact to ALARP.<br>Given the potential presence of sensitive marine mammal species in the Operational Area, impacts have been assessed as **Minor (2)**. | 2 | A | L | A | **CM9**: VSP adaptive management procedure<br>**CM 16:** Report all fauna strikes<br>**CM43**: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans | None | ALARP | • Risks assessed as Low (tolerable) and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions.<br>• No stakeholder objections or claims have been raised. | Acceptable |
| | | | Marine Reptiles | There is limited data regarding strikes to fauna such as turtles, possibly due to lack of collisions being noticed and lack of reporting; however, marks observed on animals show that strikes have occurred (Peel et al. (2016; cited in CoA, 2016).<br>There are no BIAs or critical habitats for marine reptiles within the Operational Area. Five listed threatened species of marine turtle (Loggerhead Turtle [E], Green Turtle [V], Leatherback Turtle [E], Hawksbill Turtle [V] and Flatback Turtle [V]) are likely to be present in the Operational Area. The Recovery Plan for Marine Turtles in Australia 2017-2027 (DEE 2017) lists Vessel Disturbance as a threat, particularly in shallow coastal foraging areas and areas with high numbers of recreational and commercial vessels. Given that critical behaviours are unlikely to occur within the Operational Area, and | 2 | A | L | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment: Severity Level | Likelihood | Risk Rating | Demonstration of ALARP: ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Acceptability Outcome |
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| | | | | vessel numbers will be low, impacts to listed threatened marine turtles are unlikely.<br><br>Western Gas will adopt all legislative and best practise controls in order to sufficiently lower the risk of an impact to ALARP.<br><br>Given the potential presence of sensitive marine mammal species in the Operational Area, impacts have been assessed as **Minor (2)**. | | | | | | | | | |
| MODU Operations<br><br>Vessel Operations | Introduction of IMS<br><br>Invasive Marine Species (IMS) can be introduced through ballast water exchanges or biofouling. | Change in ecosystem dynamics<br><br>The introduction of an IMS can potentially alter the ecosystem dynamics of an area. | Benthic Habitats & Communities | Successful marine pest invasion requires the following three steps:<br><br>1. Colonisation and establishment of the marine pest on a vector (e.g. vessel hull) in a donor region (e.g. home port).<br><br>2. Survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g. project area).<br><br>3. Colonisation (e.g. dislodgement or reproduction) of the marine species in the recipient region, followed by successful establishment of a viable new local population.<br><br>IMS are likely to face little or no natural competition or predation and can potentially outcompete native species for food or space, prey on native species, or change the nature of the environment. This will affect the biodiversity of benthic habitats and communities.<br><br>The benthic habitat and communities of the Operational Area is expected to contain low diversity of infauna which is typical of deep-water sediments (RPS 2012b, Rowe et al 1982).<br><br>The soft sediments found within the Operational Area, and the water depth, indicate that establishment of IMS would be difficult. Natural dispersal barriers such as water currents and upwellings, extensive tracts of deep water, soft sediment or severe wave exposure; reduce densities of IMS larvae or algal spores whereby settlement is prevented by limiting successful reproduction and establishment of founder populations i.e. IMS is dispersed too far apart for successful reproduction and establishment of a population (Forrest et al. 2009).<br><br>However, in the low likelihood that IMS were introduced and established founder populations, their introduction could result in widespread colonisation and subsequent alteration of marine habitat ecology. Impacts to benthic habitats and communities would | 3 | B | **M** | A | **CM 17:** Pre-start audit of Australian Ballast Water Management Requirements Version 7<br><br>**CM 18:** National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry<br><br>**CM 19:** Biofouling Management Plan<br><br>**CM 20:** MODU already operating in Australian waters | Anti-fouling and in-water Cleaning Guidelines (DoAa 2015) - prior to demobilisation<br><br>Adopted (**CM 31**).<br><br>Biofouling Management Plan (as per DoAa 2015)<br><br>Adopted (**CM 32)**<br><br>Only use rig which is already operating in Australian waters<br><br>Adopted (**CM 33**). | ALARP | • Risks assessed as Medium (tolerable) and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• No stakeholder objections or claims have been raised. | Acceptable |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment: Severity Level | Likelihood | Risk Rating | Demonstration of ALARP: ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Acceptability Outcome |
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| | | | | be **Severe (3),** but likelihood **Unlikely (2)**, resulting in a **medium risk ranking**. | | | | | | | | | |
| MODU Operations<br><br>Vessel Operations | <u>Accidental Release - Hazardous Materials</u><br><br>Small quantities of hazardous materials (solid and liquid) may be accidentally released due to errors in handling and storage.<br><br>The most credible volume is estimated to be 1 $m^3$ (based upon the complete loss of an IBC or container). | <u>Change in water quality</u><br><br>Accidental release can lead to toxicity impacts near the spill location. | Water Quality | A minor spill of hazardous materials would result in a change in water quality through toxicity.<br><br>Due to the small volumes released, any change in toxicity is expected to be quickly dissipated in the high energy marine environment, with no long-term changes to water quality expected. Short-term local degradation to ambient water quality is likely to occur, resulting in a **Minor (2)** consequence. | 2 | B | L | A | **CM 23:** Bunded storage<br><br>**CM 7:** Planned Maintenance System | None | ALARP | • Risks assessed as Low (tolerable) and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions. | Acceptable |
| | | <u>Injury / mortality to fauna</u><br><br>Accidental release can lead to toxicity impacts near the spill location, however due to the high-energy nature of the receiving water column, impacts are expected to be localised and temporary. | Plankton | Phytoplankton are typically not sensitive to the impacts of oil, though they do accumulate it rapidly (Hook et al., 2016). However, oil can affect the rate of photosynthesis and inhibit growth in phytoplankton, depending on the concentration range.<br><br>Zooplankton (microscopic animals such as rotifers, copepods and krill that feed on phytoplankton) are vulnerable to hydrocarbons (Hook et al., 2016). Water column organisms that come into contact with oil risk exposure through ingestion, inhalation and dermal contact (NRDA, 2012), which can cause immediate mortality or declines in egg production and hatching rates along with a decline in swimming speeds (Hook et al., 2016).<br><br>Plankton is generally abundant in the upper layers of the water column and is the basis of the marine food web, so a release of hydrocarbons in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Reproduction by survivors or migration from unaffected areas is likely to rapidly replenish losses (Volkman et al., 2004). Field observations during an oil spill show minimal or transient effects on plankton (Volkman et al., 2004). Once background water quality is re-established, plankton takes weeks to months to recover (ITOPF, 2011). Given the small scale nature of the maximum release volume, impacts to plankton are expected to be highly localised and temporary.<br><br>Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. A change in water quality is likely to lead to localised injury / mortality to plankton, | 2 | B | L | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Severity Level | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | | | | however the impacts will be temporary with no change to the population or ecosystem expected. Impacts will be **Minor (2).** | | | | | | | | • No stakeholder objections or claims have been raised. | |
| | | | Fish & Sharks | Toxic exposure from small volumes of released chemicals and hydrocarbons can affect fish in close vicinity to the discharge through dermal contact, ingestion and inhalation.<br>Pelagic species are generally highly mobile and as such are not likely to suffer extended exposure (e.g. >96 hours) at concentrations that would lead to chronic effects due to their patterns of movement. Many fish species can metabolize toxic hydrocarbons, which reduces the risk of bioaccumulation (NRDA, 2012).<br>There are no BIAs for fish or shark species within the Operational Area. Great White Shark (Vulnerable) may occur within the area. The Recovery Plan for the White Shark (DSEWPC 2013) does not list pollution or chemical exposure as a threat.<br>Fish communities in the Operational Area are typical of the region. Listed threatened species may occur; however, any impacts will be localised to the release site and temporary, with toxicity dissipating quickly in the high energy marine environment and fish species not expected to suffer extended exposure. Impacts are not expected to result in population or ecosystem level effects and will not affect the long-term survival or recovery of listed threatened species. Given the potential presence of sensitive species, impacts will be **Minor (2)**. | 2 | B | L | | | | | | |
| MODU Operations<br>Vessel Operations | <u>Accidental Release - Solid Waste</u><br>Inappropriate waste storage and/or handling error can lead to an accidental release of solid waste.<br>These non-hazardous | <u>Injury / mortality to fauna</u><br>Marine fauna most at risk from marine pollution include marine reptiles and seabirds through ingestion or | Birds<br>Marine reptiles<br>Marine mammals | The ingestion or entanglement of marine fauna has the potential to result in a range of internal and external impacts to species limiting feeding / foraging behaviours. Ingestion of waste may lead to digestive blockages, leading to internal injuries which may result in mortalities. Entanglement of fauna may result in amputation, reduced mobility, starvation, smothering, drowning and infections which may also result in death.<br>The ingestion or entanglement of marine fauna has the potential to limit feeding / foraging behaviours and thus can result in mortalities.<br>There are no BIAs for bird species within the Operational Area. Red Knot (Endangered) and Southern Giant-Petrel (Endangered) may occur within the area. The Wildlife Conservation Plan for Migratory | 2 | C | L | A | **CM 6:** Marine assurance system - vessel contractor pre-qualification assessment.<br>**CM 21:** Garbage management plan<br>**CM 22:** Site induction | None | ALARP | • Risks assessed as Low (tolerable) and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore | Acceptable |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment: Severity Level | Likelihood | Risk Rating | Demonstration of ALARP: ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Acceptability Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | wastes include paper and cardboard, wood, scrap metal, glass and plastics. | entanglement of waste. | | Shorebirds (DotE 2015b) and the National recovery plan for threatened albatrosses and giant petrels 2011-2016 (DSEWPC 2011) do not list debris as a threat.<br>The Operational Area is within the migration BIA for Pygmy Blue Whale. Migration route for Blue Whale (E) is known to occur within the area. Fin Whale (V) and Sei Whale (V) are likely to occur, whilst Humpback Whale (V) may occur. Marine debris is not listed as a threat in the Conservation Management Plan for the Blue Whale (DotE 2015a), and the Conservation Advice for Humpback Whale (TSSC 2015a), Sei Whale (TSSC 2015b) or Fin Whale (TSSC 2015c).<br>There are no BIAs or critical habitats for marine reptiles within the Operational Area. Five listed threatened species of marine turtle (Loggerhead Turtle [E], Green Turtle [V], Leatherback Turtle [E], Hawksbill Turtle [V] and Flatback Turtle [V]) are likely to be present in the Operational Area. The Recovery Plan for Marine Turtles in Australia 2017-2027 (DEE 2017) lists marine debris as a threat, with ingestion or entanglement recognised as a key threatening process for marine vertebrates under the EPBC Act. This is managed through the Threat Abatement Plan (TAP) for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DEE 2018).<br>Listed threatened species of marine fauna may occur within the Operational Area; however, any impacts will be localised to the release site and affect individual fauna only. Impacts are not expected to result in population or ecosystem level effects and will not affect the long-term survival or recovery of listed threatened species. Given the potential presence of sensitive species, impacts are **Minor (2)**. | | | | | | | | practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions.<br>• No stakeholder objections or claims have been raised. | |
| MODU Operations<br>Vessel Operations | Accidental Release - Bulk Transfer<br>Bulk transfer of glycol, methanol, brine, or diesel fuel from vessel to | Change in water quality<br>Accidental release can lead to toxicity impacts near the spill location. | Water Quality | A spill of chemicals or hydrocarbons during bulk transfer would result in a change in water quality through toxicity.<br>Due to the limited volumes released, any change in toxicity is expected to be quickly dissipated in the high energy marine environment, with no long-term changes to water quality expected. Short-term local degradation to ambient water quality is likely to occur, resulting in a **Slight (1)** consequence. | 1 | C | L | A | **CM 24**: Bunkering procedure<br>**CM 25:** Bunkering hoses and Connections | Daylight lifting only<br>Adopted (**CM 39**). | ALARP | • Risks assessed as Low (tolerable) and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant | Acceptable |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
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| | | | | | Severity Level | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | MODU is conducted using flexible hoses. Accidental release may occur with hose failure.<br><br>Maximum release <8 $m^3$. | Injury / mortality to fauna<br><br>Spills of hydrocarbons and chemicals can lead to toxicity impacts near the spill location. | Plankton | Early life stages of fish (embryos, larvae) and other plankton would be most susceptible to the toxic exposure from an unplanned release of chemicals / hydrocarbons, as they are less mobile and therefore can become exposed to the plume at the outfall. However, these are expected to rapidly recover once the activity ceases, as they are known to have high levels of natural mortality and a rapid replacement rate (UNEP, 1985).<br><br>Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. A change in water quality is likely to lead to localised injury / mortality to plankton, however the impacts will be temporary with no change to the population or ecosystem expected. Impacts will be **Slight (1)**. | 1 | B | L | | **CM 26:** Crane transfer procedures | | | legislation, industry standards and guidelines, offshore practises and benchmarking.<br><br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br><br>• The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions.<br><br>• No stakeholder objections or claims have been raised. | |
| | | | Fish & Sharks | Toxic exposure can affect fish through dermal contact, ingestion and inhalation.<br><br>Given the maximum release volume, surface and entrained oil concentrations are possible. Fish are at risk from dissolved hydrocarbons and entrained hydrocarbons in the water column. Some fish are attracted to floating objects at sea and may congregate under slicks.<br><br>Pelagic species are generally highly mobile and as such are not likely to suffer extended exposure (e.g. >96 hours) at concentrations that would lead to chronic effects due to their patterns of movement. Many fish species can metabolize toxic hydrocarbons, which reduces the risk of bioaccumulation (NRDA, 2012). Fish are most vulnerable to water column toxicity in shallow nearshore waters, bays and estuaries, where the toxicity concentration can significantly rise. In the open marine environment, dilution is likely, and impacts are significantly reduced.<br><br>There are no BIAs for fish or shark species within the Operational Area. Great White Shark (Vulnerable) may occur within the area. The Recovery Plan for the White Shark (DSEWPC 2013) does not list pollution or chemical exposure as a threat.<br><br>Fish communities in the Operational Area are typical of the region. Listed threatened species may occur; however, any impacts will be localised to the release site and temporary, with toxicity dissipating quickly in the high energy marine environment and fish species not | 2 | B | L | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
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| | | | | | Severity Level | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | | | | expected to suffer extended exposure. Impacts are not expected to result in population or ecosystem level effects and will not affect the long-term survival or recovery of listed threatened species. Given the potential presence of sensitive species, impacts will be **Minor (2)**. | | | | | | | | | |
| Well Design and Drilling Operations | Accidental Release - Unplanned Riser Disconnect / Failure of Slip Joint Packer<br><br>Unplanned riser disconnect could occur due to loss of mooring, extreme weather conditions; vessel collision; rig stabilisation; or human error.<br><br>The riser will contain drilling muds / fluids, which would be released into the marine environment in the event of an unplanned riser disconnect.<br><br>Up to the riser volume of 200 m³ (1267 | Change in water quality<br><br>Unplanned discharge of drilling fluids and muds would result in a change in water quality | Water Quality | The American Chemistry Council (2006) evaluated toxicity data for water and sediment dwelling organisms against synthetic based fluids such as SBM. Toxicity tests found synthetic based fluids are non-toxic to water dwelling organisms but have toxicity effects to sediment-dwelling organisms similar to diesel oil. Details on potential impacts from sediment (seabed) toxicity is provided in the next section.<br><br>Drilling muds and fluids including SBM and WBM used for the exploration drilling activity is required to be of low toxicity.<br><br>Water quality within the Operational Area is expected to be representative of the typically pristine and high water quality found in offshore Western Australian waters. Given the localised impact area and the high energy marine environment, change in water quality will be localised and temporary, and impacts will be **Slight (1).** | 1 | C | L | A | **CM 10:** Chemical Assessment Procedure<br><br>**CM 7:** Preventative maintenance system<br><br>**CM 27:** Well specific operating guidelines (WSOG) includes weather criteria for safe operations<br><br>**CM 28:** Well Operations Procedures<br><br>**CM 42:** Response arrangements | None | ALARP | • Risks assessed as Low (tolerable) and are considered to be ALARP<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable | Acceptable |
| | | Change in habitat<br><br>Unplanned discharge of drilling fluids and muds would result in a change in habitat. | Benthic Habitats & Communities | In the event of an emergency riser disconnect, drilling fluids will be released at the top of the BOP, within tens of metres above the seabed. Due to the density of drilling fluids (SBM/WBM), the fluids would exit the from the bottom of the lower marine riser package, thereby directly blanketing the seabed. If the riser is disconnected in an emergency, there is the potential for the riser volume estimated to be in the order of 200 m³ of drilling fluids to be lost to the environment.<br><br>The potential volume of drilling fluids released is less than the volume of cuttings and fluids discharged as part of planned activities (Table 3-3). Therefore, seafloor exposure of drilling fluids from an emergency riser disconnect or failure of the joint slip packer is expected to less than the seafloor exposure for planned release of drill cuttings and fluids evaluated in Table 6-1. | 2 | B | L | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment: Severity Level | Risk Assessment: Likelihood | Risk Assessment: Risk Rating | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Good Practice Control Measures | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
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| | bbls) of fluids either WBM or SBM depending when this occurs.<br><br>Or in the event of failure of slip joint packer the worst case loss of hydraulic fluid is ~5.3 m$^3$ (approximately 30 m air gap on a 20" riser). | | | The benthic habitat and communities of the Operational Area is expected to contain low diversity of infauna which is typical of deep-water sediments (RPS 2012b, Rowe et al 1982).<br><br>Given the potential volume of drilling fluids released is less than the volume of cuttings and fluids discharged as part of planned activities, and anticipated low diversity of benthic assemblages within the Operational Area, any impacts will be localised, and recovery is expected. Impacts are assessed as **Minor (2).** | | | | | | | | management actions.<br>• No stakeholder objections or claims have been raised. | |
| | | Injury / mortality to fauna<br><br>As a result of change in water quality and change in habitat, injury / mortality to fauna could occur. | Plankton | Toxicity tests found synthetic based fluids are non-toxic to water dwelling organisms (American Chemistry Council 2006).<br><br>Neff (2010) also explains that the lack of toxicity and low bioaccumulation potential of the drilling muds means that the effects of the discharges are highly localised and are not expected to spread through the food web. This confirms the evaluation that any potential for impact is limited to the area around the well locations with concentrations rapidly diluted below that known to result in an impact to marine fauna.<br><br>Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Given the localised and temporary nature of the impact, it has been assessed as **Slight (1).** Impacts to other ecological and social receptors are not expected. | 1 | B | L | | | | | | |
| | | | KEFs | The Operational Area is within the Exmouth Plateau KEF, which is believed may modify deepwater flow and be associated with the generation of internal tides. Both may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007). The area is generally considered to have low habitat heterogeneity.<br><br>Habitat modification is not listed as a pressure in the Marine Bioregional Plan for the North-west Marine Bioregion (DSEWPC, 2012a). Any impacts to the seabed habitat within the Exmouth Plateau KEF will therefore be localised and temporary and have been assessed as **Slight (1).** | 1 | B | L | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Severity Level | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| MODU Operations<br>Vessel Operations | Accidental Release - Vessel Collision<br>A collision between the support vessel and the MODU or a third-party vessel can result in fuel tank rupture and a discharge of 250 m³ Marine Diesel Oil (MDO).<br>An accidental release of 250 m³ of MDO instantaneously is considered to be the worst-case scenario. | Change in water quality<br>Accidental release of MDO at the surface will result in a change in water quality. | Water Quality | A vessel collision resulting in the accidental release of MDO would affect water quality through surface and entrained hydrocarbon exposure.<br>To determine the extent of hydrocarbon exposure from an accidental release of MDO, oil weathering model ADIOS (Automated Data Inquiry for Oil Spills) was used to estimate how long an instantaneous release of 250 m³ of MDO will remain in the marine environment.<br>NERA Reference Case 2018:1003 identified ADIOS predictions show greater evaporation of hydrocarbons at higher seawater temperatures and high dispersion at high wind speeds. Therefore, to predict the greatest consequence extent using ADIOS, the low windspeed and low seawater temperature values representative of offshore Australian waters as defined by DNV's study for AMSA (DNV 2011) was used. Based on the parameters to predict the greatest consequence extent, ADIOS estimated that within 52 hours of an instantaneous release of 250 m³ diesel, no surface expression is expected as volatiles have evaporated, and the remaining components have entrained and dispersed into the water-column.<br>To calculate the extent of surface hydrocarbon exposures from this type of spill event, WG considered 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, considered as calm weather conditions as used in the ADIOS model), which indicates that the horizontal extent of a surface slick associated with a 250 m³ MDO spill is limited to a 28 km horizontal buffer applied around the Operational Area. The vertical extent of the spill within the water column is expected to be limited to the top 10 m of the water column (NERA Reference Case 2018:1003).<br>Therefore, change in water quality in limited to the top 10 m of the water column within a 28 km buffer around the Operational Area.<br>Duration of exposure to hydrocarbons from this event would be limited with modelling indicating that following a 52-hour period, | 4 | A | **M** | A | **CM 1:** Pre-start notifications<br>**CM 2:** Ongoing consultation<br>**CM6:** Marine assurance system - vessel contractor pre-qualification assessment.<br>**CM 42:** Response arrangements | None | ALARP | • Risks assessed as Low (tolerable) and are considered to be ALARP.<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures.<br>• The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions.<br>• No stakeholder objections or claims have been raised. | Acceptable |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Severity Level | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | | | | water quality is expected to return to background levels. The impact to water quality will be **Minor (2).** | | | | | | | | | |
| | | Injury / mortality to fauna<br><br>A change in water quality could lead to injury / mortality of fauna. | Plankton | Plankton has the potential to be directly impacted by in-water hydrocarbons a result of toxicity effects.<br><br>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. No specific spawning locations have been identified within a 28 km buffer of the Operational Area.<br><br>Planktonic communities within a 28 km buffer of the Operational Area will be typical of the offshore marine environment in the region. Impacts to plankton from in-water hydrocarbon exposure as a result of a vessel collision will be localised (within 28 km of the Operational Area) and temporary (approximately 52 hours) and have been assessed as **Minor (2).** | 4 | A | M | | | | | | |
| | | | Fish & Sharks | Pelagic free-swimming fish and sharks, such as Whale Sharks foraging within a 28 km buffer of the Operational Area, have the potential to be directly impacted by in-water hydrocarbons.<br><br>Exposure of pelagic free-swimming fish and sharks to in-water hydrocarbons is unlikely to result in long-term damage because dissolved/entrained hydrocarbons are not expected to be sufficient to cause harm (ITOPF 2011). In-water 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. | 4 | A | M | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Severity Level | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | | | | Impacts to fish and sharks from in-water hydrocarbons exposure as a result of a vessel collision is expected to be localised (within 28 km of the Operational Area) and temporary (approximately 52 hours), with no long-term effects expected. Impacts have been assessed as **Minor (2)** | | | | | | | | | |
| | | | Birds | Seabirds dive in ocean waters to feed or rest at the surface therefore has the potential to be directly impacted by surface hydrocarbons.<br><br>These seabird behaviours, within a 28 km buffer of the Operational Area, 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. No known offshore aggregation areas for seabirds or BIAs are located within a 28 km buffer of the Operational Area.<br><br>In the event a vessel collision would result in the release of diesel, individual seabird casualties may result (given the absence of offshore aggregation areas) and impacts local seabird populations is unlikely.<br><br>Impacts to seabirds from surface hydrocarbon exposure as a result of a vessel collision is expected to be localised (within 28 km of the Operational Area) and temporary (approximately 52 hours), with no long-term effects expected. Impacts have been assessed as **Severe (3)** | 4 | A | M | | | | | | |
| | | | Marine Mammals | Marine mammals can be exposed to hydrocarbons through:<br>• Internal exposure by consuming oil or contaminated prey;<br>• Inhaling volatile oil compounds when surfacing to breathe (NRDA, 2012).<br><br>Surfacing marine mammals such as Blue Whales migrating through the 28 km buffer of the Operational Area 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 | 4 | A | M | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment: Severity Level | Risk Assessment: Likelihood | Risk Assessment: Risk Rating | Demonstration of ALARP: ALARP Decision Context | Demonstration of ALARP: Good Practice Control Measures | Demonstration of ALARP: Additional Control Measures Considered | Demonstration of ALARP: ALARP Outcome | Demonstration of Acceptability: Acceptability Assessment | Demonstration of Acceptability: Acceptability Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | geographical distribution of whales on the NWS, only a small proportion of the population would be expected to surface within 28 km of the Operational Area, resulting in short-term and localised consequences, with no long-term population viability effects (Helm et al. 2015). Geraci and St Aubin (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.<br><br>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.<br><br>A proportion of the migrating population of whales could be affected for a single migration event, which could result in localised (within 28 km of the Operational Area) and temporary (approximately 52 hours), with no long-term effects expected. Impacts have been assessed as **Minor (2).** | | | | | | | | | |
| | | | Marine Reptiles | Marine reptiles within a 28 km buffer of the Operational Area 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 2010). No known offshore aggregation areas for marine turtles are located within a 28 km buffer of the Operational Area.<br><br>It should be noted that the threat and relative impacts of an unplanned discharge on some marine reptile species are considered less damaging than other stressors. Report cards produced on protected marine reptiles in Australia generally ranked oil pollution as either 'not of concern' or 'of less concern' depending on the marine region (DSEWPC 2012).<br><br>There are no BIAs or critical habitats for marine reptiles within a 28 km buffer of the Operational Area. Five listed threatened species of | 4 | A | **M** | | | | | | |

| Activity | Aspect | Risk | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Severity Level | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | | | | marine turtle (Loggerhead Turtle [E], Green Turtle [V], Leatherback Turtle [E], Hawksbill Turtle [V] and Flatback Turtle [V]) are likely to be present in the Operational Area. The Recovery Plan for Marine Turtles in Australia 2017-2027 (DEE 2017) lists chemical and terrestrial discharge as a threat, however this is mostly in relation to oil present on or near marine turtle nesting beaches.<br><br>Given that critical behaviours are unlikely to occur within a 28 km buffer of the Operational Area, impacts to listed threatened marine turtles are expected to be localised (within 28 km of the Operational Area) and temporary (approximately 52 hours), with no long-term effects expected. Impacts have been assessed as **Minor (2).** | | | | | | | | | |

## 6.3 UNDERWATER SOUND EMISSIONS – CONTINUOUS

During activities associated with Sasanof-1 Exploration Drilling, continuous sound emissions will be generated which will propagate through the water column and contribute to the ambient noise levels in the area.

### 6.3.1 Aspect Source

Activities which will produce continuous sound emissions include:

- MODU Operations;
- Vessel Operations;
- Helicopter Operations; and
- Cutting of wellhead.

#### 6.3.1.1 MODU Operations

Drilling activities will be undertaken using a MODU. The MODU will maintain position using either DP or an anchored mooring system.

The MODU will generate noise from the operation of on-board machinery, including diesel engines, mud pumps, ventilation fans (and associated exhaust) and electrical generators, and also (during drilling) from the drill string and bit. The source level of the MODU on DP during drilling is 182 dB SPL RMS (Hannay et al, 2004).

#### 6.3.1.2 Vessel Operations

The MODU will be supported by two or three vessels, including AHSV and PSVs. The vessels will be either stationary or operating at slow speeds while undertaking activities within the Operational Area.

The support vessels will emit noise from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment. Most sounds associated with vessels are broadband, but low frequency sound (i.e., below 1 kHz) can be produced from machinery noise (e.g., engine noise) and hydrodynamic noise (e.g., water flowing past the hull and propeller singing). The main source of vessel noise will be from propellers (during transit). The source level of support vessels is 182 dB SPL RMS (McCauley, 1998).

#### 6.3.1.3 Helicopter Operations

The MODU is serviced by helicopters, with an expected flight frequency of up to 8 times per week. The source level of helicopter operations is 149 dB SPL RMS (Richardson, et al 1995).

#### 6.3.1.4 Cutting of Wellhead

Noise from the mechanical cutting of the wellhead for removal is likely to be generated for a period of up to 5 hours while cutting is undertaken. The US Navy measured underwater sound levels when the diamond wire saw was cutting caissons for replacing piles at an old fuel pier at Naval Base Point Loma and reported an average SPL for a single cutter at 156.4 dB SPL at source and 132.5 dB SPL at 40 m (NAVFAC SW 2018).

### 6.3.2 Impact Evaluation

Continuous sound emissions from the MODU, vessel or helicopter operations has the potential to result in the following impacts:

- Change in ambient noise

As a result of a change in ambient noise, further impacts may occur, which include:

- Change in fauna behaviour

The extent of the impacts from continuous underwater sound emissions will depend upon the frequency range and intensity of the noise produced.

#### 6.3.2.1 Change in Ambient Noise

Dynamic positioning (i.e. MODU and vessels holding position) generates sound of up to 182 dB SPL RMS, with levels of 120 dB SPL RMS recorded at 3–4 km (McCauley 1998). Sound emitted from helicopter operations is typically of a low frequency, below 500 Hz, and has a sound level of 149 dB SPL RMS (Richardson et al. 1995). An acoustic monitoring program commissioned by Santos was conducted during an exploratory drilling program in 2003, which indicated that the drilling operation was not audible between 8 and 28 km from the MODU (McCauley 2004), with most sound above 120 dB SPL RMS confined within a 2–4 km radius of the MODU.

Pangerc et al. (2016) described the underwater sound measurement data during an underwater diamond wire cutting of a 32" conductor (10 m above seabed in ~80 m depth) and found that the sound radiated from the diamond wire cutting of the conductor was not easily discernible above the background noise at the closest recorder located at 100 m from the source. The sound that could be associated with the diamond wire cutting was primarily detectable above the background noise at the higher acoustic frequencies (above around 5 kHz) (Pangerc et. al. 2016) above the hearing range of low frequency cetaceans. Background noise was attributed to surface vessel activity such as dynamic positioning. Noise from the mechanical cutting of the wellhead for removal is likely to be generated. The US Navy measured underwater sound levels when the diamond wire saw was cutting caissons for replacing piles at an old fuel pier at Naval Base Point Loma and reported an average SPL for a single cutter at 132.5 dB SPL at 40 m (NAVFAC SW 2018).Ambient noise in the Operational Area is expected to be low and typical of the offshore marine environment in Western Australia. Change in ambient noise levels will be localised (between 2-4 km from source at 120 dB SPL RMS) and temporary (approximately 25 days), with ambient noise levels returning once the source moves away from an area. Impacts are evaluated as **Slight (1)**.

#### 6.3.2.2 Change in fauna behaviour

As a result of change in ambient noise, change in fauna behaviour could occur to receptors in one main ways:

- Disturbance leading to behavioural changes or displacement to fauna. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation.

**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 minor and be limited to a range of a few tens of metres from the source.

Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region, and any mortality is likely to be negligible due to rapid recovery of populations. Impacts to plankton from underwater sound emissions will be localised and temporary and have been assessed as **Slight (1).**

**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 1µPa 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 170 dB SPL for 48 hr 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).

McCauley (1998) determined that sound levels from dynamic positioning (vessel and MODU) would be below ambient 120 dB SPL RMS within 3-4 km of the source, therefore it is conservatively assumed that any behavioural changes to fish will be limited to the same area.

Twachtman et al. (2004) studied the operations and socioeconomic impact of nonexplosive removal of offshore structures, including noise, and concluded that mechanical cutting and abrasive water jet, as well as diamond wire cutting methods are generally considered harmless to marine life and the environment. Based on underwater sound measurement data during underwater cutting of conductors and pylons (Pangerc 2016; NAVFAC SW 2018) sound levels from mechanical cutting of the wellhead is likely to attenuate to levels at, or close to background ambient levels within <100 m of the source. Thus, any behavioural changes to fish will be limited to within the area of where sound levels for the vessel and MODU are above ambient levels and thus no increased impact is predicted for the short period of 5 hrs while cutting is undertaken.

There are no BIAs for fish or shark species within the Operational Area. Great White Shark (Vulnerable) may occur within the area. The Recovery Plan for the White Shark (DSEWPC 2013) does not list noise pollution as a threat.

Impacts to fish and sharks from underwater sound emissions will be localised and temporary, with impacts ceasing when the noise source is no longer detected, and no long-term effects expected. Impacts have been assessed as **Slight (1)**.

**Marine Mammals**

Within the Operational Area, listed threatened species include sei whale (Vulnerable), blue whale (Endangered), fin whale (Vulnerable) and humpback whale (Vulnerable). Noise disturbance / interference listed as a threat in the Conservation Management Plan for the Blue Whale (DotE 2015a), and the Conservation Advice for Humpback Whale (TSSC 2015a), Sei Whale (TSSC 2015b) or Fin Whale (TSSC 2015c), mostly due to the effects of anthropogenic noise on marine mammal vocalisation. It is possible that continuous noise generated by the Petroleum Activity will mask natural vocalisation undertaken by these species, however impacts will be localised to the Operational Area and limited to the duration of the Petroleum Activity (25 days), with no long-term impacts expected.

Shipping and industrial noise are assessed by the Conservation Management Plan for the Blue Whale (DotE 2015a) as posing a moderate risk to the blue whale, with an outcome that additional controls may be required.

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 re1µPa root mean squared (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 re1µPa or possibly higher (Table 6-3).

**Table 6-3: Continuous Noise: Acoustic Effects of Continuous Noise on Low-frequency Cetaceans: Unweighted SPL and SEL24h Thresholds**

| Hearing Group | NOAA (2019) | NMFS (2018); Southall et al., (2019) | |
|---|---|---|---|
| | Behaviour | PTS onset thresholds (received level) | TTS onset thresholds (received level) |
| | SPL (Lp; dB re 1 µPa) | Weighted SEL24h (LE,24h; dB re 1 µPa2·s) | Weighted SEL24h (LE,24h; dB re 1 µPa2·s) |
| Low-frequency cetaceans | 120 | 199 | 179 |
| High-frequency cetaceans | | 198 | 178 |

McCauley (1998; 2004) indicates that continuous noise sources from MODU and vessel operations are expected to fall below 120 dB re1µPA within 4 km of the MODU / vessel. Hearing damage in marine mammals from shipping noise has not been widely reported (OSPAR Commission, 2009).

Twachtman et al. (2004) studied the operations and socioeconomic impact of nonexplosive removal of offshore structures, including noise, and concluded that mechanical cutting and abrasive water jet, as well as diamond wire cutting methods are generally considered harmless to marine life and the environment. Based on underwater sound measurement data during underwater cutting of conductors and pylons (Pangerc 2016; NAVFAC SW 2018) sound levels from mechanical cutting of the wellhead is likely to attenuate to levels at, or close to background ambient levels within <100 m of the source. Thus, any behavioural changes to marine mammals will be limited to within the area of where sound levels for the vessel and MODU are above ambient levels and thus no increased impact is predicted for the short period of 5 hrs while cutting is undertaken. Hearing damage to marine mammals from mechanical cutting of the wellhead is not predicted due to the short period of low levels of sound generated.

The Blue Whale Conservation Management Plan 2015 – 2025 requires that anthropogenic noise in distribution areas will be managed such that any blue whale continues to utilise the area without injury.  While the operational area does intersect the BIA for pygmy blue whale migration, it is not likely to result in injury a result of continuous sound sources resulting from this activity.

Although the operational area is located in a migration BIA for the pygmy blue whale, this represents a very small proportion of the overall BIA and is unlikely to disrupt migration. The area is not known as a BIA for pygmy blue whale foraging, however regardless the small area and temporary nature of the activity is not likely to impact on foraging, should this occur. The activity is not predicted to result in impacts to species that would be inconsistent with recovery plans or conservation advices.

Given the potential for impacts to sensitive species, the impacts have been assessed as **Minor (2)**. Western Gas will adopt all legislative and best practise controls in order to sufficiently lower the risk of an impact to ALARP. No additional controls have been identified which further reduce the impact to marine mammals.

**Marine Reptiles**

Although there are no BIAs or critical habitats for marine reptiles within the Operational Area, five listed threatened species of marine turtle (loggerhead turtle [E], green turtle [V], leatherback turtle [E], hawksbill turtle [V] and flatback turtle [V]) are identified as likely to be present in the Operational Area.

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). Studies show that behavioural responses occur to received sound levels of approximately 166 dB re 1 µPa and that avoidance responses occur at around 175 dB re 1 µPa (McCauley et al., 2000). These levels overlap with the sound frequencies produced by vessel activities. Based on the limited data regarding noise levels that illicit a behavioural response in turtles, the lower level of 166 dB re 1 µPa level drawn from National Science Foundation (NSF) (2011) is typically applied, both in Australia and by NMFS, as the threshold level at which behavioural disturbance could occur.

The recommended criteria for impulsive and continuous sound sources are shown in Table 6-4.

**Table 6-4 Recommended criteria for impulsive and continuous sound sources for Reptiles**

| Potential Marine Fauna Receptor | Popper et al. 2014 | | Finneran et al. (2017) Weighted SEL24h (LE,24h; dB re 1 µPa2·s) | |
|---|---|---|---|---|
| | Masking | Behaviour | PTS onset threshold | TTS onset threshold |
| Marine Turtle | (N) High<br>(I) High<br>(F) Moderate | (N) High<br>(I) Moderate<br>(F) Low | 220 | 200 |

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

The Recovery Plan for Marine Turtles in Australia 2017-2027 (DEE 2017) lists noise disturbance from acute and chronic sources as a threat. Noise generated by the petroleum activity will be chronic noise, which is considered a threat to marine turtles as it may lead to avoidance of important habitats. Important habitats such as nesting sites do not occur within the Operational Area, and critical behaviours such as internesting are unlikely to occur within the Operational Area, therefore no ecosystem or population level effects and no threat to recovery of species are expected.

Given the potential for impacts to sensitive species, the impacts have been assessed as **Minor (2).** Western Gas will adopt all legislative and best practise controls in order to sufficiently lower the risk of an impact to ALARP. No additional controls have been identified which further reduce the impact to marine reptiles.

### 6.3.3 Control measures ALARP and acceptability assessment

<table>
<tr><th colspan="4">Control, ALARP and acceptability assessment: Loss of well control</th></tr>
<tr><td>ALARP decision context and justification</td><td colspan="3">ALARP Decision Context: Type A<br>Exploration drilling is a standard offshore activity. Drilling activities are highly regulated with associated control measures, well understood, and are implemented across the offshore industry.<br>During stakeholder engagement, no concerns were raised regarding the acceptability of impacts from these events.</td></tr>
<tr><td>Adopted Control Measures</td><td colspan="3">Source of good practice control measures</td></tr>
<tr><td colspan="4">Preventative</td></tr>
<tr><td>CM 7: Planned Maintenance System</td><td colspan="3">Power generation and propulsion systems on the vessels and MODU will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation.</td></tr>
<tr><td>CM43: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans</td><td colspan="3">EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels and helicopters.<br>All vessels will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. These regulations stipulate a safe operating distance of 300 m.<br>Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans.</td></tr>
<tr><td colspan="4">Additional controls assessed</td></tr>
<tr><td>Control Measure</td><td>Environmental Benefit</td><td>Potential Cost/Issues</td><td>Evaluation</td></tr>
<tr><td>Dedicated Marine Fauna Observer on vessels</td><td>Improved ability to spot and identify marine fauna at risk of impact by vessel noise.</td><td>Additional cost of contracting several specialist Marine Fauna Observers while the risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species.</td><td>Not adopted<br>Cost disproportionate to increase in environmental benefit and given that crew member will be observing for marine fauna during MODU VSP activities (refer to Section 6.4).</td></tr>
<tr><td>Use of Passive acoustic monitoring (PAM)</td><td>Improve detection of some sensitive receptors.</td><td>Costs of PAM operators.</td><td>Not adopted<br>Cost disproportionate to increase in environmental benefit given the low-level behavioural response expected.</td></tr>
</table>

| | | | |
|---|---|---|---|
| Scheduling activities to avoid coinciding with sensitive periods for marine fauna which may be present. | Avoiding peak periods for species (such as migration) will reduce a potential for impact. | Costs of scheduling and managing logistics of reorganising activities. | Not adopted<br><br>While avoiding peak periods for species (such as migration) will reduce a potential for impact, there are high costs and logistical constraints associated with varying the timing of the activities. The costs associated with this are disproportionate to the low – level behavioural risk predicted from the MODU and vessel operations. |
| **Acceptability assessment** | Impacts assessed as Minor to Slight and are considered to be ALARP. Although the operational area is located in a BIA for the pygmy blue whale, this represents a very small proportion of the overall BIA and is unlikely to disrupt migration. The area is not known as a BIA for pygmy blue whale foraging, however regardless the small area and temporary nature of the activity is not likely to impact on foraging, should this occur. The activity is not predicted to result in impacts to species that would be inconsistent with recovery plans or conservation advices. | | |
| **To meet the principles of ESD** | Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures. | | |
| **Internal context** | No stakeholder objections or claims have been raised. | | |
| **External context** | Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practices and benchmarking.<br><br>The activity is not predicted to result in impacts to species that would be inconsistent with recovery plans or conservation advices. | | |
| **Other requirements** | The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions. | | |
| **Acceptability outcome** | Acceptable | | |

## 6.4 UNDERWATER SOUND EMISSIONS – IMPULSIVE

During activities associated with Sasanof-1 Exploration Drilling, impulsive sound emissions will be generated which will propagate through the water column and contribute to the ambient noise levels in the area.

### 6.4.1 Aspect Source

Activities which will produce impulsive sound emissions include:

- Well Evaluation; and
- ROV Operations (survey)

#### 6.4.1.1 Well evaluation

Well evaluation will be undertaken via Vertical Seismic Profiling (VSP). VSP is a routine activity that is conducted as part of a drilling activity to provide detailed information regarding geological structures and stratigraphy in the vicinity of the well. The duration of VSP is estimated at 4 hours using a source array of four x 150 cubic inches (cui) (for a total of 600 cui). A conservative maximum source level of 239 dB re 1 µPa @ 1 m RMS will be used for the impact assessment.

#### 6.4.1.2 ROV Operations (survey)

A post operation ROV survey will be completed for the exploration well prior to the MODU demobilising from the operational area. The ROV will be deployed from the MODU to conduct a post operation survey that involves a 100 m radius sonar check from the wellhead location. This survey records the condition of the seabed at the completion of the program to ensure that no dropped objects or subsea equipment intended for removal remain on the seabed. The post operations ROV survey will be conducted after completing the exploration well at a source level of 180 - 206 dB re 1 µPa @ 1 m RMS.

### 6.4.2 Impact Evaluation

Impulsive sound emissions from VSP and/or ROV operations survey has the potential to result in the following impacts:

- Change in ambient noise

As a result of a change in ambient noise, further impacts may occur, which include:

- Change in fauna behaviour
- Injury / mortality to fauna

The extent of the impacts from impulsive underwater sound emissions will depend upon the frequency range and intensity of the noise produced.

#### 6.4.2.1 Change in Ambient Noise

In the absence of published literature on sound level measurements and propagation of sound with distance for the environmental setting (in particular water depth) applicable to the Petroleum Activity, the spherical spreading model (Richardson et al. 1995) was used to calculate the distance from the source where received SPL RMS levels greater than 160 dB re 1 µPa was predicted. This model is highly simplified, and does not consider directionality, reflection, refraction or absorption of sound at the seabed. The bubble model calculated received SPL levels greater than 160 dB re 1 µPa as within 10 km of the source, based on a sound source level of 239 dB re 1 µPa @ 1 m RMS.

Ambient noise in the Operational Area are expected to be low and typical of the offshore marine environment in Western Australia. Change in ambient noise levels will be localised (10 km from the source) and temporarily intermittent (24 hours), with ambient noise levels returning once the VSP/post ROV survey is completed. Impacts are evaluated as **Slight (1)**.

#### 6.4.2.2 Change in fauna behaviour

As a result of change in ambient noise, change in fauna behaviour could occur to receptors in one main ways:

- Disturbance leading to behavioural changes or displacement to fauna. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation.

#### 6.4.2.3 Injury / Mortality to Fauna

As a result of change in ambient noise, injury / mortality to fauna could occur to receptors in two main ways:

- Injury to hearing or other organs. Hearing loss may be temporary (temporary threshold shift (TTS)) or permanent (permanent threshold shift (PTS)); and
- Masking or interfering with other biologically important sounds (including vocal communications, echolocation, signals and sounds produced by predators or prey).

**Plankton**

Change in fauna behaviour

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 minor and be limited to close to the source.

Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Impacts to plankton from underwater sound emissions will be localised and temporary and have been assessed as **Slight (1).**

Injury / Mortality to fauna

McCauley et al (2017 cited in Richardson 2017) conducted a study which observed the impact of seismic activity on zooplankton to be within 1.2 km of the sound source. Contrary to McCauley et al (2017), Fields et al (2019) conducted a study which observed no immediate mortality at distances greater than 5 m from a seismic airgun. Either range cited does not overlap fish spawning grounds, critical primary productive habitat such as coral reefs or the Whale Shark foraging behaviours BIA located northward from Ningaloo along the 200 m isobath. Primary productivity within the NWMR is generally low and this is also to be expected within the area with the potential to illicit injury to eggs and larvae.

Planktonic communities within the Operational Area will be typical of the offshore marine environment in the region. Impacts to plankton from underwater sound emissions will be localised and temporary and have been assessed as **Slight (1).**

**Fish and Sharks**

Change in fauna behaviour

There is a high risk of behavioural effects to fish with and without swim bladders within tens of metres of the source (Popper et al. 2014). It is possible that fish and sharks exhibit behavioural responses including increased swim speeds, changes in swim directions and avoidance within tens of metres of the source. Based on fishes' morphology, Popper et al (2014) classified fishes into three groups comprising:

- Fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes;
- Fishes whose hearing does involve a swim bladder or other gas volume; and
- Fishes without a swim bladder that can sink and settle on the substrate when inactive.

Thresholds for recoverable injury are between 203 dB PK and 216 dB PK (depending on the presence or absence of a swim bladder) (Popper et al., 2014) (Table 6-5). Given there is no exposure criteria for sharks and rays, the same criteria are adopted, though typically sharks and rays do not possess a swim bladder.

**Table 6-5: Impulsive noise: Criteria for noise exposure for fish, adapted from Popper et al. (2014)**

| Potential Marine Fauna Receptor | Mortality and Potential mortal injury | Impairment | | | Behaviour |
|---|---|---|---|---|---|
| | | Recoverable Injury | TTS | Masking | |
| Fish<br>No swim bladder (particle motion detection) | > 219 dB SEL24h<br>or<br>> 213 dB PK | > 216 dB SEL24h<br>or<br>> 213 dB PK | >> 186 dB SEL24h | (N) Low<br>(I) Low<br>(F) Low | (N) High<br>(I) Moderate<br>(F) Low |
| Fish:<br>Swim bladder not involved in hearing (particle motion detection) | 210 dB SEL24h<br>or<br>> 207 dB PK | 203 dB SEL24h<br>or<br>> 207 dB PK | >> 186 dB SEL24h | (N) Low<br>(I) Low<br>(F) Low | (N) High<br>(I) Moderate<br>(F) Low |
| Fish:<br>Swim bladder involved in hearing (primarily pressure detection) | 207 dB SEL24h<br>or<br>> 207 dB PK | 203 dB SEL24h<br>or<br>> 207 dB PK | 186 dB SEL24h | (N) Low<br>(I) Low<br>(F) Moderate | (N) High<br>(I) High<br>(F) Moderate |
| Fish eggs and fish larvae | > 210 dB SEL24h<br>or<br>> 207 dB PK | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low |

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

There are no BIAs for fish or shark species within the Operational Area. The PEBC PMST Report identified the great white shark (V) may occur within the Operational Area. The Recovery Plan for the White Shark (DSEWPC 2013) does not list noise pollution as a threat. There are no features (lack of distinct habitat features or conditions for site-attached fishes) within the area exposed to increased sound levels where fishes are likely to be site-attached in large numbers.

Impacts to fish and sharks from underwater sound emissions will be localised and temporary, with impacts ceasing when the noise source is no longer detected, and no long-term effects expected. Impacts have been assessed as **Slight (1).**

Injury / Mortality to fauna

Thresholds for TTS is 186 dB SELcum (Popper et al., 2014) (Table 6-5). Given there is no exposure criteria for sharks and rays, the same criteria are adopted, though typically sharks and rays do not possess a swim bladder. The NMFS guidance has also identified the above TTS threshold, it is a conservative approach and has been used to determine the range in which the potential for mortality, potential mortal injury, recoverable injury and TTS may occur for fishes with and without a swim bladder (NFMS 2016).

The bubble model calculated received SPL levels greater than 186 dB re1µPa.s as within 100 m of the source, based on the maximum impulsive sound source level of 239 dB re 1 µPa @ 1 m RMS. Mortality, potential mortal injury, recoverable injury and TTS may occur if fishes of all hearing sensitivities (with or without swim bladder) are present within less than 100 m of the impulsive source. As there are no features within these ranges where fish are likely to be site-attached, only individual transient and foraging fish or common bottom-dwelling fish are expected to be near the exposure area.

In the absence of published literature on potential impacts to fishes from VSP or sonar activities, studies based on seismic impulsive sources has been used as a conservative approach. Studies to date have not shown fish mortality from exposure to seismic sound sources under field-operating conditions; though prolonged or extreme exposure to high-intensity, low-frequency sound, may lead to physical damage such as threshold shifts in hearing or barotraumatic ruptures (DFO 2004; Carroll et al. 2017). Prolonged exposure of wild, unrestrained, transient fish from stationary VSP activities within close enough proximity for injury is considered negligible.

It is therefore expected that fishes are unlikely to experience mortality, potential mortal injury, recoverable injury and TTS during the activity. Any impacts will be **Slight (1).**

**Marine Mammals**

Change in fauna behaviour

Using the NMFS guidance for pulsed sound, a behavioural disturbance limit of 160 dB re1µPa RMS is adopted (NFMS, 2016). The bubble model calculated received SPL levels greater than 160 dB re 1 µPa as within 10 km of the source, based on the maximum impulsive sound source level of 239 dB re 1 µPa @ 1 m RMS.

The migration BIA for pygmy blue whale is located within 10 km of the sound source. The fin whale (V) and sei whale (V) are likely to occur, whilst humpback whale (V) may occur. Noise disturbance / interference listed as a threat in the Conservation Management Plan for the Blue Whale (DotE 2015a), and the Conservation Advice for Humpback Whale (TSSC 2015a), Sei Whale (TSSC 2015b) or Fin Whale (TSSC 2015c), mostly due to the effects of anthropogenic noise on marine mammal vocalisation.

Exposure to impulsive noise may be more hazardous to hearing than continuous (non-impulsive) noise. For marine mammals, National Marine Fisheries Service (NMFS) issued a Technical Guidance document that provides acoustic thresholds for the onset of TTS and PTS in marine mammal hearing for all sound sources (NMFS 2018). Southall et al. (2019) published an updated set of criteria for onset of TTS and PTS in marine mammals. While the authors propose a new nomenclature and classification for the marine mammal functional hearing groups, the proposed thresholds and weighting functions for exposure to underwater sound do not differ in effect from those proposed by NMFS (2018). These thresholds that detail receptor noise impacts and behavioural response for continuous noise (MODU, vessels) and impulsive noises (VSP) are summarised in Table 6-3 and Table 6-6.

**Table 6-6: Impulsive Noise: Unweighted SPL, SEL24h and PK Thresholds for Acoustic Effects on Low-frequency Cetaceans**

| Hearing Group | NOAA (2019) | NMFS (2018); Southall et al., (2019) | | | |
|---|---|---|---|---|---|
| | Behaviour | PTS onset thresholds (received level) | | TTS onset thresholds (received level) | |
| | SPL (Lp; dB re 1 µPa) | Weighted SEL24h (LE,24h; dB re 1 µPa2·s) | PK (Lpk; dB re 1 µPa) | Weighted SEL24h (LE,24h; dB re 1 µPa2·s) | PK (Lpk; dB re 1 µPa) |
| Low-frequency cetaceans | 160 | 183 | 219 | 168 | 213 |
| High-frequency cetaceans | | 185 | 230 | 170 | 224 |

Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. Hence, it is difficult to determine thresholds for behavioural response in individual cetaceans as the way they respond often varies (Nowacek et al. 2004, Gomez et al. 2016, and Southall et al. 2019) and is influenced by both biological and environmental factors. Observed disturbance responses to anthropogenic sound in cetaceans include altered swimming direction; increased swimming speed including pronounced 'startle' reactions; changes to surfacing, breathing and diving patterns; avoidance of the sound source area and other behavioural changes. The Behavioural Response of Australian Humpback Whales to Seismic Survey's (BRAHSS) found short-term changes in the behaviour of migrating humpback whales that were exposed to seismic air guns. These changes in behaviour included dive behaviour (making less progress southwards) and social behaviour, however the study noted that no 'abnormal' behaviours were noted (e.g. groups turning and migrating in the opposite direction, groups ceasing to migrate or moving at high speed, abnormally high or low rates of surface behaviours, cessation of breeding interactions etc. (Cato et al, 2019). Humpback whale populations have increased since being placed on the threatened species list for exploitation from whaling, resulting in a higher abundance of species off our Western Australian coastline. Humpback whales have been able to thrive and increase in numbers despite the heavy oil and gas exploration. A study presented by Bejder et al (2016) has prompted a review of the species being down listed under Commonwealth legislation and regulations, as they are not eligible for listing as a threatened species under all statutory criteria.

Although there is the potential for a larger number of cetaceans to be present during migration periods exposure to sound levels above the behavioural response thresholds for impulsive sound is not expected to significantly affect migration behaviours. Studies on the effect of seismic surveys on humpback whales (Dunlop et al. 2017) found that although no gross changes in migration paths were observed, behavioural and avoidance reactions to the sound source were documented. There is currently a lack of scientific evidence to validate potential behavioural impacts to blue whales from exposure to impulsive sound sources (DoE 2015). Effects of impulsive sound sources on blue whales are anticipated to be similar to that observed by humpback whales. The known blue whale migration pathways do not include areas which are characterised by narrow corridors or bottlenecks resulting from physical and other barriers (DoE 2015; TSSC 2015a).

The area affected by sound levels that may result in behavioural responses (10 km of the source), overlap parts of the blue whale migration BIA; however, it is in open ocean with no obstacles to prevent movement of cetaceans transiting through or near the indicative well locations. Therefore, potential behavioural responses from the short duration VSP activity are expected to be limited to temporary and insignificant avoidance reactions by migrating cetaceans.

Given the potential for impacts to sensitive species, the impacts have been assessed as **Minor (2)**. Western Gas will adopt all legislative and best practise controls in order to sufficiently lower the risk of an impact to ALARP. No additional controls have been identified which further reduce the impact to marine mammals.

Injury / Mortality to fauna

Using the NMFS guidance for pulsed sound, a permanent threshold shift (PTS) and TTS limit of 219- and 213-dB SPL PK is adopted, respectively (NFMS, 2016) (Table 6-6). The bubble model calculated received dB SPL PK greater than 219- and 213-dB SPL PK as within 10 m and 60 m of the source, respectively, based on the maximum impulsive sound source level of 239 dB re 1 µPa @ 1 m RMS (NOAA 2018).

The estimated range for potential TTS or PTS to marine mammals is within the migratory BIA for blue whales however does not overlap known or possible foraging areas for Blue Whales (CoA 2017a). The likelihood a low frequency and moderate frequency cetacean to be within close enough proximity for TTS or PTS to occur due to sound from the stationary VSP source or moving vessel and remain within this range for a significant duration is negligible. A behavioural response (avoidance) is likely to occur prior to a marine mammal coming close to the vessel while undertaking the activity. Although the operational area is located in a BIA for the pygmy blue whale, this represents a very small proportion of the overall BIA and is unlikely to disrupt migration. The area is not known as a BIA for pygmy blue whale foraging, however regardless the small area and temporary nature of the activity is not likely to impact on foraging, should this occur. The activity is not predicted to result in impacts to species that would be inconsistent with recovery plans or conservation advices.

Given the small area of disturbance, the short time frame of the activity (approximately 4 hours) and the controls adopted, any impacts have been assessed as **Slight (1).**

**Marine Reptiles**

Change in fauna behaviour

Five listed threatened species of marine turtle (loggerhead turtle [E], green turtle [V], leatherback turtle [E], hawksbill turtle [V] and flatback turtle [V]) are likely to be present in the Operational Area. The Recovery Plan for Marine Turtles in Australia 2017-2027 (DEE 2017) lists noise disturbance from acute and chronic sources as a threat. Noise generated by the petroleum activity will be chronic noise, which is considered a threat to marine turtles as it may lead to avoidance of important habitats. Important habitats such as nesting sites do not occur within the Operational Area, and critical behaviours such as internesting are unlikely to occur within the Operational Area, therefore no ecosystem or population level effects and no threat to recovery of species are expected.

Studies show that behavioural responses by marine turtles from impulsive sound, including rising to the surface and altered swimming patterns, have been elicited in caged animals exposed to a seismic sound source at received levels of 153 dB SEL (McCauley et al. 2000), estimated to be within 1 km of the source, which is a conservative source in comparison to VSP.

The area affected by sound levels that can cause behavioural responses does not contain critical habitat or BIAs for marine turtles and is in open ocean where marine turtles can move away from increased sound levels. It is anticipated that potential sound generated behavioural effects on marine turtles is unlikely to have a significant impact on individuals or at a population level.

The recommended criteria for impulsive sound sources are shown in Table 6-7.

**Table 6-7: Acoustic effects of impulsive noise on sea turtles: Unweighted SPL, SEL24h, and PK thresholds**

| **NFS (2011)** | **Moein et al. (1995), McCauley et al. (2000)** | **Finneran et al. (2017)** | | | |
|---|---|---|---|---|---|
| Behaviour | | PTS onset threshold | | TTS onset threshold | |
| SPL ($L_p$; dB re 1 µPa) | | Weighted $SEL_{24h}$ ($L_{E,24h}$; dB re 1 $\mu Pa^2 \cdot s$) | PK ($L_{pk}$; dB re 1 µPa) | Weighted $SEL_{24h}$ ($L_{E,24h}$; dB re 1 $\mu Pa^2 \cdot s$) | PK ($L_{pk}$; dB re 1 µPa) |
| 166 | 175 | 204 | 232 | 189 | 226 |

Given the potential for impacts to sensitive species, the impacts have been assessed as **Minor (2).** Western Gas will adopt all legislative and best practise controls in order to sufficiently lower the risk of an impact to ALARP. No additional controls have been identified which further reduce the impact to marine reptiles.

Injury / mortality to fauna

Finneran et al. (2017) presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS) (Table 6-7). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol & Ketten, 2006; Dow Piniak et al. 2012; Martin et al. 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al. 2014).

Using the NMFS guidance for pulsed sound, a PTS limit of 207 dB SPL PK is adopted (NFMS, 2016). The bubble model calculated received SPL levels greater than 207 dB SPL PK as within 130 m of the source, based on the maximum impulsive sound source level of 239 dB re 1 µPa @ 1 m RMS.

There is a high risk of TTS to marine reptiles within tens of metres of the source (Popper et al. 2014). These ranges do not overlap any critical habitat or BIA for marine reptiles. With only low numbers of individual marine reptiles transiting the area, no population level effects would be expected.

A behavioural response (avoidance) is likely to occur prior to marine reptiles coming close to the MODU or ROV while conducting VSP or sonar activities. It is therefore expected that marine turtles will not experience TTS, mortality and potential mortal injury from the drilling activity. Any impacts will be **Slight (1).**

### 6.4.3 Control measures ALARP and acceptability assessment

| Control, ALARP and acceptability assessment: Loss of well control | |
|---|---|
| **ALARP decision context and justification** | **ALARP Decision Context: Type A**<br>Exploration drilling is a standard offshore activity. Drilling activities are highly regulated with associated control measures, well understood, and are implemented across the offshore industry.<br>During stakeholder engagement, no concerns were raised regarding the acceptability of impacts from these events. |
| **Adopted Control Measures** | **Source of good practice control measures** |
| **Preventative** | |
| **CM 8** : Marine Fauna Observer | At least one trained MFO will be on active duty during daylight hours when VSP activities are undertaken. |
| **CM9** : VSP adaptive management procedure | Management procedures implemented during VSP will include :<br>• Pre-start monitoring: visual observations will be conducted out to the extent of the observation zone (3 km horizontal radius from the VSP acoustic source) for at least 30 minutes before commencing the soft start.<br>• Start up: Soft starts of VSP will occur if no cetaceans have been sighted within the shutdown zone (500m).<br>• Operations and shutdown: The MFO on active duty will monitor the observation zone (3km) and shutdown zone (500m) and ensures VSP activities are shutdown if there is a cetacean sighting within the shutdown zone.<br>• Low-visibility / night-time: VSP can only commence at night if during the preceding 24-hour period there have been fewer than three cetacean instigated shutdowns and there was a two-hour period of no sightings in the observation zone. |

| Additional controls assessed | | | |
|---|---|---|---|
| **Control Measure** | **Environmental Benefit** | **Potential Cost/Issues** | **Evaluation** |
| Dedicated Marine Fauna Observer on vessels | Improved ability to spot and identify marine fauna at risk of impact by VSP. | Additional cost of contracting several specialist Marine Fauna Observers while the risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species. | Not adopted<br>Cost disproportionate to increase in environmental benefit and given that crew member will be observing for marine fauna during VSP activities (refer to Section 6.4). |
| Use of Passive acoustic monitoring (PAM) | Improve detection of some sensitive receptors. | Costs of PAM operators. | Not adopted<br>Cost disproportionate to increase in environmental benefit given the low-level behavioural response expected. |

| | | | |
|---|---|---|---|
| Scheduling activities to avoid coinciding with sensitive periods for marine fauna which may be present. | Avoiding peak periods for species (such as migration) will reduce a potential for impact. | Costs of scheduling and managing logistics of reorganising activities. | Not adopted<br><br>While avoiding peak periods for species (such as migration) will reduce a potential for impact, there are high costs and logistical constraints associated with varying the timing of the activities. The costs associated with this are disproportionate to the low – level behavioural risk predicted from the MODU and vessel operations. |

| **Acceptability assessment** | |
|---|---|
| **To meet the principles of ESD** | Impacts assessed as Minor to Slight and are considered to be ALARP. Although the operational area is located in a BIA for the pygmy blue whale, this represents a very small proportion of the overall BIA and is unlikely to disrupt migration. The area is not known as a BIA for pygmy blue whale foraging, however regardless the small area and temporary nature of the activity is not likely to impact on foraging, should this occur. |
| **Internal context** | Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures. |
| **External context** | No stakeholder objections or claims have been raised. |
| **Other requirements** | Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br><br>The activity is not predicted to result in impacts to species that would be inconsistent with recovery plans or conservation advices. |
| **Monitoring and reporting** | The activity will not impact the long term survival and recovery of listed and threatened marine species and will be undertaken in accordance with all applicable management actions. |
| **Acceptability outcome** | Acceptable |

## 6.5 ACCIDENTAL RELEASE – LOSS OF WELL CONTROL

During activities associated with the Sasanof-1 Exploration Drilling, an accidental release due to loss of well control may occur.

### 6.5.1 Aspect Source

Activities which may lead to an accidental release due to loss of well control include:

- Well design and drilling operations

#### 6.5.1.1 Well Design and Drilling Operations

During drilling, pressure is maintained in the wellbore to prevent the flow of formation/reservoir fluids into the wellbore. If uncontrolled, an unplanned entry of water, gas or oil into the wellbore may expand and rise rapidly due to being lighter than the surrounding fluids and the resulting decreasing wellbore pressure. To retain control of the formation fluids, a blow-out preventor

(BOP) may be closed. By closing the BOP and then increasing the mud density it is then possible to reopen the BOP and retain pressure control of the formation. Although very unlikely, a failure in this system may result in a loss of well control (LOWC) and an accidental release of reservoir hydrocarbons.

### 6.5.2 Oil Spill Modelling

Oil spill modelling (Section 4.2.1) indicates that a number of ecological and socio-economic receptors have the potential to be exposed to in-water (entrained) and in-water (floating) hydrocarbons in a LOWC event.

No shoreline contact was predicted, consequently no shoreline accumulation related impacts are discussed in this section.

No in-water (dissolved) hydrocarbon exposure was predicted above the low threshold in the top 30 m of the water column, consequently no in-water (dissolved) hydrocarbon related impacts are discussed in this section.

### 6.5.3 Risk Evaluation

An accidental release of hydrocarbons has the potential to result in the following impacts:

- change in water quality
- change in sediment quality
- change in habitat.

As a result of a change in water quality, sediment quality and/or habitat, further impacts may occur, which include:

- change in fauna behaviour
- injury / mortality to fauna
- changes to the functions, interests or activities of other users

#### 6.5.3.1 Likelihood Assessment

Western Gas follows processes that provide rigour in implementing and testing of barriers. Barriers are identified and criteria for determining their performance, such as performance standards, will be established. These performance criteria are tested through existing operational processes, e.g. maintenance and inspection programs. These in turn are supported by self-verification activities, or assurance activities, as described in the WOMP.

On this basis, Western Gas deems the likelihood of a LOWC event to be **Rare (A)**.

#### 6.5.3.2 Change in Water Quality

An accidental release of condensate from LOWC has the potential to result in a change in water quality due to exposure to in-water (entrained) and in-water (floating) hydrocarbons.

Details on oil fate and weathering is provided in Section 4.2.1.1 which highlights that in a LOWC event in-water (entrained) hydrocarbons have the potential to affect the largest area over a limited period. It is anticipated that approximately 104,561 bbl (4%) of in-water (entrained) hydrocarbons was predicted to remain within the water column at the conclusion of the simulation (day-141). The 4% of in-water (entrained) hydrocarbons is expected to persist and be subject to relatively slow degradation and may persist for weeks to months.

The extent of in-water (entrained) hydrocarbons was predicted to be limited to the top 30 m of the water column within a maximum range of 705 km from the well location.

The consequence to water quality is considered **Severe (3)** given the extensive area affected with the potential to illicit environmental impacts which can persist for weeks to months.

#### 6.5.3.3 Change in Habitat

Accidental release of hydrocarbons from LOWC would result in a change in habitat for seabed receptors such as corals, macroalgae and seagrass communities. Stochastic modelling predicts exposure of these habitats to in-water (entrained) hydrocarbons above exposure thresholds. Recovery of benthic habitats and communities is expected to occur. The potential impacts to these receptors associated with exposure to in-water (entrained) hydrocarbons is summarised in Table 6-8.

**Table 6-8: Potential impacts to seabed habitat receptors from LOWC**

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| **Coral** | Experimental studies and field observations indicate all coral species are sensitive to the effects of oil, although there are considerable differences in the degree of tolerance between species (e.g. NOAA 2010). Differences in sensitivities may be due to depth, the ease with which oil adheres to the coral structures, the degree of mucous production and self-cleaning, or simply different physiological tolerances (e.g. branching corals appear to have a higher susceptibility than massive corals or corals with large polyps).<br><br>Physical oiling of coral tissue can cause a decline in metabolic rate and may cause varying degrees of tissue decomposition and death (Negri & Heyward 2000). Direct contact of coral by oil may also impair respiration and photosynthesis by symbiotic zooanthellae (Peters 1981; Knap et al. 1985). | Severe (3) |
| **Macroalgae** | Physical contact with entrained hydrocarbon droplets could cause sub-lethal stress, causing reduced growth rates and reduced tolerance to other stress factors (Zieman et al., 1984). In macroalgae, oil can act as a physical barrier for the diffusion of $CO_2$ across cell walls (O'Brian & Dixon 1976). The effect of oil however is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to algae, which will vary depending on the oils physical state and relative 'stickiness'. | Severe (3) |
| **Seagrass** | Seagrass may be exposed to oil by direct contact (i.e. smothering). 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). | Severe (3) |

Studies undertaken after the Montara incident included diver surveys to assess the status of Ashmore, Cartier and Seringapatam coral reefs. These found that other than a region-wide coral bleaching event caused by thermal stress (i.e. caused by sea water exceeding 32°C), the condition of the reefs was consistent with previous surveys, suggesting that any effects of oil reaching these reefs was minor, transitory or sub-lethal and not detectable (Heyward et al. 2010). This is despite AMSA observations of surface slicks or sheen nears these shallow reefs during the spill (Heyward et al. 2010). Surveys in 2011 indicated that the corals exhibiting bleaching in 2010 had largely survived and recovered (Heyward et al. 2012), indicating that potential exposure to hydrocarbons while in an already stressed state did not have any impact on the healthy recovery of the coral.

Other studies have indicated that oiled kelp beds had a 90% recovery within 3-4 years of impact, however full recovery to pre-spill diversity may not occur for long periods after the spill (French-McCay 2004).

Given the details above and potential extent, the consequence level for change in habitat has been assessed to be **Severe (3)**.

#### 6.5.3.4 Injury / Mortality to Fauna

As a result of change in water quality and change in habitat, injury / mortality to fauna could occur to receptors from exposure to:

- In-water (floating) hydrocarbon exposure to airbreathing and surface foraging fauna such as birds, fish and sharks, marine reptiles, marine mammals.
- In-water (entrained) hydrocarbon exposure to fauna within the water columns such as plankton, fish and sharks, marine reptiles, marine mammals.

**In-water (Floating) Hydrocarbons**

The potential impacts from exposure in-water (floating) hydrocarbons above exposure thresholds are summarised in Table 6-9.

**Table 6-9: Potential impacts to fauna from exposure in-water (floating) hydrocarbons from LOWC**

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| **Birds** | Birds at sea (e.g. foraging, resting) have the potential to directly interact with surface oils. Seabird species most at risk include those that readily rest on the sea surface (e.g. shearwaters) and surface plunging species (e.g. terns, boobies).<br><br>Direct contact with oils can foul feathers, which may subsequently result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair waterproofing. Direct contact with surface oil may also result in dehydration, drowning and starvation (DSEWPC 2011b; AMSA 2013b). Oiling of birds can also suffer from damage to external tissues, including skin and eyes, as well as internal tissue irritation in their lungs and stomachs. Toxic effects on birds may result where oil is ingested as the bird attempts to preen its feathers, or via consumption of oil-affected prey. Whether this toxicity ultimately results in mortality will depend on the amount consumed and other factors relating to the health and sensitivity of the particular bird species.<br><br>The maximum distance from the source predicted for floating oil at levels with the potential to affect marine fauna (moderate and high) is 63 km (Hydrocarbon Exposure Area) which intersects with breeding or foraging BIAs for the Wedge-tailed Shearwater, Lesser Frigatebird, Lesser Crested Tern, Roseate Tern, Fairy Tern and the White-tailed Tropicbird.<br><br>The presence of offshore aggregation areas for seabirds may result in population level impacts. It has been observed that chronic oil spill effects to some bird species persisted for at least two decades until population recovery was achieved (Esler et al. 2018).<br><br>The consequence level of potential injury/mortality to birds is considered to be **Severe** given the extensive area affected with the potential for population affects. | Severe (3) |
| **Fish and Sharks** | Most fish do generally not break the sea surface and are therefore not at risk from surface oil slicks. However, some shark species, such as the whale shark, tend to feed close to the surface. Whale sharks feeding within in-water (floating) hydrocarbons have direct exposure | Severe (3) |

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| | to floating oil, including consumption of oil-contaminated prey, which may result in possible population effects (DPAW 2013). A foraging BIA for the whale shark was identified as intersecting with the surface oil exposure area. The whale sharks are known to routinely move between surface and to depths or >30 m, and in offshore regions can spend most of their time near the seafloor (DSEWPC 2012).<br><br>The consequence level of potential injury/mortality to fish and sharks is considered **Severe** given the extensive area affected with the potential for population affects. | |
| **Marine Reptiles** | Marine reptiles (e.g. turtles, sea snakes) can be impacted by surface exposure when 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).<br><br>The area of exposure intersected with part of an internesting BIA for the loggerhead, green, hawksbill and flatback turtle. The species would typically be present during summer season and using the area for mating and foraging activities between nesting attempts. Turtles are predominately carnivorous and therefore typically forage within the water column or near the seabed rather than the surface waters; therefore, reducing any potential impact from surface oil exposure.<br><br>The consequence level of potential injury/mortality to marine reptiles is considered **Severe** given the extensive area affected with the potential for population affects. | Severe (3) |
| **Marine Mammals** | Marine mammals (e.g. cetaceans, dugongs) may be impacted by surface exposure when they surface to breathe. Marine mammals can be exposed to oil externally (e.g. swimming through surface slick) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Direct contact with surface oil is considered to have little deleterious effect on whales, possibly due to the skin's effectiveness as a barrier to toxicity. Furthermore, effect of oil on cetacean skin is probably minor and temporary (Geraci & St Aubin 1982).<br><br>Impacts from ingested oil and subsequent lethal or sub-lethal toxicity are possible; however, the susceptibility of cetaceans varies with feeding habits (e.g. baleen whales feed by surface skimming; however toothed whales and dolphins gulp feed at depth).<br><br>There is a migration BIA for the Pygmy blue whale that intersects with the in-water (floating) hydrocarbon exposure. 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. The known Blue Whale migration pathways do not include areas which are characterised by narrow corridors or bottlenecks resulting from physical and other barriers (DoE 2015; TSSC 2015).<br><br>The consequence level of potential injury/mortality to marine mammals is considered **Minor** given the extensive area affected with the unlikely potential for chronic effects. | Minor (2) |

Given the transient nature of any presence of marine fauna within the in-water (floating) hydrocarbon exposure area, recovery of any impacted surface water associated receptors is expected to occur. No confirmed reports of impacts to marine wildlife were received or surveyed during the Montara oil spill scientific monitoring studies (UniQuest 2010).

Given the details above and potential extent of in-water (floating) hydrocarbons, the consequence level for injury / mortality to fauna has been assessed to be **Severe (3)**.

### In-water (Entrained) Hydrocarbons

The potential impacts from exposure to in-water (entrained) hydrocarbons above exposure thresholds are summarised in Table 6-10.

**Table 6-10: Potential impacts to fauna from exposure in-water (entrained) hydrocarbons from LOWC**

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| Plankton | While plankton can occur throughout the water column, they are generally more abundant in the surface layers; this coincides with the area predicted to be exposed to entrained and dissolved oils. Surface waters of the NWS are typically low in nutrients and plankton abundance is low; however, in areas of greater vertical mixing (e.g. upwelling along the shelf edge, or around some reefs/shoals) there is likely to be a higher abundance of plankton.<br><br>Phytoplankton are typically not sensitive to oil, though they do accumulate it rapidly (Hook et al. 2016). Phytoplankton exposed to hydrocarbons may directly affect their ability to photosynthesize and impact for the next trophic level in the food chain (Hook et al., 2016).<br><br>Zooplankton (microscopic animals such as rotifers, copepods and krill that feed on phytoplankton) are vulnerable to hydrocarbons (Hook et al., 2016). Water column organisms may be impacted by oil via exposure through ingestion, inhalation and dermal contact (NRDA 2012), which can cause immediate mortality or declines in reproduction (Hook et al. 2016). Lethal and sublethal effects on zooplankton include narcosis, alterations in feeding, development, and reproduction (Almeda et al. 2013).<br><br>Plankton populations have evolved to respond to environmental perturbations by copious production within short generation times (ITOPF 2011; UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions. Reproduction by survivors or migration from unaffected areas is likely to rapidly replenish losses (Volkman et al., 2004). Oil spill field observations show minimal or transient effects on plankton (Volkman et al., 2004).<br><br>Impacts to plankton are therefore assessed to result in extensive damage to a non-sensitive environment, which can however be restored to an equivalent capability in a period of around 1 year.<br><br>The consequence level of potential injury/mortality to plankton is considered **Minor** as they could be expected to cause short-term and localised impacts, but not affecting local ecosystem functioning. | Minor (2) |
| Fish and Sharks | Exposure to entrained oil in the water column can be toxic to fish. Fish can be exposed to oil through a variety of pathways, including direct dermal contact (e.g. swimming through oil); ingestion (e.g. directly or via oil-affected prey/foods); and inhalation (e.g. elevated dissolved contaminant concentrations in water passing over the gills). Studies have shown a range of impacts including changes in abundance, decreased size, inhibited swimming ability, changes to oxygen consumption and respiration, changes to reproduction, immune system responses, DNA damage, visible skin and organ lesions, and increased parasitism. However, | Minor (2) |

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| | many fish species can metabolize toxic hydrocarbons, which reduces the risk of bioaccumulation (NRDA 2012). In addition, very few studies have demonstrated increased mortality of fish as a result of oil spills (Fodrie et al. 2014, Hjermann et al. 2007, IPIECA, 1997).<br><br>Demersal fish within the hydrocarbon exposure area are not expected to be impacted given the presence of entrained oil is predicted in the surface layers (<30 m depth) only. However, pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because entrained 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.<br><br>The hydrocarbon exposure area is within a whale shark foraging BIA. Whale shark are surface feeders, and may be affected by in-water hydrocarbon exposure and secondary impacts from changes in prey availability.<br><br>The consequence level of potential injury/mortality to fish and sharks is considered **Severe** given the extensive area affected and potential for acute impacts. | |
| Marine Reptiles | Marine reptiles (e.g. turtles, seasnakes) can be exposed to oil externally (e.g. swimming through) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Effects of oil include increased mortality and developmental defects; and negative impacts to the skin, blood, digestive and immune systems, and salt glands.<br><br>There are a number of BIAs for turtle species (loggerhead, flatback, green and hawksbill) that occur within this area of exposure. However, turtles are more susceptible to surface and shoreline oil, than the dissolved and entrained components.<br><br>The consequence level of potential injury/mortality to fish and sharks is considered **Severe** given the extensive area affecting a number of turtle BIAs. | Severe (3) |
| Marine Mammals | Marine mammals can be exposed to oil externally (e.g. swimming through oil) or internally (e.g. swallowing the oil, consuming oil affected prey).<br><br>Impacts from ingested oil and subsequent lethal or sub-lethal toxicity are possible; however, the susceptibility of cetaceans varies with feeding habits. Baleen whales feed by surface skimming; however, 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 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.<br><br>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 BIAs identified for the Pygmy blue (migration and foraging) and Humpback (migration and resting) whales within this exposure area. Oil in biologically important habitats may disrupt natural behaviours, displace animals, reduce foraging or reproductive success rates and increase mortality. | Severe (3) |

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| | 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).<br><br>The consequence level of potential injury/mortality to fish and sharks is considered **Severe** given the extensive area affecting a number of marine mammal BIAs. | |

Given the transient nature of any presence of marine fauna within the in-water (entrained) hydrocarbon exposure area, recovery of any impacted surface water associated receptors is expected to occur. No confirmed reports of impacts to marine wildlife were received or surveyed during the Montara oil spill scientific monitoring studies (UniQuest 2010).

Given the details above and potential extent of in-water (entrained) hydrocarbons, the consequence level for injury / mortality to fauna has been assessed to be **Severe (3)**.

#### 6.5.3.5 Change to Values and Sensitivities

As a result of change in water quality, change in habitat and injury / mortality to fauna; changes to the values and sensitivities of socio-economic receptors could occur from exposure to hydrocarbons from LOWC.

Stochastic modelling indicates that a number of socio-economic receptors have the potential to be exposed to hydrocarbon concentrations above exposure thresholds. A summary of the types of impacts and assessed consequence levels for these receptors is evaluated in Table 6-11.

**Table 6-11: Potential impacts to fauna from exposure in-water (entrained) hydrocarbons from LOWC**

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| Australian Marine Parks<br><br>State Marine Protected Areas | Marine protected areas may be vulnerable to oil exposure from a spill event. As the values and sensitivities of these protected places are a combination of quality, habitat, marine fauna and flora, and human use, the impact pathways are varied. Refer also to impact assessments for related receptors, including benthic habitats and communities and marine fauna.<br><br>Australian Marine Park that may be exposed to surface oil is the Gascoyne MP. The AMPs Argo-Rowley Terrace, the Carnarvon Canyon and the Ningaloo may also be exposed to in-water oil within the surface (<30 m) water layers. The probability of exposure was variable between the parks (Table 4-6).<br><br>No surface oil was predicted to occur for State marine protected areas. Six marine parks (Montebello Islands MP, Barrow Islands MP and MMA, Muiron Islands MMA and Ningaloo MP) may be exposed to in-water oil within the surface (<30 m) water layers; probability of exposure was variable between the parks (Table 4-6).<br><br>Potential impacts range from a temporary decrease in aesthetic values (e.g. from visible surface oil slicks) to physical coating and/or toxicity effects associated with the values of the marine protected area (e.g. marine fauna, benthic habitats etc.). Impacts resulting from in-water oil to pelagic values (e.g. marine fauna) are restricted to those in surface waters only.<br><br>Given the details above and potential extent, the consequence level for marine protected areas has been assessed to be **Severe**. | Severe (3) |
| KEFs | KEFs may be vulnerable to oil exposure from a spill event. As the values and sensitivities of these protected places are often a combination of quality, habitat, marine fauna and flora, the impact pathways are varied. Refer also to impact assessments for related receptors, including benthic habitats and communities and marine fauna.<br><br>Given the stochastic modelling predicted that all in-water oil exposure would remain in the surface (<30 m) layers, those KEFS associated with deeper water and/or benthic features are not expected to be impacted. Three KEFs were identified as potentially being exposed to in-water oil:<br><br>• Commonwealth waters adjacent to Ningaloo Reef<br>• Glomar Shoals<br>• Commonwealth marine environment surrounding the Houtman Abrolhos Islands.<br><br>The probability of exposure was variable between the parks (Appendix C).<br><br>The actual area of exposure for an individual spill event will be relatively small, with exposure shown to be transient and temporary due to the influence of waves, currents and weathering processes.<br><br>Given the details above and potential extent, the consequence level KEFs has been assessed to be **Severe**. | Severe (3) |
| Commercial Fisheries | Oil spills can damage fishery resources through physical contamination, toxic effects on stock and by disrupting business activities. Refer also to impact assessments for related receptors, including benthic habitats and communities and fish and sharks. | Severe (3) |

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| | 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).<br><br>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. Oil spills may also foul fishing equipment (e.g. traps and trawl nets) and requiring cleaning or replacement; however due to the volatility of condensate, this is not expected to occur.<br><br>Given the details above and potential extent, the consequence level for commercial fisheries has been assessed to be **Severe**. | |
| Marine and Coastal Industries | Marine and coastal industries in the area of exposure mainly consist of petroleum activities, commercial shipping and defence activities.<br><br>In the event of a large spill, an exclusion zone may be established within the immediate vicinity of the spill-affected area. However, as the condensate is subject to rapid evaporation the exclusion zone is likely to be temporary, thus minimising the impacts to these developments.<br><br>There are defence practice and training areas that extend offshore from Learmonth RAAF base. In-water hydrocarbon exposure is not expected to adversely impact the use of these areas.<br><br>Given the details above and potential extent, the consequence level for other industries has been assessed to be **Severe**. | Severe (3) |
| Recreation and Tourism | Due to the small spatial extent of in-water (floating) hydrocarbons, and its occurrence beyond State waters, direct impacts to the recreation and tourism industry associated with a reduction in aesthetics are not expected.<br><br>In-water (entrained) hydrocarbon exposure does extend into some State water areas and therefore in-direct impacts may occur. Activities common in the area include recreational and charter fishing, marine fauna watching and diving. Consequently, these impacts are related to any changes in ecological receptors (e.g. marine fauna, benthic habitats and communities) that may occur as a result of in-water (entrained) hydrocarbon exposure; refer also to impact assessments for the related receptors.<br><br>Any disruption to activities such as vessel activities, fishing and diving can have follow-on effects on accommodation, tourism business and other companies who gain their livelihood from tourism. However, given the limited exposure and predicted impact to ecological receptors, this type of impact is not expected to occur.<br><br>Given the details above and potential extent, the consequence level for recreation and tourism has been assessed to be **Severe**. | Severe (3) |
| Heritage and Cultural Features | Heritage listed places may be vulnerable to oil exposure from a spill event. As the values and sensitivities of these protected places are a combination of quality, habitat, marine fauna | Severe (3) |

| Affected Receptor | Consequence Evaluation | Consequence Level |
|---|---|---|
| | and flora, and human use, the impact pathways are varied. Refer also to impact assessments for related receptors, including benthic habitats and communities and marine fauna.<br>There are no heritage or cultural features predicted to be exposed to visible surface oil (>1 g/m2), therefore, no aesthetic impacts are expected to occur.<br>The Ningaloo Coast World and National heritage area and Ningaloo Marine Area may be exposed to entrained oil components in the event of LOWC event. Potential impacts may include physical coating and/or toxicity effects associated with the values of the respective areas (e.g. marine fauna, coastal habitats etc.).<br>There are also known shipwrecks within the predicted area of entrained and dissolved oil exposure. However, stochastic modelling indicates that in-water oil exposure is limited to surface (<30 m) layers, therefore no impact to known shipwrecks is expected to occur.<br>Given the details above and potential extent, the consequence level for heritage areas has been assessed to be **Severe**. | |

Given the details above, the consequence level for change in values and sensitivities has been assessed to be **Severe (3)**.

### 6.5.4 Control measures ALARP and acceptability assessment

| Control, ALARP and acceptability assessment: Loss of well control | |
|---|---|
| **ALARP decision context and justification** | **ALARP Decision Context: Type B**<br>Exploration drilling is a standard offshore activity. Drilling activities are highly regulated with associated control measures, well understood, and are implemented across the offshore industry.<br>During stakeholder engagement, no concerns were raised regarding the acceptability of impacts from these events. However, a LOWC incident would likely attract public and media interest. Consequently, Western Gas believes that ALARP Decision Context B should be applied. |
| **Adopted Control Measures** | **Source of good practice control measures** |
| **Preventative** | |
| **CM 1:** Pre-start notifications | Under the Navigation Act 2012, the Australian Hydrographic Service (AHS) are responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications such as Notices to Mariners. AMSA also issue AUSCOAST warnings.<br>Relevant details in relation to the drilling activity will be provided to the AHS and AMSA and to relevant stakeholders to ensure the presence of the MODU is known in the area.<br>See Section 9.6 (Ongoing Stakeholder Consultation). |
| **CM 28:** Well operations procedures | Western Gas have in place a Well Operations Procedure that ensures well activities are fit for purpose with operational risks managed to a level that is as low as reasonably practicable.<br>It also ensures that changes are made in a controlled manner, that appropriate standards are adhered to, and that a sufficiently resourced and competent organisation is in place. |

| | |
|---|---|
| **CM 30:** Maintain capability to operate BOP | BOP routinely function and pressure tested in accordance with manufacturer's specifications and in alignment with Drilling Contractors preventative maintenance System. |
| **Response** | |
| **CM 34:** Source Control Emergency Response Plan (SCERP) including Relief Well Plan | A SCERP shall be developed consistent with International Oil and Gas Producers (IOGP) Report 594 - Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (January 2019). Specifically detailing:<br>• The structure and function of the Western Gas Crisis Management Team (CMT) and Drilling Incident Management Team (DIMT);<br>• A timeline for the effective implementation of source control key events / actions;<br>• A well-specific worst-case discharge (WCD analysis);<br>• Casing design; and<br>• Structural integrity analysis |
| | A relief well plan shall be developed in line with OGUK guidance to ensure that Western Gas has considered the response requirements in order to:<br>• Reduce the time required to initiate relief well drilling operations in the event of a LOWC; and<br>• Allow the relief well to be completed in the shortest time practicable.<br>The relief well plan includes a detailed schedule with estimated times to:<br>• Source, mobilise and position a rig;<br>• Drill and intercept the well; and<br>• Complete the well kill successfully |
| **CM 33:** OPEP | Under the OPGGS(E)R, NOPSEMA require that the petroleum activity have an accepted Oil Pollution Emergency Plan (OPEP) in place before the activity commences. In the event of a LOWC, the OPEP will be implemented. |
| **CM 35:** OSMP | Under the OPGGS(E)R, NOPSEMA require that the Implementation Strategy of the Environment Plan provides for monitoring of an oil pollution emergency. The OSMP details:<br>• Operational monitoring to inform response planning; and<br>• Scientific monitoring to inform the extent of impacts from hydrocarbon exposure and potential remediation requirements. |

| **Additional controls assessed** | | | |
|---|---|---|---|
| **Control** | **Control type** | **Cost/benefit analysis** | **Control implemented?** |
| **Preventative** | | | |
| Do not drill the well | Elimination | Drilling of the exploration well is required to fulfil the commitments under the petroleum title. | No |
| Undertake activity at a different time of year to reduce potential exposure | Substitute | Based upon the probability of exposure to various receptors, and the volatile nature of the gas condensate, there is no discernible benefit to be gained by drilling at a different time of year given the similarity in potential | No |

| | | | |
|---|---|---|---|
| of receptors to hydrocarbons | | hydrocarbon exposure for both summer and winter seasons. | |
| **Source control** | | | |
| Reduce 80 days | Equipment | The period for drilling a relief well has been refined to 80 days based on a review of the proposed relief well design, potential relief well rigs and the required equipment and resources. | No |
| Alternate MODU on standby | Equipment | Any MODU on location would require an in-force Safety Case to operate in Australian Commonwealth waters.<br>Having another rig on standby would result in significant additional costs (approx. $800k / day) to the project that that are considered grossly disproportionate to the level of environmental benefit gained given that no shoreline oiling is predicted. | No |
| Capping Stack System (CSS) | Equipment | Well CSS is designed to stem the hydrocarbon flow prior to permanent plugging of the well.<br>This option requires vertical access over the existing BOP/well. | Yes |
| Dispersant application | Equipment | Chemical dispersants are generally ineffective for gas-condensate hydrocarbon releases. Sub-surface dispersant application was considered in the early stages of LOWC spill response source control selection strategy, primarily as an aid for capping stack deployment. However, the subsea plume studies conducted by Western Gas show that with the combination of water depth, the VOC / LEL levels are low enough to allow vertical deployment of a capping stack. | No |
| **Consequence rating** | Serious (3) | | |
| **Likelihood of occurrence** | **Rare (A)** (1.5 x 10-4 drilled based upon exploration (appraisal) drilling normal gas wells drilled to North Sea Standard) ref IOGP Risk Assessment Data Directory Blowout Frequencies September 2019: https://www.iogp.org/bookstore/product/risk-assessment-data-directory-blowout-frequencies/ | | |
| **Residual risk** | Low | | |
| **Acceptability assessment** | | | |
| **To meet the principles of ESD** | The activities were evaluated as having the potential to result in a **Serious (3)** consequence, resulting in a **Low** risk rating. Low risks are acceptable, and not considered as having the potential to result in serious or irreversible environmental damage. Medium risks are considered tolerable and acceptable, provided efforts are made to reduce the risk to ALARP. This has been demonstrated in the section above with consideration and adoption of additional controls. These controls reduce the impacts to ALARP, and serious or irreversible environmental damage is not expected to receptors ranked as Medium risk. | | |
| **Internal context** | Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures. | | |

| | |
|---|---|
| **External context** | No stakeholder objections or claims have been raised. |
| **Other requirements** | Activities undertaken during the operation will adhere to the requirements for EPs and Oil Pollution Emergency Plans (OPEPs) under the OPGGS(E)R.<br>Offshore Petroleum and Greenhouse Gas Storage Act requires an accepted Well Operations Management Plan (WOMP) in place for all wells, which describes well integrity risk management process and well control measures.<br>Conservation Advice / Management Plans / Recovery Plans which list marine pollution as a threat include:<br>• Approved Conservation Advice for *Calidris canutus* (Red Knot);<br>• National recovery plan for threatened albatrosses and giant petrels 2011-2016; and<br>• Wildlife Conservation Plan for Migratory Shorebirds. |
| **Monitoring and reporting** | Impacts as a result of a hydrocarbon spill will be monitored and reported in accordance with the OSMP. |
| **Acceptability outcome** | Acceptable |

## 6.6 ENVIRONMENTAL PERFORMANCE OUTCOMES, PERFORMANCE STANDARDS AND MEASUREMENT CRITERIA

The Environmental Performance Outcomes, Environmental Performance Standards and Measurement Criteria relevant for the environmental management of all impacts and risks identified in Sections 6.2 and 6.3 are provided in Table 6-12.

**Table 6-12: EPOs, EPSs and MC for the Petroleum Activity**

| EPOs | Ref | Control Measure | EPSs | MC |
|---|---|---|---|---|
| **EPO 1:** Undertake the activity in a manner that will not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted | 1 | Pre-start notifications | The AHS will be notified no less than four working weeks before operations commence to enable Notices to Mariners to be published. | Notification records and communication records. |
| | 2 | On-going consultation | AMSA's Joint Rescue Coordination Centre (JRCC) will be notified 24–48 hours before operations commence to enable AMSA to distribute an AUSCOAST warning. | Notification records and communication records. |
| | | | Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 9 (Stakeholder Consultation). | Notification records and communication records. |
| **EPO 2:** Undertake the activity in a way that does not:<br>- Modify, destroy, fragment, isolate or disturb an important area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.<br>- Disturb the seabed outside of the operational area.<br>**EPO 3:** Undertake the activity in a way such that:<br>- No death or injury to fauna, including listed threatened or migratory species.<br>- Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area.<br>- Biologically important behaviours within a BIA or outside a BIA can continue.<br>- Result in a change in water quality, sediment quality or air quality outside of the operational area. | 3 | API RP 2SK - Mooring analysis | A mooring analysis shall be undertaken prior to anchoring. | Documented mooring analysis. |
| | 4 | Rig move and positioning plan | All mooring equipment to be within the operational area. Mooring equipment will not be deployed outside the area that has been surveyed as part of the site survey. | Documented mooring plan. |
| | 5 | Removal of subsea infrastructure | Upon well abandonment, all subsea equipment shall be removed from sea floor, with wellheads cut below mudline and retrieved to surface. | Drilling Report. |
| | | | Retrieval of all mooring equipment from the sea floor following the drilling campaign. | Drilling Report. |
| | 6 | Marine assurance system - vessel contractor pre-qualification assessment. | Ensures compliance of contract vessels with MARPOL, COLREGS, and Marine Orders 21, 30, 70, 71,72, 91, 95, 96, 97, 98. | Pre-mobilisation inspection report, including sighting of the relevant certificates. |
| | 7 | Planned Maintenance System | Power generation and propulsion systems on the vessels and MODU will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation. | PMS records. |
| | | | Equipment used to treat planned discharges shall be maintained in accordance with manufacturer's specification as detailed within the preventative maintenance system. | PMS records |
| | 8 | Marine Fauna Observer | At least one trained MFO will be on active duty during daylight hours when VSP activities are undertaken. | Records demonstrate MFOs presence during VSP activities for daylight hours. |
| | 9 | VSP adaptive management procedure | Pre-start monitoring: visual observations will be conducted out to the extent of the observation zone (3 km horizontal radius from the VSP | VSP operations report verifies that pre-start visual observations were conducted. |

| EPOs | Ref | Control Measure | EPSs | MC |
|---|---|---|---|---|
| | | | acoustic source) for at least 30 minutes before commencing the soft start. | |
| | | | Start up: Soft starts of VSP will occur if no cetaceans have been sighted within the shutdown zone (500m). | VSP operations report verifies soft-start procedures were applied for at least 20 minutes. |
| | | | Operations and shutdown: The MFO on active duty will monitor the observation zone (3km) and shutdown zone (500m) and ensures VSP activities are shutdown if there is a cetacean sighting within the shutdown zone. | VSP operations report verifies observation and shutdown zones were adhered to. |
| | | | Low-visibility / night-time: VSP can only commence at night if during the preceding 24-hour period there have been fewer than three cetacean instigated shutdowns and there was a two-hour period of no sightings in the observation zone. | VSP operations report verifies low-visibility procedures were implemented. |
| | 43 | EPBC Regulations 2000 | Vessels operators shall adhere to the distances and vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with dolphins specifically:<br>• Do not approach a dolphin.<br>• Maintain a distance of 150 m from a dolphin.<br>• If a dolphin approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal.<br>Vessels operators shall adhere to the vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with whales specifically:<br>• Do not approach a whale.<br>• Maintain a distance of 300 m from a whale.<br>• If a whale approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal.<br>Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on. | Induction records<br>DAWE cetacean sighting records |
| | 10 | Chemical Assessment Procedure | All planned discharges which contain chemical additives are PLONOR, 'D'/'E' (non-CHARM) or 'Gold'/'Silver' (CHARM) OCNS-rated. | Chemical Assessment records. |

| EPOs | Ref | Control Measure | EPSs | MC |
|---|---|---|---|---|
| | 11 | Use of WBM during riserless drilling | During riserless top-hole drilling operations seawater and viscous sweeps will be used to limit the volume of drilling chemicals discharged directly to sea. A simple water-based spud mud will be used to support the borehole prior to running the steel casing strings. | Daily drilling reports. |
| | 12 | No overboard discharge of whole SBM | No whole SBM will be discharged. Recovered SBM and SBM chemicals are to be recycled or sent to the mainland for treatment and/or disposal | Daily drilling reports. |
| | 13 | Solids Control Equipment | Appropriate shaker screen size and centrifuge speed for cuttings processing to manage %ROC | Records to show %ROC for discharged fluid is aligned with <8% requirement. Shaker screen sizes to be reported on the daily report. |
| | 14 | Solids control equipment operator | Ensure %ROC <8% per well sections drilled with SBM are verified by completing at least one full ROC test per 12- hour drilling period and recorded in accordance with API Recommended Practice 13B-2 Recommended Practice for Field Testing Oil-Based Drilling Fluids. | Records to show %ROC for discharged fluid is aligned with 8% requirement. |
| | 15 | Cementing procedures | Detailed cementing procedures will be developed before cementing activities commence | Cementing program developed. |
| | 16 | Report all fauna strikes | Any injury to, or mortality of, an EPBC Act Listed Threatened or Migratory species (including those from a vessel strike) will be reported to the DAWE within seven business days. | Reporting records confirm report made within 7 business days. |
| | 44 | Residual Materials Management | Residual barite, bentonite and cement will only be discharged at the end of the drilling if they will not be taken by the next drilling operator.<br>Residual barite, bentonite and cement will only be discharged as a slurry. | Correspondence with next operator<br>Daily drilling report |
| **EPO4:** No introduction of a known or potential invasive marine species | 17 | Pre-start audit of Australian Ballast Water Management Requirements Version 7 | MODU and support vessels shall have a valid Ballast Water Management Plan and ballast water management certificate. | Ballast water plan and certificate. |
| | 18 | National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry | Rental anchors and/or mooring equipment shall be cleaned prior to deployment to field. | In-water equipment checklist. |
| | | | Support vessels shall have a low-risk rating based on (or equivalent to) the WA Department of Fisheries Biofouling Risk Assessment Tool. | Documented biofouling risk assessment indicating 'low-risk' rating. |

| EPOs | Ref | Control Measure | EPSs | MC |
|---|---|---|---|---|
| | 19 | Biofouling Management Plan | A biofouling management plan and record book will be available for the MODU and each support vessel. | Review of the biofouling management plan and record books confirm they are in place and maintained. |
| | 20 | MODU already operating in Australian waters | The MODU for this petroleum activity will only be selected if is it currently operating in Australian Waters. | MODU records |
| **EPO5:** No unplanned discharge of waste to the marine environment. | 21 | Garbage management plan | A Garbage Management Plan will be in place and implemented for the MODU and support vessels. | Garbage Management Plan. |
| | 22 | Site induction | All crew will undertake site inductions that include a component on storing and handling hazardous materials and wastes. | Induction records. |
| **EPO6:** No spills of chemicals or hydrocarbons to the marine environment. | 23 | Bunded storage | Storage areas or containers are provided with secondary containment capacity in the event of a spill. | Inspection records. |
| | 24 | Bunkering procedure | Chemical and hydrocarbon bunkering shall be undertaken in accordance with Drilling Contractor bunkering procedures. | JHA records and bunkering records. |
| | 25 | Bunkering hoses and connections | Transfer hoses shall comprise of floating devices and self-sealing weak-link couplings in the mid-section of the hose string, in accordance with GOMO 0611- 1401 (2013). | Records demonstrate transfer hoses meet GOMO 0611-1401 requirements (2013). |
| | 26 | Crane transfer procedures | Crane transfer shall be undertaken in accordance with Drilling Contractor crane transfer procedure, including daylight lifting only. | JHA records. |
| | 27 | Well specific operating guidelines (WSOG) includes weather criteria for safe operations | Drilling operations shall be undertaken in accordance with Drilling Contractor Well specific operating guidelines (WSOG). | Records confirm that WSOG have been developed. |
| | 28 | Well Operations Procedures | Well Operations Procedure ensure well activities are fit for purpose with operational risks managed to a level that is as low as reasonably practicable. | Sasanof-1 Drilling Program in place. |
| **EPO 7:** Western Gas will maintain preparedness to respond in the unlikely event of a Tier 3 spill event. | 29 | Maintain capability to implement capping and containment operations | A well control specialist confirms availability to perform services to support capping and containment operations. | Contracts/memberships verify currency of contract and/or membership |
| | | | Capping and containment readiness (inc. safety case requirements) reviewed 2 months prior to spud. | Readiness review report. |
| | 30 | Maintain capability to operate BOP | The BOP shall be routinely function and pressure tested in accordance with manufacturer's specifications and in alignment with Drilling Contractors preventative maintenance system. | BOP maintenance records. |

| EPOs | Ref | Control Measure | EPSs | MC |
|---|---|---|---|---|
| | | | ROV contractors are under contract or pre-qualified for all source control activities. | Contracts or pre-qualification documents. |
| | 31 | Maintain capability to implement relief well operations | Mutual aid agreements in place which provide access to rigs operating in Australian waters to reduce relief well response time. | APPEA MOU signed and in place. |
| | | | A well engineering contractor confirms availability to perform services to support relief well operations. | Contracts/memberships verify currency of contract and/or membership |
| | | | Relief well readiness (inc. safety case requirements) reviewed 2 months prior to spud. | Readiness review report. |
| | 32 | SOPEP | Emergency response activities will be implemented in accordance with the vessel SOPEP (or equivalent). | Records confirm that emergency response activities were implemented in accordance with the vessel SOPEP. |
| | 33 | OPEP | Emergency spill response capability shall be maintained in accordance with the OPEP. | Outcomes of internal audits and tests demonstrate preparedness. |
| | 34 | SCERP | The SCERP shall be consistent with the International Oil and Gas Producers (IOGP) Report 594 - Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (2019). | Documented well-specific relief well plan developed in line with OGUK guidance prior to drilling. |
| | 35 | OSMP | Operational and scientific monitoring capability shall be maintained in accordance with the OSMP. | Outcomes of internal audits and tests demonstrate preparedness. |
| | 36 | Conduct Tier 3 Spill desktop exercise (inc. source control arrangements) | A Tier 3 spill desktop exercise is conducted 3 months prior to commencement of drilling activity. | Desktop exercise report confirms exercise conducted prior to commencement of drilling activity |
| | 37 | Maintain capability to implement MES in the event of a Tier 3 spill event | Tracking buoy located on MODU/vessel and is tested at least once prior to spud. | Testing record. |
| | | | Contracts or pre-qualification is in place for aircraft and at least two oil spill observers. | Contracts/memberships verify currency of contract and/or membership. |
| | | | Contracts or pre-qualification is in place OSMP service providers. | Contracts/memberships verify currency of contract and/or membership. |
| | 38 | Maintain OWR capability through contracts with AMOSC. | OWR activities are mobilised within 24 hours of notification. | Contracts/memberships verify currency of contract and/or membership. |
| | 39 | Notification of spill to relevant State authorities. | Undertake notification and reporting of relevant authorities as per the Incident Commander and Incident Management Team (IMT) Initial Actions Checklist | Incident records. |

| EPOs | Ref | Control Measure | EPSs | MC |
|---|---|---|---|---|
| | 40 | Maintain capability to implement Waste Management in the event of a Tier 3 spill event | Agreement in place with Waste Management Contractor. | Contracts/memberships verify currency of contract and/or membership. |
| | 41 | Waste management included in IMP. | Waste management requirements are identified as part of the planning and logistics section of IMP. | Incident records confirm waste requirements included in IMP. |
| **EPO 8:** Undertake marine pollution response activities to minimise marine environmental impacts. | 42 | Response arrangements | Implement spill response in accordance with relevant EPOs and EPSs in the NOPSEMA accepted OPEP and OSMP. | Records confirm that emergency response activities were implemented in accordance with the OPEP. |

# 7 HYDROCARBON POLLUTION EMERGENCY RESPONSE

As required by Regulation 14(8AA) of the OPGGS (Environment) Regulations, Western Gas has prepared the Sasanof-1 Exploration Drilling Oil Pollution Emergency Plan (OPEP) (WG-EHS-PLN-003). The OPEP is the primary reference document and key control measure to be implemented in the unlikely event of a spill during the drilling activity.

## 7.1 SOURCE OF RISK

This EP has identified all credible and worst-case hydrocarbon spill scenarios as:

- Tier 3: Loss of well control, resulting in an uninterrupted flow of 22,542 bbl / day for 80 days (refer to Section 4.2.1)
- Tier 2: Unplanned diesel spill from a vessel collision resulting in a ruptured fuel tank of 250 $m^3$ (1,572 bbl).

## 7.2 PRELIMINARY NET ENVIRONMENTAL BENEFIT ANALYSIS (NEBA) OF RESPONSE STRATEGY OPTIONS

The overall aim of a spill response is to mitigate further damage to the environment. Not all spill response options will be effective to meet the aim to protect the environment. This section provides an overview of the available oil spill response strategies along with the preliminary net environmental benefit analysis (NEBA) of each strategy as to their applicability to the credible and worst-case spill scenarios that could occur during the drilling (Table 7-1). The NEBA takes into account several criteria including the effectiveness for the spill parameters, the benefit(s), potential environmental impacts and risks and the operational/functional constraints of the proposed response option before the applicability is decided. Once applicability is determined, the response is assessed to evaluate appropriateness as a primary or secondary response.

The focus of the NEBA is to understand the consequences of 'no action' and to select an oil spill response strategy that delivered a net environmental benefit. The NEBA methodology is to:

- List the response strategies available.
- Identify the benefit, environmental impact and operational challenge of each response strategy.
- Evaluate the viability of each response strategy in a particular credible worst-case scenario.
- Identify all the viable strategies for a particular credible scenario.
- Formulate options of different strategy combinations.
- Compare these options and select the preferred option.

The preferred option is formulated as follows:

- Primary response strategies will be used and applied as soon as possible in the event of a spill.
- Secondary response strategies are only applied as needed when practical.
- Not applicable (s) response strategies are options that will not be used because of a lack of net environmental benefit.

In the event of a spill during the drilling activity, the assessment of response options will be reviewed and verified prior to implementation (through the Incident Action Planning (IAP) process) to ensure that the assumptions made in the planning process are valid and the response strategy will be effective. This process, along with the protection prioritisation process and tactical response planning, is described in detail in the OPEP.

**Table 7-1: Preliminary NEBA of Response Options for Hydrocarbon Spill Scenarios**

| Response Option | Overview of Environmental Benefit(s) | Potential Environmental Impacts / Risks | Functional/Operational Constraints | Response Applicability | | Primary / Secondary Response | Justification |
|---|---|---|---|---|---|---|---|
| **Source Control**<br>(ROV Emergency Intervention) | Restricting or halting the flow of hydrocarbons from the well reducing the total volume of hydrocarbons released into the environment, reducing the overall potential impact to the environment. | Risks / impacts from operation of MODU and vessels (e.g. seabed disturbance liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.). | Effective only if BOP barriers are not fully compromised.<br>ROV on MODU may be inoperable, may require additional ROV support from another vessel, increasing mobilisation time for ROV intervention.<br>Availability of ROV capabilities on support vessels. | Tier 3 | Yes | Primary | Will be implemented in order to attempt to regain control of well through operation of the BOP. |
| **Source Control**<br>(Capping Stack) | Restricting the flow of hydrocarbons from the well reducing the total volume of hydrocarbons released into the environment, reducing the overall potential impact to the environment. | Risks / impacts from operation of heavy lift vessels (e.g. liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.).<br>Seabed disturbance from positioning of capping stack. | The effectiveness of capping a condensate well with a high gas component in 1,000 m water depth is unknown and will largely be dependent on the event and operational conditions at the time. | Tier 3 | Yes | Secondary | Will be implemented as a secondary response option should the parameters of the event and the operational conditions at the time deemed to be appropriate, through consultation with capability provider. |
| **Source Control**<br>(Relief Well) | Halting the flow of hydrocarbons from the well reducing the total volume of hydrocarbons released into the environment, reducing the overall potential impact to the environment. | Risks / impacts from operation of MODU and vessels (e.g. seabed disturbance liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.).<br>Discharge of chemicals/cement to the environment. | Health and safety of relief rig and personnel. | Tier 3 | Yes | Primary | The drilling of a relief well is the only permanent solution for a LOWC event. Installation of cement plug(s) to permanently stabilise and abandon the well. |
| **Monitor and Evaluate**<br>(Operational Monitoring) | Constant monitoring and evaluation is required for real-time decision making during a spill event. This mandatory | Risks/ impacts from operations of monitoring vessels and aircraft (e.g. liquid waste, air emissions from fuel usage, noise, marine | | Tier 2 | Yes | Primary | Essential surveillance activities ensure constant monitoring and evaluation of the spill event. This response |

| Response Option | Overview of Environmental Benefit(s) | Potential Environmental Impacts / Risks | Functional/Operational Constraints | Response Applicability | | Primary / Secondary Response | Justification |
|---|---|---|---|---|---|---|---|
| | primary response strategy provides identification of emerging risks to sensitive receptors; information for response planning and assessment of effectiveness of response actions. | fauna interaction, interference with other users, collisions, etc.). | Visual observation activities at night or during poor weather restricted.<br>Stringent safety management requirements for aerial and marine operations employed.<br>Coordination of multiple vessels within limited area. | Tier 3 | Yes | Primary | primary response strategy will be implemented in all spill situations at various scales dependent on the nature and scale of the spill. |
| **Dispersant Application (Surface) –** via Aerial and Vessel Applications | Accelerates the break-up of surface hydrocarbons by reducing the oil-water interfacial tension so that hydrocarbons on the surface become entrained within the water column and disperse via subsurface currents (note reduces but does not eliminate impacts).<br>Potential for high efficacy (75-85%) on surface hydrocarbons (for hydrocarbons amenable to dispersant use) when applied within first 24 hours of spill.<br>The trajectory of subsurface dispersed hydrocarbons trajectory influenced only by ocean currents, removing the surface wind component. Accelerates the break-up of surface hydrocarbons reducing potential impacts to surface receptors (e.g. seabirds) and shoreline receptors (e.g. mangroves).<br>Reduction in hydrocarbon waste. | Discharge of dispersant into environment.<br>No removal of hydrocarbons from environment.<br>Increased concentration of subsurface hydrocarbons in the water column.<br>Adds chemical to environment when spill is not likely to significantly impact sensitive environment receptors.<br>Risks/ impacts from operation of vessel and aircraft to support application of dispersant (e.g. liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.). | Not suitable for hydrocarbons which are non-persistent and highly evaporative.<br>Dispersant application for diesel spills not appropriate as diesel spreads and weathers rapidly such that window for application is less than mobilisation time.<br>Cannot be applied in high wind conditions. Vessel application has a wider range of suitable weather compared to aerial application.<br>Requires clear area with no simultaneous operations. | Tier 2 | No | Reject | Not applicable for any spill tier for the drilling activity.<br>No predicted shoreline contact at adopted thresholds, diesel and condensate will disperse quickly and naturally. |
| | | | | Tier 3 | No | Reject | |

| Response Option | Overview of Environmental Benefit(s) | Potential Environmental Impacts / Risks | Functional/Operational Constraints | Response Applicability | | Primary / Secondary Response | Justification |
|---|---|---|---|---|---|---|---|
| **Dispersant Application (Sub-surface)** | Prevent hydrocarbons released subsea from reaching the sea surface by dispersing oil into the water close to the release location.<br><br>Increases availability of hydrocarbons for biodegradation and thereby speeds up the natural breakdown processes.<br><br>Decreased surface oil component results in reduction of surface oil reducing impacts to surface receptors (e.g. seabirds) and shoreline receptors.<br><br>Requires less dispersant compared to surface dispersant application.<br><br>Shoreline clean up and waste management requirements reduced. | Discharge of dispersant into environment.<br><br>Adds chemical to environment when spill is not likely to significantly impact sensitive environment receptors.<br><br>No removal of hydrocarbons from environment.<br><br>Increased concentration of subsurface hydrocarbons in the water column.<br><br>Ingestion of chemically-dispersed oil by marine organisms resulting in marine fauna toxicity and/or mortality. | Chemical dispersants are expected to have limited effectiveness on condensate spills due to low density/high volatility of condensate, and high release velocity of hydrocarbons.<br><br>Can be conducted 24 hours a day in practically any weather conditions, unlike surface response methods. | Tier 3 | No | Reject | Not applicable for a Tier 3 spill during the drilling activity.<br><br>No predicted shoreline contact at adopted thresholds, condensate will disperse quickly and naturally, and no shoreline contact predicted. |
| **Containment and Recovery** | Contains the spill as close as possible to the spill source. Recovery enables the spread of surface hydrocarbons to be reduced, thereby reducing the risk of impact to sensitive receptors.<br><br>Removal of hydrocarbons from the marine environment. | Risks/ impacts from operation of vessel-based containment and recovery activities (e.g. liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.).<br><br>Equipment and labour intensive.<br><br>Waste disposal of recovered condensate.<br><br>Cleaning and disposal of contamination from booms and response vessels. | This strategy requires relatively calm conditions with currents speeds <0.5 m/s (<~1 knot).<br><br>Requires slick concentrations >10 g/m$^2$. | Tier 2 | No | Reject | Not applicable for Tier 2 and 3 spills given the evaporative and dispersive nature of these hydrocarbons.<br><br>Weather conditions unlikely to permit efficient offshore containment using booms, weirs and skimmers.<br><br>Surface concentrations >10 g/m$^2$ remain offshore, no predicted shoreline contact. |
| | | | | Tier 3 | No | Reject | |

| Response Option | Overview of Environmental Benefit(s) | Potential Environmental Impacts / Risks | Functional/Operational Constraints | Response Applicability | | Primary / Secondary Response | Justification |
|---|---|---|---|---|---|---|---|
| **Shoreline Protection and Deflection** | If modelling predicts impacts to sensitive receptors, then near-shoreline deployment of booming equipment can be undertaken to protect target receptors and to deflect to lower priority areas. | Risks/ impacts from operation of vessel-based protection and deflection activities (e.g. liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.).<br>Habitat disturbance from securing booms on shallow nearshore benthic environments.<br>Generation of waste from booms and disposal of recovered condensate and water.<br>Potential impacts to intertidal areas if deflected to low sensitivity shorelines. | Wind and surface currents are key constraint in the deployment and operations of booms in nearshore coastal environments.<br>Considerable resources and logistics support needed (i.e. equipment and labour intensive).<br>Site constraints such as breaking waves, etc. | Tier 2 | No | Reject | Not applicable for Tier 2 and 3 spills given the evaporative and dispersive nature of these hydrocarbons.<br>No shoreline contact predicted. |
| | | | | Tier 3 | No | Reject | |
| **Mechanical Dispersion** | Enhances dispersion and break-up of surface hydrocarbons to facilitate natural degradation processes. | Increased concentration subsurface hydrocarbons in the water column.<br>Risks/ impacts from operation of vessel mechanical dispersion activities (e.g. liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.). | Offshore vessels are designed not to cavitate, so not efficient at breaking up hydrocarbon films.<br>Small hydrocarbon droplet size required otherwise material resurfaces, hence for some hydrocarbon types limited benefit unless combined with dispersant application.<br>Wind speeds above 20 knots provide natural dispersion, making this method redundant.<br>Cannot be performed where high concentrations of vapour occur, which is possible in proximity to the source. | Tier 2 | No | Reject | Safety considerations of mechanical dispersion due to volatility of condensate.<br>Not applicable for Tier 2 and 3 spills given the evaporative and dispersive nature of these hydrocarbons. |
| | | | | Tier 3 | No | Reject | |

| Response Option | Overview of Environmental Benefit(s) | Potential Environmental Impacts / Risks | Functional/Operational Constraints | Response Applicability | | Primary / Secondary Response | Justification |
|---|---|---|---|---|---|---|---|
| ***In Situ* Burning** | Combustion of hydrocarbons on sea surface reduces the hydrocarbon volume remaining on the surface.<br>Generates modest waste products for recovery and disposal. | Generates highly visible black smoke, particulates and atmospheric emissions including greenhouse gases.<br>Incomplete combustion residues may be toxicologically damaging and could be ingested by marine organisms.<br>Burn residues can also physically impact marine fauna and flora through coating of gills, feathers and fur, etc.<br>Particulates (smoke) in air with associated health risks.<br>Risks/ impacts from operation of vessel-based in situ burning activities (e.g. liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.). | Need a thick hydrocarbon film for ignition/ combustion (5 to 10 mm).<br>Availability of fire proof booms.<br>Never been carried out in Australia; limited experience available nationally.<br>Ignition of the hydrocarbon requires specialist training and equipment.<br>Diesel not suitable for burning.<br>Wind conditions a key constraint as calm conditions required for safe and controlled burning. | Tier 2 | No | Reject | Not applicable for Tier 2 and 3 spills given the evaporative and dispersive nature of these hydrocarbons.<br>Safety considerations of in situ burning due to volatility of condensate. |
| | | | | Tier 3 | No | Reject | |
| **Shoreline Clean-Up** | Hydrocarbon removal from shorelines to minimise impacts to marine fauna that may use shorelines:<br>Reduced visual impact.<br>Reduces risk of marine fauna contact and smothering effects.<br>Reduce risk of re-entrainment of hydrocarbons from shoreline back into marine environment. | Potential shoreline disturbance to sensitive habitats (e.g. turtle nesting beaches) from clean-up operations (trampling by response personnel and equipment).<br>Waste from removal of contaminated sediment from beaches and impacts to associated flora and fauna during removal activities.<br>Temporary storage of waste has the potential to cause | Labour intensive, significant logistics including waste management considerations required.<br>Personnel management and coordination to reduce environmental and safety risks/impacts.<br>Applicability is influenced by shoreline characteristics (substrate type, beach type, exposure to wave action, biological, social, heritage or economic resources, amount of | Tier 2 | No | Reject | Not applicable for Tier 1 and Tier 2 diesel spills as no predicted shoreline contact. |
| | | | | Tier 3 | No | Reject | |

| Response Option | Overview of Environmental Benefit(s) | Potential Environmental Impacts / Risks | Functional/Operational Constraints | Response Applicability | | Primary / Secondary Response | Justification |
|---|---|---|---|---|---|---|---|
| | | contamination to areas not originally contacted by the spill.<br>Presence of response personnel, equipment and facilities will increase the risk of hydrocarbon cross contamination from an impacted site to a non-impacted site. | hydrocarbon present) and access to site. | | | | |
| **Oiled Wildlife Response** | Reduce impacts to wildlife (e.g. onshore exclusion barriers, hazing, pre-emptive capture).<br>Collection and rehabilitation to treat oiled fauna and return to similar suitable habitat. | Risks/ impacts from operation of vessel-based oiled wildlife response activities (e.g. liquid waste, air emissions from fuel usage, noise, marine fauna interaction, interference with other users, collisions, etc.).<br>During hazing could accidentally drive wildlife into spills or separate groups/individuals (e.g. parents/offspring pairs).<br>Potential risk of fauna injury and inappropriate field collection/ handling during pre-emptive capture and post-oiled collection.<br>Rehabilitation activities could result in inadequate/ inappropriate animal husbandry leading to stress/ injury/ death.<br>Inappropriate fauna relocation points leading to disorientation/ stress. | Labour intensive and significant logistics considerations.<br>Wind is a key constraint, calm seas and ideal conditions are considered necessary for capture operations.<br>Weather constraints for use of aerial observation/ tracking fauna.<br>Navigation of multiple vessels within a small area.<br>Availability of suitable space/ location in township for staging area and rehabilitation and fauna treatment areas.<br>Utilisation of local skilled fauna handlers and veterinarians for treatment of oiled wildlife. | Tier 2 | No | Reject | Not applicable for Tier 1 spills as spill volume, offshore location, and high evaporative losses of diesel will have limited impacts to wildlife.<br>Will be implemented as a secondary response option for a Tier 3 spill should the MES data suggest it is required and is deemed feasible through the incident management process. |
| | | | | Tier 3 | Yes | Secondary | |
| | | | | Tier 2 | Yes | Primary | |

| Response Option | Overview of Environmental Benefit(s) | Potential Environmental Impacts / Risks | Functional/Operational Constraints | Response Applicability | | Primary / Secondary Response | Justification |
|---|---|---|---|---|---|---|---|
| **Waste Management** | Appropriate management of hydrocarbon-contaminated waste to reduce the potential for further contamination of the environment if not disposed of correctly. | Temporary storage and/or the inadequate disposal of waste has the potential to cause contamination to areas not originally contacted by the spill.<br>Risks / impacts from transport of wastes via vessels and/or land vehicle (air emissions from fuel usage, noise, fauna interaction, interference with other users, collisions, etc.). | Appropriate waste receptacles required for potentially large volumes of contaminated waste. | Tier 3 | Yes | Primary | Any hydrocarbon contaminated wastes generated during a spill will be managed appropriately. |

Based on the preliminary NEBA, the following spill response options have been identified as appropriate for the credible and worst-case spill scenarios for the drilling activity. Further information, including capability and resources to facilitate the response options, are included in the OPEP.

**Source Control**

Source control tactics for consideration in this plan include:

- ROV emergency BOP intervention;
- Well capping and containment; and
- Relief well.

Emergency BOP activation involves delivering hydraulic fluid to the BOP stack using an ROV to mitigate any problems that may have arisen with the BOP control system in a loss of well control event.

Well capping and containment involves the deployment of specialist capping stack equipment, which uses hydraulic pressure to seal off the damaged BOP and stop the flow of hydrocarbons. An intervention riser system may also be used to capture and transport hydrocarbons for safe storage and processing via a supporting vessel. Western Gas maintains a service agreement with a capping stack provider to ensure access to well capping and containment equipment.

The drilling of a relief well provides an opportunity to permanently suspend the well. A relief well is drilled to intersect the compromised well bore above the blowout location. Weighted drill fluid is pumped down the relief well at high rates to kill the existing well. This requires the mobilisation of another suitable MODU to the existing well location.

**Monitoring, Evaluation and Surveillance**

Monitoring, Evaluation and Surveillance (MES) is conducted to assist in anticipating resources at risk of exposure, directing response resources, and evaluating the effectiveness of response techniques. MES activities are conducted throughout the incident response. The MES tactics that may be used to evaluate the parameters and potential trajectory of the spill may include:

- Fate and weathering modelling – computer modelling and computational techniques estimate the weathering of an oil spill;
- Trajectory modelling – computer models and computational techniques estimate the speed and direction of movement, weathering and dispersal patterns;
- Visual observation (from aircraft and/or vessels) – observers on aircraft or vessels use standard references to characterise surface oil; and
- Remote sensing – uses remote sensing technologies, including tracking buoys and satellite imagery, to identify and track surface oil.

**Oiled Wildlife Response**

Any release of oil into the marine environment has the potential to impact wildlife. The level of oiled wildlife response (OWR) will be determined by data collected via initial MES tactics. The OWR will be conducted in accordance with the WA Oiled Wildlife Response Plan (Parks and Wildlife & AMOSC 2014). This overarching document provides the framework for OWR, with the regional context and detail required to carry out an OWR provided in seven regional response plans. The relevant Regional Oiled Wildlife Response Plan(s) will be enacted, if required, following initial MES information.

**Waste Management**

Oil spills to the marine environment may generate significant amounts of oily waste that need to be collected, stored and disposed of appropriately, in accordance with MARPOL 73/78 Annex V – Garbage, relevant Commonwealth and State/Territory laws and regulations. As there is not predicted to be any shoreline contact of surface oil associated with the credible worst-case spill scenario for the drilling activity, significant volumes of waste are not anticipated.

## 7.3 SPILL RESPONSE OPTIONS ENVIRONMENTAL IMPACT ASSESSMENT

This section outlines the environmental impact and risk assessment to ensure that all potential impacts and risks associated with the response options are identified and evaluated, and the resulting impacts are demonstrated to be ALARP and Acceptable in accordance with the impact and risk assessment methodology (Section 2). The Environmental Performance Outcomes and Standards relevant to the potential impacts associated with the response options are provided in the OPEP.

Based on the response options identified appropriate for the credible and worst-case spill scenarios associated with the drilling activity, potential environmental hazards resulting from each activity have been identified for assessment and management. The relationship between activities and aspects is shown in Table 7-2.

**Table 7-2: Activity – Aspect Relationship – Spill Response Options**

| Aspects | Source Control | Monitoring, Evaluation and Surveillance | Oiled Wildlife Response | Waste Management | Support Operations – MODU / Vessel/Aircraft |
|---|---|---|---|---|---|
| Physical Presence – Interaction with Other Users | | | | | ✓ |
| Physical Presence – Interaction with Marine Fauna | | | ✓ | | ✓ |
| Physical Presence - Seabed Disturbance | ✓ | | | | ✓ |
| Emissions - Atmospheric | | | | | ✓ |
| Emissions - Light | | | | | ✓ |
| Underwater Sound Emissions - Continuous | | ✓ | | | ✓ |
| Underwater Sound Emissions - Impulsive | | | | | |
| Planned Discharge - Drill Cuttings and Fluids | ✓ | | | | |
| Planned Discharge - Cement | ✓ | | | | |
| Planned Discharge - Hydraulic Fluids and Chemicals | ✓ | | | | |
| Planned Discharge - Sewage and Greywater | | | | | ✓ |
| Planned Discharge - Food Waste | | | | | ✓ |
| Planned Discharge - Deck Drainage and Bilge | | | | | ✓ |
| Planned Discharge - Brine | | | | | ✓ |
| Planned Discharge - Cooling Water | | | | | ✓ |
| Accidental Release – Solid and Hazardous Waste | | | | ✓ | |

Only those aspects specific to the response option implementation are assessed in Table 7-3. The following aspects associated with the implementation of the response options are considered addressed in Section 6.2, and are not discussed or assessed further in this section:

- Source Control: Physical Presence – Seabed Disturbance, Planned Discharges of drill cuttings and fluids, cement, hydraulic fluids and chemicals.
- Monitoring, Evaluation and Surveillance: Underwater Sound Emissions – Continuous.
- All aspects associated with Support Operations - MODU / Vessel/Aircraft operations, provided to support the response activities.

These aspects are all considered routine and will be conducted in accordance with the relevant environmental performance outcomes and standards as described in Section 6.2.

**Table 7-3: Impact and Risk Assessment – Spill Response Options**

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Consequence | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| Source Control | No additional aspects or impacts identified – addressed in Section 6.2 | | | | | | | | | | | | |
| Monitoring, Evaluation and Surveillance | No additional aspects or impacts identified – addressed in Section 6.2 | | | | | | | | | | | | |
| Oiled Wildlife Response<br>• Hazing<br>• Handling and treatment | <u>Physical Presence – Interaction with Marine Fauna</u><br>Deterrence, pre-emptive capture and capture following physical oiling to prevent fauna from entering a spill affected area and aid in the recovery of fauna once affected. | Deterring non-target species from activities (breeding, feeding)<br>Distress, injury or mortality through inappropriate handling / treatment | Birds | The deliberate deterrence, or attempted capture of fauna following a spill has the potential to alter the behaviour of the fauna targeted. Behavioural changes following deliberate disturbance may include:<br>• Avoidance of an area;<br>• Temporary stress;<br>The nearest BIA for seabirds is located at Muiron Islands, approx. 23 km from the Hydrocarbon Exposure Area.<br>Given that the oil concentrations that may cause significant impact to birds remain offshore, significant numbers of affected wildlife are not expected to occur and require deterrence, handling and rehabilitation. Any impacts would be limited to individuals, are not expected at a community or species level, and have been assessed as **Minor (2)**. | 2 | B | L | A | **CM 33:** OPEP | **No OWR tactics:** Oiled wildlife response is included as a secondary response option and will only be conducted following assessment to determine if the net environmental benefits outweigh the consequences. Therefore, no OWR tactics is rejected. | ALARP | • Risks assessed as Low and are considered to be ALARP and Acceptable.<br>• Activity only undertaken following assessment for NEBA.<br>• Activity will be undertaken in a manner consistent with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity will be undertaken in consultation with regulatory agencies. | Acceptable |
| Waste Management | Accidental Release – Solid Waste | Cross-contamination of unaffected areas by hydrocarbon-contaminated wastes | Water Quality | The inappropriate storage, handling and/or disposal has the potential to result in the contamination of the environment in an area unaffected by the original spill event.<br>Loss of containment of hydrocarbon contaminated waste materials would result in a change in water quality through toxicity. | 1 | B | L | A | **CM 33:** OPEP | None identified. | ALARP | • Risks assessed as Low and are considered to be ALARP and Acceptable.<br>• Activity will be undertaken in a manner consistent | Acceptable |

| Activity | Aspect | Impact | Affected Receptor | Consequence Evaluation | Risk Assessment | | | Demonstration of ALARP | | | | Demonstration of Acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Consequence | Likelihood | Risk Rating | ALARP Decision Context | Good Practice Control Measures | Additional Control Measures Considered | ALARP Outcome | Acceptability Assessment | Acceptability Outcome |
| | | | | Due to the small volumes released, any change in toxicity is expected to be quickly dissipated in the high energy marine environment, with no long-term changes to water quality expected. Short-term local degradation to ambient water quality is likely to occur, resulting in a **Slight (1)** consequence. | | | | | | | | with relevant legislation, industry standards and guidelines, offshore practises and benchmarking.<br>• Activity and impacts will be managed in accordance with Western Gas policies, standards and procedures. | |
| Support Operations – MODU and Vessel Operations | No additional aspects or impacts identified – addressed in Section 6.2 | | | | | | | | | | | | |

# 8 STAKEHOLDER CONSULTATION

## 8.1 INTRODUCTION

Western Gas is committed to early and open engagement with individuals or groups who are potentially affected by our activities or who have an interest in, or influence on, what we do.

Stakeholder consultation for this Environment Plan (EP) builds on Western Gas' ongoing engagement program in the region, for exploration activities and the Equus Gas Project, which lies in adjacent permits to WA-519-P.

In support of this EP, Western Gas has sought to:

- Build on engagement activities undertaken in late 2019 and early 2020 to support planned exploration activities in permit WA-519-P. This exploration activity was not progressed due to operational impacts related to COVID-19.
- Reassess relevancy of stakeholders previously identified for proposed activities in WA-519-P relevant to the Sasanof-1 location, as well as currency of feedback previously provided.
- Engage relevant stakeholders in a timely manner and in a way that is appropriate to their interests and information needs.
- Maintain open communications and incorporate stakeholder feedback into our planning considerations for the proposed Activity.
- Provide opportunities for interested stakeholders to have a say about the proposed Activity.
- Provide feedback to stakeholders on the outcomes of our planning where they have provided input.
- Establish communications protocols for stakeholder notifications prior to, during and upon completion of the proposed Activity.

Western Gas typically provides stakeholders up to 30 days to review and respond to advice about proposed activities where stakeholders are potentially affected. Western Gas believes this time to be appropriate for the Sasanof-1 exploration well given the nature and potential impacts of the activity.

## 8.2 CONSULTATION APPROACH

### 8.2.1 Relevant Stakeholder Consultation

Western Gas has followed the requirements of Subregulation 11A (1) of the Environment Regulations to identify relevant stakeholders, these being:

- 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
- 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
- The Department of the responsible State Minister, or the responsible Northern Territory Minister
- 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
- Any other person or organisation that the titleholder considers relevant

Western Gas has also considered:

- NOPSEMA Guidance Notes
  - GL1721 - Environment plan decision making - Rev 6 - November 2019
  - GN1847 - Responding to public comment on environment plans - September 2020
  - GN1344 - Environment plan content requirements - September 2020
  - GN1488 - Oil pollution risk management - February 2021
  - GN1785 – Petroleum activities and Australian Marine Parks - June 2020
  - GL1887 – Consultation with Commonwealth agencies with responsibilities in the marine area – July 2020
  - NOPSEMA Bulletin #2 - Clarifying statutory requirements and good practice consultation – November 2019
- Guidance notes issued by Commonwealth and State government agencies for consultation with respect to commercial fishing, biosecurity and marine pollution interests.

Commonwealth and State Government agencies relevant to this EP have been identified based on their responsibility for managing or protecting the marine environment, including those with responsibilities for environmental and fisheries management, oil pollution preparedness and response, defence and communications, biosecurity, maritime/navigational safety, marine parks and Native Title.

Commonwealth and State managed fisheries relevant to this EP have been identified based on fishing licence overlap with titles the Sasanof-1 well location and consideration of Commonwealth and State fishing effort data. Relevant stakeholders for this EP are outlined in Table 8-1.

**Table 8-1 Relevant stakeholders for the proposed activity**

| Stakeholder organisation | Stakeholder role/responsibility | Stakeholder relevance |
|---|---|---|
| **Australian Government** | | |
| Australian Border Force (ABF) | Australian Government agency responsible for maritime security. | Proposed Activity has the potential impact maritime security interests. |
| Australian Fisheries Management Authority (AFMA) | Australian Government agency responsible for the management and sustainable use of fisheries resources. | Proposed Activity has the potential to impact Commonwealth managed fishery licence holders. |
| Australian Hydrographic Office (AHO) | Australian Government agency responsible for providing hydrographic services, enabling safe navigation, maritime trade and supporting protection of the marine environment. | AHO has an expectation to be provided activity information prior to the commencement of activities to promulgate a Notice to Mariners to ensure marine users are aware of the presence of the MODU and support vessels for the duration of the activity. |
| Australian Maritime Safety Authority (AMSA) – nautical advice | Australia's national agency responsible for maritime safety, protection of the marine environment, and maritime aviation search and rescue | AMSA has an expectation to be provided activity information prior to the commencement of activities in the event that AMSA coordinated search and rescue activities are required. |
| Australian Maritime Safety Authority (AMSA) - marine environment pollution response | Australia's national agency responsible for maritime safety, protection of the marine environment, and maritime aviation search and rescue | AMSA has an expectation to be consulted on marine pollution planning for the proposed activities. |
| Department of Agriculture, Water and the Environment (DAWE) | Australian Government department responsible for Australia's primary industries. | DAWE has an expectation to be consulted on management measures to prevent introduction of invasive marine species and Commonwealth-managed fisheries. |
| Department of Defence (DoD) | Australian Government department responsible for defending Australia and its national interests. | Proposed activities take place within DoD's North West Exercise Area and in restricted air space. |
| Department of Industry, Science, Energy and Resources DISER) | Department of the relevant Commonwealth Minister. | DISER is required to be consulted under Subregulation 11A (1) of the Environment Regulations. |
| Director of National Parks | Australian Government department that supports management Australian Marine Parks. | While not impacted by planned activities, Western Gas has provided communications material in the unlikely event of an unplanned event, such as oil spill, given the proximity of the proposed Sasanof-1 exploration well location to an Australian Mark Parks. |
| **Western Australian Government** | | |
| Department of Biodiversity, Conservation and Attractions (DBCA), Parks and Wildlife Service | Western Australian Government department responsible for promotion of biodiversity and conservation through sustainable management of the State's species, ecosystems, lands and the attractions in its care, including the management of Western Australian marine and terrestrial parks. | While not expected to be impacted by planned or unplanned activities (such as oil spill), Western Gas has provided communications material given the organisation's management role of the values of Western Australian marine and terrestrial parks. |
| Department of Mines, Industry Regulation and Safety (DMIRS) | Department of the relevant State Minister. | DMIRS is required to be consulted under Subregulation 11A (1) of the Environment Regulations. |

| | | |
|---|---|---|
| Department of Primary Industries and Regional Development (DPIRD) | Western Australian Government department responsible for the management and sustainable use of fisheries resources. | While not expected to be impacted by the Proposed Activity, Western Gas has consulted DPIRD to confirm previous stakeholder advice that State-managed fishing activities do not occur at the proposed Sasanof-1 exploration well location. |
| Department of Transport (DoT) | Western Australian Government department responsible for marine pollution response in State Waters. | While DoT resources are unlikely to be drawn upon for the proposed Activity based on oil spill modelling and proposed response measures, Western Gas has consulted DoT given its interest in potential implications for |
| **Industry associations** | | |
| Australian Southern Bluefin Tuna Industry Association (ASBTIA) | Peak body representing the interests the Australian Southern Bluefin Tuna industry. | ASBTIA has previously requested to be consulted due to the migratory nature of the target species. |
| Commonwealth Fisheries Association (CFA) | Peak body representing the collective rights, responsibilities and interests of commercial fishing industries in Commonwealth Waters. | Proposed Activity has the potential to impact Commonwealth managed fishery licence holders. |
| Pearl Producers Association (PPA) | Peak body representing the collective rights, responsibilities and interests of commercial fishing industries in Commonwealth Waters. | While not expected to be impacted by the Proposed Activity, PPA has previously sought to be kept informed about petroleum industry activities. |
| Western Australian Fishing Industry Council (WAFIC) | Industry representative organisation for professional fishing, pearling and aquaculture enterprises, processors and exporters in Western Australia. | Western Gas is consulting WAFIC to confirm previous stakeholder advice that State-managed fishing activities do not occur at the proposed Sasanof-1 exploration well location. |
| **Commercial fisheries – Commonwealth (refer Section 5.5.3.1)** | | |
| Western Deepwater Trawl Fishery | Commonwealth managed fishery | Proposed Activity overlaps the fishery and there is potential for interaction with licence holders. |
| No other active fisheries | Commonwealth managed fishery | Proposed Activity overlaps fishery, however determined that there has been no fishing effort in recent years (See section 5.5.3.1) |
| **Commercial fisheries – State (refer Section 5.5.3.2)** | | |
| No other active fisheries | State managed fishery | Proposed Activity overlaps fishery, however determined that there has been no fishing effort in recent years (See section 5.5.3.2) |
| **Adjacent titleholders*** | | |
| Chevron<br>- WA-383-P | Operator of adjacent petroleum title | Proposed Activity has the potential to impact activities in the adjoining permit. |
| Kufpec<br>- WA-538-P | Operator of adjacent petroleum title | Proposed Activity has the potential to impact activities in the adjoining permit. |

* Western gas notes that other adjacent titles are currently being determined as part of Australian Government gazettal processes. Western Gas will engage these titleholders following publication of title award by the National Offshore Petroleum Titles Administrator.

### 8.2.2 Community Advice

For this EP, Western Gas has also provided communications material to community stakeholders, with a focus on stakeholder organisations that have previously expressed interest in Western Gas and its planned Equus Gas Project, located in titles adjacent to WA-519-P.

These stakeholders include Government agencies and organisations with an interest in commercial fishing, tourism, and industrial and commercial development, as well as local government and Indigenous representative organisations. Additional stakeholders provided advice about this EP are outlined in Table 8-2.

**Table 8-2 Additional stakeholders provided communications materials for the proposed Activity**

| Stakeholder organisation | Stakeholder interest |
|---|---|
| Agility | Global logistics company and operator of the Onslow Marine Supply Base. |
| Australian Petroleum Production and Exploration Association (APPEA) | Australian industry association representing companies that explore for and produce oil and gas in Australia. |
| Buurabalayji Thalanyji Aboriginal Corporation (BTAC) | Registered Native Title body and prescribed body corporate for the Thalanyji People, the determined Native Title holders over Onslow and the surrounding area in Western Australia. |
| Mackerel Islands | Tourism operator with accommodation facilities in Onslow and on Thevenard and Direction Islands. |
| Onslow Chamber of Commerce and Industry (OCCI) | Industry representative organisation for its members in the Onslow business community. |
| Pearl Producers Association (PPA) | Industry representative organisation for the Australian South Sea Pearl Industry. |
| Pilbara Development Commission (PDC) | Australian Government organisation established to coordinate and promote economic development in the Pilbara region of Western Australia. |
| Pilbara Ports Authority | Western Australian Government Trading Enterprise that manages the Port of Ashburton. |
| Shire of Ashburton | Local Government serving communities in the Pilbara region of Western Australia and operates a subsidiary office in Onslow. |

On this occasion, Western Gas has not provided information to Recfishwest, given the distance of the Sasanof-1 location from shore, deep water depth and low likelihood of interaction with recreational fishers.

### 8.2.3 Public Comment

Western Gas has promoted in its communications material to identified stakeholders the opportunity to provide comment and feedback on the proposed Activity by way of NOPSEMA's public comment process.

Western Gas will promote this opportunity to a broader range of stakeholders by way of advertising in regional, State-wide and national newspapers prior to NOPSEMA publishing the EP on its web site for public comment.

## 8.3 STAKEHOLDER CONSULTATION OUTCOMES

Western Gas provides in this Section:

- A summary of stakeholder consultation activities (Table 8-3) that commenced in late 2019 to support planned exploration activities in permit WA-519-P. Exploration activities were not progressed due to operational impacts related to COVID-19.

- A summary of stakeholder consultation activities and feedback from relevant stakeholders (Table 8-4) and community stakeholders (Table 8-5) for the planned Sasanof-1 Activities

Overall, there were no objections and few specific issues or concerns raised by stakeholders resulting from both phases of consultation. A full text copy of Western Gas' correspondence to stakeholders for the Sasanof-1 consultation is provided in the stakeholder consultation record (Appendix D: Stakeholder Consultation Record).

Western Gas acknowledges that additional stakeholders may be identified prior to or during the proposed Activity. These stakeholders will be contacted, provided information relevant to their interests and invited to provide feedback about the proposed Activity. Western Gas will assess their feedback, respond to the stakeholder and incorporate feedback into the management of the proposed Activity where practicable.

**Table 8-3 Summary of stakeholder responses for consultation activities conducted in 2019-2020 for exploration activities in permits WA-519-P**

| Stakeholder | Consultation activity | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas' Assessment |
|---|---|---|---|---|
| **Australian Government** | | | | |
| DNP | On 20 December 2019 Western Gas sent an email and an Information Sheet. | On 9 January 2020 the DNP emailed Western Gas noting that there was no overlap with Australian Marine Parks and that there were no authorisation requirements from the DNP.<br>The DNP provided guidance on the preparation Environment Plans aspects that proponents need to consider and evaluate if petroleum activities are likely to impact an Australian Marine Park.<br>DNP stated it did not require further notification of progress made in relation to the activity unless details regarding the activity change and result in an overlap with or new impact to a marine park, or for emergency responses.<br>DNP provided contact details and expectations for engagement in the result of an emergency. | No claims or objections raised. | Western Gas considered this adequately addressed stakeholder interests and no further consultation was undertaken. |
| **Western Australian Government** | | | | |
| DBCA | On 20 December 2019 Western Gas sent an email and an Information Sheet. | On 14 January 2020 the DBCA emailed Western Gas noting that based on information provided and other readily available information, DBCA did not have any comments in relation to its *Conservation and Land Management Act 1984*and *Biodiversity Conservation Act 2016* related responsibilities. | No claims or objections raised.<br>On 14 January 2020 Western Gas emailed DBCA noting its feedback. | Western Gas considered this adequately addressed stakeholder interests and no further consultation was undertaken. |
| DMIRS | On 20 December 2019 Western Gas sent an email and an Information Sheet. | On 23 December 2019 DMIRS emailed Western Gas acknowledging it had reviewed the consultation package and that no further information was required. | No claims or objections raised.<br>On 6 January 2020 Western Gas emailed DMIRS noting its feedback. | Western Gas considered this adequately addressed stakeholder interests and no |

| Stakeholder | Consultation activity | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas' Assessment |
|---|---|---|---|---|
| | | | | further consultation was undertaken. |
| DoT | On 20 December 2019 Western Gas sent an email and an Information Sheet. | On 10 January 2020 DoT emailed Western Gas noting that it should be consulted as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018) if there is a risk of a spill entering State waters. | No claims or objections raised. | This consultation was not closed out due to the Proposed Activity being deferred due to operational impacts associated with COVID-19. |
| **Industry associations** | | | | |
| WAFIC | On 20 December 2019 Western Gas sent an email, an Information Sheet and a fisheries map. | On 20 December 2019 WAFIC emailed Western Gas thanking it for clarifying and determining commercial fishers who are actually "relevant and potentially affected stakeholders.<br><br>WAFIC confirmed that there was no active commercial fishing for state managed fisheries over 1,000 metres water depth.<br><br>WAFIC provided comment on Commonwealth managed fisheries, noting:<br>- Southern Bluefin Tuna – no active fishing, it is the migratory route, you must engage with the Australian Southern Bluefin Tuna Industry Association.<br>- Western Tuna and Billfish – one active fisher in WA, our agreed engagement is for seismic activities only.<br>- Can't 100% see if there is an overlap with the Northwest Slope Trawl fishery (200m depth contour to the outer limit of the Australian Fishing Zone), confirm | No claims or objections raised.<br><br>On 3 January 2020 Western Gas emailed WAFIC noting its feedback on Commonwealth and State managed fisheries.<br><br>Western Gas also noted the potential based on ABARES data the potential for interaction with licence holders in the Western Deepwater Trawl Fishery.<br><br>Western Gas sought feedback outside of consultation for the exploration program to engage fishers on a whole-of-project consultation approach for the planned Equus Gas Project in adjacent petroleum titles. | Western Gas considered this adequately addressed stakeholder interests and no further consultation was undertaken. |

| Stakeholder | Consultation activity | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas' Assessment |
|---|---|---|---|---|
| | | commercial fishing is between 200 and 750 metres water depth)<br>- Western Skipjack Tuna – no active fishing.<br>WAFIC confirmed consultation was not required with either State or Commonwealth managed commercial fisheries for the activities described for this EP at this deep-water location.<br>WAFIC noted that all fisheries with a legal boundary overlapping this site and fisheries which are part of the EMBA, resource identification and mitigations in the instance of a significant spill event must be a standard part of the EP. | | |
| **Community** | | | | |
| Agility | On 20 December 2019 Western Gas sent Agility an email and an Information Sheet. | On 24 December 2019 Agility emailed Western Gas seeking a meeting to discuss opportunities for using the Onslow Marine Supply Base to support drilling activities. | No claims or objections raised. | Western Gas considered this adequately addressed stakeholder interests and no further consultation was undertaken. |

**Table 8-4 Summary of relevant stakeholder responses received, assessment and response for consultation activities conducted for the Sasanof-1 exploration well**

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| **Australian Government** | | | | | |
| ABF | On 26 May 2021 Western Gas sent an email and an Information Sheet. | Stakeholder consultation record, Reference 1.1 | No response at the completion of the 30-day stakeholder feedback period. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br><br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| AFMA | On 26 May 2021 Western Gas sent an email, Information Sheet and a Commonwealth Fisheries map. | Stakeholder consultation record, Reference 1.2 | On 4 June 2021 AFMA emailed Western Gas acknowledging the importance of consulting fishers with entitlements to fish within proposed areas.<br><br>AFMA advised this could be done through liaison with licence holders and representative organisations, in particular concession holders in the Western Deepwater Trawl Fishery, as well as the Western Australia Fishing Industry Council.<br><br>AFMA provided details on relevant representative organisations, concession holders and how to obtain contact details for concession holders. | No claims or objections raised.<br><br>On 24 June 2021 Western Gas emailed AFMA noting its feedback cand confirming it had provided consultation materials to licence holders in the Commonwealth-managed Western Deepwater Trawl Fishery and the Western Australia Fishing Industry Council.<br><br>Western Gas also noted it had provided consultation material to the Commonwealth Fisheries Association, the representative organisation for the Western Deepwater Trawl Fishery. | Western Gas acknowledges AFMA's advice, noting that the representative organisation for the Western Deepwater Trawl Fishery is the Commonwealth Fisheries Association.<br><br>Western Gas has consulted the licence holders in the Western Deepwater Trawl Fishery, the Commonwealth Fisheries Association and the Western Australia Fishing Industry Council for the proposed activity.<br><br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| AHO | On 26 May 2021 Western Gas sent an email, an Information Sheet and a shipping fairways map. | Stakeholder consultation record, Reference 1.3 | No response at the completion of the 30-day stakeholder feedback period. | No claims or objections raised. No response required. | Western Gas notes feedback provided by AMSA with respect to AHO interests and will contact the AHO no less than four weeks before operations, with details relevant to the Proposed Activity. |
| AMSA (nautical advice) | On 26 May 2021 Western Gas sent an email, an Information Sheet and a shipping fairways map. | | On 27 May 2021 AMSA emailed Western Gas, and provided the following advice:<br>- Contact the Australian Hydrographic Office no less than four weeks before operations, with details relevant to the operations.<br>- Notify AMSA's Joint Rescue Coordination Centre (JRCC) at least 24-48 hours before operations commence.<br>- Provide updates to both the Australian Hydrographic Office and the JRCC on progress and any changes to the intended operations.<br>AMSA also reminded Western Gas of vessels' obligations to comply with the International Rules for Preventing Collisions at Sea, including use of appropriate lights and shapes and for vessels to ensure their navigation status is set correctly in the ship's AIS unit. | No claims or objections raised. On 24 June 2021 Western Gas emailed AMSA noting its feedback. | Western Gas notes advice provided by AMSA and will:<br>- Contact AHO no less than four weeks before operations commence.<br>- Notify AMSA's Joint Rescue Coordination Centre (JRCC) at least 24-48 hours before operations commence.<br>- Provide updates to both the AHO and the JRCC on progress and any changes to the intended operations. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
| --- | --- | --- | --- | --- | --- |
| AMSA (marine environment pollution response) | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.4 | No response at the completion of the 30-day stakeholder feedback period. | No claims or objections raised. | Western Gas notes AMSA's interests in marine pollution in Commonwealth Waters and will provide a copy of its OPEP upon submission to NOPSEMA for assessment. |
| | On 30 June 2021 Western Gas emailed AMSA its OPEP for the proposed Activity. | Stakeholder consultation record, Reference 1.21 | No response at the time of Environment Plan submission. | No claims or objections raised. Western Gas will continue to accept feedback during the NOPSEMA public comment period and assessment of the Environment Plan. | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| DAWE | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.5 | No response at the completion of the 30-day stakeholder feedback period. | No claims or objections raised. No response required. | Western Gas has assessed the relevancy of Commonwealth fisheries in Section 5.5.3.1 of this EP and notes feedback from WAFIC that Commonwealth fisheries were not impacted by the proposed Activity.<br><br>Western Gas has addressed biosecurity issues in Section 6.2 of this EP.<br><br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| DoD | On 26 May 2021 Western Gas sent an email, an Information Sheet and a defence map. | Stakeholder consultation record, Reference 1.6 | On 25 June 2021 DoD emailed Western Gas noting:<br>- The operational area was within the North West Exercise Area (NWXA) and restricted airspace.<br>- Unexploded ordnance (UXO) may be present on and in the sea floor within the NWXA and Western Gas must inform itself as to the risks associated with conducting activities in the area.<br>- All activities in the area were conducted at Western Gas' own risk and the Commonwealth of Australia, represented by the DoD, would take no responsibility for:<br>  o Reporting the location and type of UXO that may be in the areas<br>  o Identifying or removing any UXO from these areas<br>  o Any loss or damage suffered or incurred by Western Gas or any third party arising out of, or directly related to, UXO in the area.<br>- DoD required a minimum of five weeks' notice prior to the start of activities<br>DoD provided contact details in the event Notices to Airmen (NOTAM) were required for activities in restricted airspace and if the airspace was activated.<br>DoD advised Western Gas a NOTAM may be required for a temporary structure or in the | On 28 June 2021 Western Gas emailed DoD noting DoD's advice on the proximity of the proposed Sasanof-1 well location to the North West Exercise Area (NWXA) and restricted air space.<br>It also noted DoD advice with respect to the location, identification, removal, or damage to equipment from unexploded ordinances.<br>In response Western Gas confirmed:<br>- It would consider the potential for UXO in the Operational Area in its safety risk assessment for activity planning and development of appropriate management measures if required.<br>- DoD had been added to notification protocols and will notify DoD at least five weeks prior to the start of activities.<br>- AMSA and AHO had been engaged for the proposed Activity and were included in notification protocols. | Western Gas considers its response adequately addresses stakeholder interests and no further consultation is required.<br>Western Gas has conducted a Safety Risk assessment on the potential presence of UXOs in the operational area with Rig Management and the anchor handling vessel providers. This assessment and the management measures considered and adopted are detailed in the MODU Safety Case.<br>As the MODU used in the Sasanof-1 Drilling Program is a semi-submersible rig, the only credible opportunity to potentially impact with UXOs is during spudding and anchor deployment / retrieval using the anchor handling vessels. Any potential UXOs which are likely to be buried, would be in a minimum distance of 1,070 m water depth |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | event a danger area needed to be established for a permanent rig.<br><br>DoD requested Western Gas to continue liaison with the Australian Hydrographic Service, in particular ensuring that the AHS was notified three weeks prior to the commencement of activities. | Western Gas also noted contacts provided by DoD for NOTAMs if restricted airspace was activated, as well as expectations for NTOAM advice with respect to temporary structures or establishment of Danger Areas. | from the MODU or vessels thus, in the highly unlikely event that spudding, or an anchor would cause an UXO to detonate, the impact to vessels or rig would be negligible.<br><br>The key controls to be implemented are:<br><br>• Inclusion of the DoD NWXA coordinates in the rig move plan to ensure awareness of the potential presence of UXOs.<br>• Inclusion of the potential presence of UXOs in the Drill Well On Paper (DWOP) exercise attended all key third party contractors including tow vessel providers.<br>• Use of subsea ROV deployed at well head during spud activities. |
| DISER | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.7 | No response at the completion of the 30-day stakeholder feedback period. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | | | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| DNP | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.8 | No response nearing the completion of the 30-day stakeholder feedback period. | Nil | Western Gas to follow up. |
| | On 24 June 2021 Western Gas sent a follow up email. | | No response at the completion of the 30-day stakeholder feedback period. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas also notes feedback from the DNP in January 2020 for previous consultation noting it did not require additional information based on that provided for the same petroleum permit.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| | | | On 2 July 2021 DNP emailed Western Gas, confirming no authorisation requirements from the DNP were required as the proposed Activity did not overlap any Australian Marine Parks.<br>DNP provided:<br>• A link to its guidance note on preparing EPs for activities that | No claims or objections raised.<br>On 3 August 2021 Western Gas emailed the DNP noting:<br>• Link provided to the guidance note outlining DNP expectations for consideration and | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | may affect Australian marine Parks, with specific reference to:<br>• Identification and management of impacts and risks on Australian Marine Park values (including ecosystem values) to an acceptable level and consideration of options to avoid or reduce them to as low as reasonably practicable.<br>• Demonstration that the activity will not be inconsistent with relevant management plans for an Australian Marine Park.<br>• Links to information on marine park values for the region.<br><br>DNP also confirmed that it did not require further notification of progress made in relation to the activity unless details regarding the activity change and result in an overlap with or new impact to a marine park, or for emergency responses.<br><br>DNP provided details on the timeframes, notification content and way in which expected to be notified in the event an incident occurred within a marine park or was likely to impact on a marine park. | evaluation of potential impacts to Australian Marine Parks. Western Gas confirmed the guidance note had been referenced in the Environment Plan for this Activity.<br>• Link provided to the North-west Marine Parks Network Management Plan 2018. Western Gas confirmed the Management Plan had been referenced in the Environment Plan for this Activity.<br><br>Western Gas also confirmed that in the event of an incident:<br><br>• DNP will be made aware as soon as practicable of oil/gas pollution incidents that are likely to impact an Australian Marine Park, with notification made to the Marine Compliance Duty Officer on contact details provided by DNP.<br>• Notification details will include:<br>  ○ WA-519-P titleholder details | |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | | ○ The time and location of the incident, including name of marine park likely to be affected<br>○ Proposed response arrangements as per the Oil Pollution Emergency Plan<br>○ Confirmation of providing access to relevant monitoring and evaluation reports when available; and<br>○ Contact details for the response coordinator.<br>• It had noted DNP's expectation for provision of daily or weekly Situation Reports, depending on the scale and severity of the pollution incident. | |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | | Western Gas confirmed it would revert to the DNP in the event there were any material changes to planned activities that resulted in a new impact to the values of an Australian Marine Park or to emergency response arrangements. | |
| **Western Australian Government** | | | | | |
| DBCA | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.9 | On 9 June 2021 the DBCA emailed Western Gas noting that based on information provided and other readily available information, DBCA did not have any comments in relation to its Conservation and Land Management Act 1984and Biodiversity Conservation Act 2016 related responsibilities. | No claims or objections raised. On 24 June 2021 Western Gas emailed DBCA noting its feedback. | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| DMIRS | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.10 | No response at the completion of the 30-day stakeholder feedback period. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| DPIRD | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.11 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has assessed the relevancy of State fisheries in Section 5.5.3.1 of this EP. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | | | It has also consulted WAFIC on the Proposed Activity, which confirmed there were no active State managed fishers operating in WA-519-P.<br><br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| DoT | On 26 May 2021 Western Gas sent an email and Information Sheet. | | On 10 June 2021 DoT emailed Western Gas seeking more information on oil spill modelling, specifically whether there is a chance that oil could reach State waters (including offshore islands) whether at the surface or otherwise. DoT also noted its consultation expectations in the in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements | Western Gas acknowledged DoT's request and consultation arrangements and arranged a meeting to present an overview of oil spill modelling, | |
| | On 25 June 2021 Western Gas met with the DoT to discuss oil spill modelling, preparedness, and resourcing. | | DOT noted that it would have a limited role in oil spill response for the proposed Activity, given the nature of hydrocarbon properties (gas and condensate) and modelling which showed no surface contact with State shorelines.<br><br>DoT noted its interests would potentially be focused on oiled wildlife, as well as the OSMP.<br><br>DoT requested a copy of Western Gas' OPEP at the time of submission to NOPSEMA, as | Western Gas notes DoT's feedback. | Western Gas to provide a copy of its OPEP for the proposed Activity, as well as information to meet DoT's consultation. guidance. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
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| | | | well as a copy of the final OPEP following acceptance by NOPSEMA.<br>DoT also drew Western Gas' attention to its consultation expectations.<br>Discussions were also held on opportunities for DoT involvement in an emergency response exercise prior to the start of Activities. | | |
| | On 30 June 2021 Western Gas emailed DoT its OPEP for the proposed Activity, as well as the presentation from the meeting on 25 June 2021. | Stakeholder consultation record, Reference 1.21 | On 6 July 2021 DoT emailed Western Gas advising it would review the OPEP and respond with any queries. | No action required. | Consultation ongoing. |
| | | | On 6 August 2021 DoT emailed Western Gas providing feedback following its review of the draft OPEP for the proposed activity. Feedback included requests for information on:<br>• Timeframes for initial response actions.<br>• Details of potential Incident Control Centre (ICC) requirements, facilities and location<br>• Staging areas / Forward Operating Base requirements, facilities and locations<br>• Potential limiting or adverse conditions that may impact response options.<br>• Contractor details for ROV management<br>• Tracking systems to be used during an incident | Western Gas notes DoT's feedback and request for additional information.<br>On 19 August 2021 Western Gas emailed DoT advising that amendments to the OPEP as a result of DoT's feedback would be included in the final OPEP submitted to NOPSEMA for assessment. These updates comprised:<br>• Inclusion of indicative timings for initial response actions in Tables 2-1, 2-2 and 2-3 of the OPEP.<br>• Details on AGR's facilities that will be used by the Drilling | Consultation ongoing. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | • Additional detail on oil spill response training and exercises<br><br>DoT also drew to Western Gas' attention incorrect document referencing and titles of oil spill responder positions. | Incident Management Team for incident response.<br>• The identification of Onslow Marine Supply Base or Dampier Port as the Forward Operating Base depending on response activity.<br>• Metocean conditions potentially limiting vessel based operational monitoring and sampling, and adverse weather potentially impacting aerial observation activities.<br>• Advice that award of contracts for ROV management was being progressed as part of the procurement process and will be in place prior to the start of drilling activities.<br>• Details on AGR's cost Tracking System<br>• Details on a series of exercises with a full-scale oil-spill response exercise occurring 3 months prior to earliest spud date to allow for lesson learnt to be incorporated into the | |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | | OPEP and supporting documents.<br><br>Western Gas has updated the incorrect references in the OPEP, as well as citing correct titles from current oil spill planning arrangements. | |
| | | | On 19 August 2021 DoT emailed Western Gas advising it had no further comments arising from the information provided.<br><br>DoT requested to be sent a final copy of the OPEP once accepted by NOPSEMA. | Western Gas notes DoTs feedback and request. | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required.<br><br>Western Gas will provide a final copy of the OPEP once accepted by NOPSEMA.<br><br>Testing arrangements appropriate to the nature and scale of Western Gas's activities are included in Table 9-9 of the EP. |
| **Industry associations** | | | | | |
| ASBTIA | On 26 May 2021 Western Gas sent an email, Information Sheet and a Commonwealth Fisheries map. | Stakeholder consultation record, Reference 1.14 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has assessed the relevancy of Commonwealth fisheries in Section 5.5.3.1 of this EP.<br><br>It has also consulted AFMA, DAWE and the Commonwealth Fisheries on the Proposed Activity. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | | | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| CFA | On 26 May 2021 Western Gas sent an email, Information Sheet and a Commonwealth Fisheries map. | Stakeholder consultation record, Reference 1.15 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has assessed the relevancy of Commonwealth fisheries in Section 5.5.3.1 of this EP.<br><br>It has also consulted AFMA, DAWE and licence holders in the Western Deepwater Trawl Fishery on the Proposed Activity.<br><br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| PPA | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.16 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has assessed the relevancy of State fisheries in Section 5.5.3.2 of this EP.<br><br>It has also consulted the Western Australian Fishing Industry Council on the Proposed Activity.<br><br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| WAFIC | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.17 | On 4 June 2021 WAFIC emailed Western Gas confirming that Fishcube data managed by DPIRD confirms there are no active State managed fishers operating in WA-519-P.<br>WAFIC requested for the Oil Pollution Emergency Plan that Western Gas have:<br>- Baseline scientific data on aquatic organisms and the aquatic environment<br>- Communication strategy and scenario that includes the commercial fishing industry in the event of an incident<br>- A detailed process for post spill scientific monitoring of aquatic organism and aquatic environment (including commercial fishing traceability of fish product to manage tainting risks)<br>- Commitment/Consideration for financial assistance to the commercial fishing industry in the event of an incident. | On date month 2021 Western Gas emailed WAFIC noting its advice with respect to the inactivity in State managed fisheries,<br>It also confirmed to WAFIC with respect to the OPEP that:<br>- Western Gas had a sound baseline understanding of the marine environment given the significant volumes of data and studies undertaken since 2007 in adjacent permits.<br>- Western Gas had identified receptors relevant to commercial fishing in developing the Environment Plan.<br>- An Operational and Scientific Monitoring Plan would form part of the OPEP, with specific reference to Hydrocarbon Monitoring of Representative Commercial and Recreational Fish Species.<br>- Western Gas confirmed it had a process for | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| | | | | individuals, businesses and organisations who consider themselves affected by planned or unplanned activities under Western Gas' control. This process aims to resolve complaints, grievances and claims in a prompt and respectful manner. | |
| | | | On 28 June 2021 WAFIC responded by email that it had no additional comments about the Sasanof-1 exploration well. | Western Gas notes feedback from WAFIC. | No further action required. |
| **Commercial fisheries – Commonwealth** | | | | | |
| Western Deepwater Trawl Fishery | On 26 May 2021 Western Gas sent an email, Information Sheet and a Commonwealth Fisheries map. | Stakeholder consultation record, Reference 1.18 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has assessed the relevancy of Commonwealth fisheries in Section 5.5.3.1 of this EP.<br><br>It has also consulted AFMA, DAWE and the Commonwealth Fisheries Association on the Proposed Activity.<br><br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims and Western Gas' response | Western Gas Assessment |
|---|---|---|---|---|---|
| **Adjacent titleholders** | | | | | |
| Chevron<br>- WA-383-P | On 26 May 2021 Western Gas sent an email, Information Sheet and an adjacent titles map. | Stakeholder consultation record, Reference 1.19 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| Kufpec<br>- WA-538-P | On 26 May 2021 Western Gas sent an email, Information Sheet and an adjacent titles map. | Stakeholder consultation record, Reference 1.19 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

**Table 8-5 Summary of community stakeholder responses received, assessment and response for consultation activities conducted for the Sasanof-1 exploration well**

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims | Western Gas Response |
|---|---|---|---|---|---|
| **Industry associations** | | | | | |
| APPEA | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.13 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims | Western Gas Response |
|---|---|---|---|---|---|
| | | | | | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| **Community** | | | | | |
| Agility | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.20 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| BTAC | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.20 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| Mackerel Islands | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.20 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims | Western Gas Response |
|---|---|---|---|---|---|
| OCCI | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.20 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| PPA | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.16 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| PDC | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.20 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| Pilbara Ports | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.20 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond. |

| Stakeholder organisation | Consultation Activity | EP reference | Stakeholder response | Stakeholder objections or claims | Western Gas Response |
|---|---|---|---|---|---|
| | | | | | Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |
| Shire of Ashburton | On 26 May 2021 Western Gas sent an email and Information Sheet. | Stakeholder consultation record, Reference 1.20 | No response at the time of Environment Plan submission. | No claims or objections raised. No response required. | Western Gas has provided sufficient information and opportunity for the stakeholder to respond.<br>Western Gas considers this adequately addresses stakeholder interests and no further consultation is required. |

## 8.4 ONGOING STAKEHOLDER CONSULTATION

Western Gas recognises that stakeholders may continue to have an interest in the Activity, particularly the timing and location of drilling activities once they have been confirmed.

As a result, Western Gas will maintain ongoing stakeholder engagement following EP assessment and approval with key activities outlined in Table 8-6.

**Table 8-6 Ongoing stakeholder consultation**

| Consultation activity | Timing | Stakeholder organisations |
|---|---|---|
| Advise vessel details and timing/location of drilling activities to promulgate Notice to Mariners | Five weeks prior to the start of activities | • DoD |
| Advise vessel details and timing/location of drilling activities to promulgate Notice to Mariners | Four weeks prior to start of activities | • AHO |
| Advise vessel details, satellite communications details, operation area, requested clearance from other vessels and any other information that may contribute to safety at sea for promulgation of radio-navigation warnings | 24–48 hours before operations commence. | • AMSA's Joint Rescue Coordination Centre |
| Liaise government agencies on oil spill planning arrangements | Following Environment Plan acceptance by NOPSEMA | • AMSA and DoT |

# 9 IMPLEMENTATION STRATEGY

As required by Regulations 14(1) and 14(10) of the OPGGS (Environment) Regulations, Western Gas (WG) has prepared this implementation strategy for the design and execution of the Activity under the framework of Western Gas' Health, Safety and Environment Policy (WG-HSE-001) (Appendix A: Western Gas Health, Safety and Environment Policy) and Health, Safety and Environment Management System (WG-HSE-002). To ensure Western Gas' environmental performance outcomes are achieved, contractors will be required to comply with all relevant requirements of Western Gas' Health, Safety and Environment Policy and the commitments made in this EP.

Western Gas retains full and ultimate responsibility as the Titleholder of the activity and is responsible for ensuring that the environmental performance outcomes and standards outlined throughout this EP are adequately implement ed. Work instructions, procedures and plans will be used for the Activity; these will be documented within Western Gas' and the contractors' systems and manuals, as well as documents written specifically for the Activity and bridging documents between Western Gas and contractor documents.

## 9.1 ACTIVITY ORGANISATIONAL STRUCTURE

Figure 9-1 provides an overview of the relationship between Western Gas, AGR, MODU contractor and support vessel contractors for the activity.

AGR is responsible to Western Gas who has overall responsibility for the management of the drilling activity to ensure that:

- Design and execution of the activities is in accordance with industry best practice and legislated standards;
- All regulatory approvals are obtained prior to activity commencement;
- Contractors have appropriate resources and equipment to undertake the investigations and have appropriate systems in place to ensure that these activities are undertaken in accordance with all legislative requirements;
- The environmental impacts and risks of the activity are minimised and reduced to ALARP and environmental performance is monitored; and
- The day-to-day direction of work and the monitoring and auditing of work by contractors is undertaken in accordance with the accepted EP (this document).

The MODU contractor will have the day-to-day control and management of the MODU through the Offshore Installation Manager (OIM) and the support vessels through the respective Vessel Masters. The OIM and Vessel Masters have authority and responsibility to make decisions with respect to environment protection and pollution prevention and to request assistance as may be necessary.

Specific environmental roles and responsibilities are outlined in Table 9-1. These will be communicated to all personnel involved in the activity. Western Gas retains full and ultimate responsibility as the Titleholder and is responsible for ensuring that the activities associated with the activities are implemented in accordance with the EPOs outlined in this EP. As the Titleholder, Western Gas has entered into an agreement with AGR to provide the following ongoing services through this phase:

- Integrated Management System (IMS) (i.e., health, safety and environment) and support (resource) services; and

- Incident management capabilities associated with this activity.

Western Gas, AGR, the MODU and support vessel contractors will undertake the activity as follows:

- Western Gas is the Titleholder for the permit, and is the Permit Operator;
- AGR provides the necessary services and resources in order to act as the Project Manager for Western Gas;
- The relationship between the parties is governed by a Project Execution Plan (PEP), however the working relationship between the parties, both internal to them and externally, is seamless except where legislation requires otherwise;
- AGR has principal responsibility for the design of the Sasanof-1 well and the design and / or management of the contracting services;
- AGR will provide Western Gas with full technical, engineering and project management services;
- The MODU and support vessel contractors are responsible for operating the MODU and support vessels while conducting the activity and interfacing with service contractors at the operations level on the vessels;
- The MODU and support vessel contractors are responsible for ensuring the safety of all personnel on board their respective facility and vessels;
- The MODU and support vessel contractors are responsible for day-to-day implementation of this EP (with AGR supervision);
- The MODU and support vessel contractors are responsible for the offshore management of emergency incidents including oil spills from the MODU or vessels;
- AGR is responsible for the onshore management of emergency incidents; and
- The AGR Drilling Supervisor will be the designated Western Gas representative on the MODU and will have a direct interface with the Rig Contractor OIM.

### 9.1.1 Contractor Management Systems

Vessel Masters have ultimate responsibility for their vessel and persons on board, including compliance with legal requirements and *in situ* control of emergency situations or incidents. Roles and responsibilities relating to emergency situations are documented in various locations such as station bills, the project-specific Incident Response Plan, OPEP and the vessel Shipboard Oil Pollution Emergency Plan (SOPEP).

## 9.2 ROLES AND RESPONSIBILITIES

The organisational structure for the activity consists of onshore and offshore AGR, MODU, support vessel and other contractor personnel. The organisational structure for the activity is illustrated in Figure 9-1, while the environmental roles and responsibilities of key project team members are summarised in Table 9-1.

Day-to-day implementation of the EP will occur on the MODU under the leadership of the OIM, and for the support vessels under the leadership of the Vessel Masters. The AGR Project Manager will have oversight of the performance of the program against the EP and other project plans and will initiate reviews and audits as required.

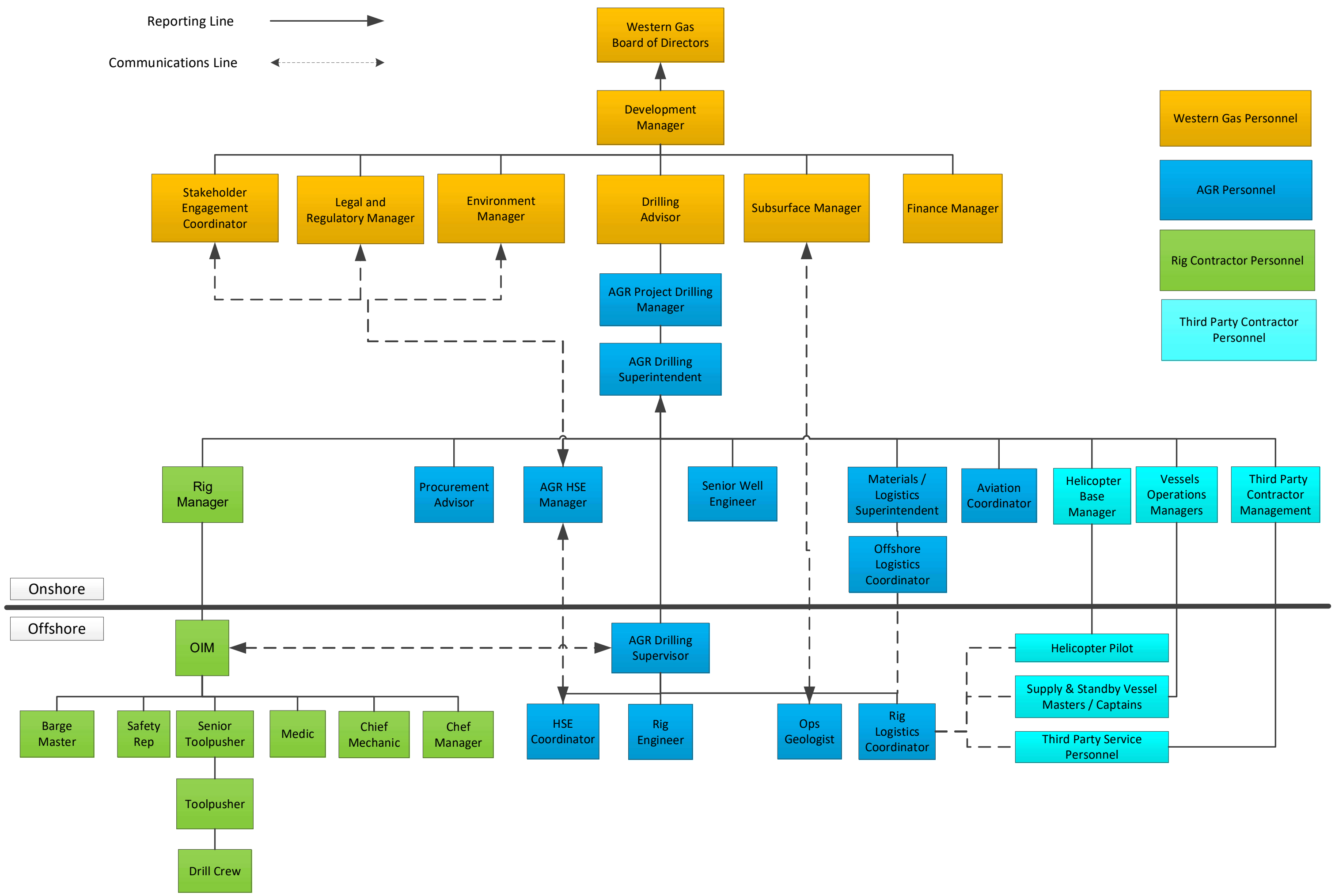


**Figure 9-1: Key Western Gas and Contractor Personnel**

**Table 9-1: Key roles and responsibilities**

| Role | Responsibility |
|---|---|
| **Western Gas** | |
| Western Gas Sasanof-1 Project Manager | • Provides direction on stakeholder consultation.<br>• Liaises with and approves incident reports for submission to regulators.<br>• Approves the Environmental Performance Report for submission to NOPSEMA.<br>• Approves the end-of-activity notification for submission to NOPSEMA. Ensures Western Gas accommodates the Activity, providing resources e.g., offices and personnel, to ensure the Activity achieves the desired technical, commercial and EHS outcomes.<br>• Ensures AGR is adequately resourced to implement the performance standards in this EP.<br>• Ensures that contractors have appropriate equipment and systems in place to undertake activities in accordance with industry best practice and this EP.<br>• Attends daily operational meetings.<br>• Approve major changes to operations.<br>• Performs routine liaison with NOPSEMA.<br>• Maintains and manages revisions of the EP as necessary.<br>• Maintains and manages revisions of the OPEP as necessary.<br>• Ensures written records of assurance assessment for identified spill response contractors.<br>• Core member of the Western Gas s Crisis Management Team (CMT) in the event of an incident. |
| Western Gas Drilling Advisor | • Primary technical interface between WG Team and AGR Team.<br>• Provides information back to WG from the DMIT.<br>• Attends daily operational meetings.<br>• Reviews major changes to operations and makes recommendations on those changes.<br>• Reviews incident reports.<br>• Supports the Western Gas Crisis Management Team (CMT) in the event of an incident.<br>• Reviews requests for changes to procedures via Western Gas Management of Change procedures. |
| Western Gas Environment Manager | • Reviews environmental approvals documentation.<br>• Assists with revisions of the EP as necessary.<br>• Supports preparation of environmental induction and vessel / MODU inspection information as required.<br>• Assists with review, investigation and reporting of environmental incidents.<br>• Monitors environmental performance against standards in this EP.<br>• Supports stakeholder consultation undertaken as per the requirements of the EP.<br>• Reviews operational reports and gathers evidence demonstrating that EPS have been met.<br>• Prepares the end-of-activity notification for submission to the regulator. |

| Role | Responsibility |
|---|---|
| | • Prepares and submits external regulatory reports required for the Activity, in line with environmental approval requirements and EHS incident reporting procedures.<br>• Leads the investigation and reporting of any environmental incidents.<br>• Supports the Western Gas Crisis Management Team (CMT) in the event of an incident.<br>• Attends daily operational meetings.<br>• Reviews major changes to operations.<br>• Prepares monthly and end-of-activity environmental performance reports. |
| Western Gas Legal and Regulatory Manager | • Reviews legislation and provides updates to the Western Gas team on legislative changes and implications for the project.<br>• Ensures all regulatory approvals are obtained before commencement of activities.<br>• Reviews environmental approvals documentation. |
| Stakeholder Consultation Manager | • Reviews and endorses the Stakeholder Engagement Plan.<br>• Ensures thorough and timely stakeholder consultation is undertaken prior to, during and after the activity. |
| **AGR** | |
| Project Drilling Manager | • Ensuring AGR's drilling operations perform to the highest required standards of HSEQ as defined by the AGR organisation, government regulators and clients.<br>• Promoting a proactive HSEQ culture within AGR operations and attendance at Project HSE meetings.<br>• Ensuring full and complete HSEQ compliance with client and government regulations.<br>• Ensure that the Well Delivery Process is followed.<br>• Focal Point for MODU selection and Contracting.<br>• Ensuring complete client satisfaction with AGR operations and that AGR carries out its operations to the highest required standard.<br>• Recruitment of onshore and offshore personnel for the operations teams.<br>• Management and selection of operational contractors and service companies.<br>• Leading any required HSEQ incident investigation.<br>• Ensures the MODU and support vessels are appropriately inspected, certified and fit for purpose.<br>• Ensures effective emergency response arrangements are in place for the activity.<br>• Ensures all Western Gas and contractor personnel are inducted and are aware of their activity-specific environmental responsibilities.<br>• Ensures all required plans, audits and reviews are undertaken in accordance with the regulatory requirements and as required by the EP. |
| Drilling Superintendent | • Facilitates clear communications between Western Gas, MODU and support vessel contractors during operations. |

| Role | Responsibility |
|---|---|
| | • Ensures compliance with this EP.<br>• Leadership of the Drilling Incident Management Team<br>• Conducts incident investigations.<br>• Provides daily feedback on operations progress to the Western Gas Drilling Advisor.<br>• Reports all incidents to the Western Gas Drilling Advisor Manager. |
| Drilling Supervisor | • Implements the Drilling Program on a daily basis while onboard the MODU.<br>• Ensures third-party compliance with AGR and Western Gas Policies and standards.<br>• Ensures all staff and contractors understand their obligations with respect to the management of environmental risk and are appropriately inducted, trained and competent in work activities undertaken.<br>• Reports environmental incidents to the AGR Project Manager.<br>• Assumes the role of On-scene Commander upon activation of the OPEP.<br>• Maintains clear communication between AGR and the MODU contractor. |
| HSE Manager | • Manages the preparation of HSE regulatory approvals documents excluding the EP which is prepared by the Western Gas Environment Manager.<br>• Provides technical input to the EP.<br>• Arranges for review of the MODU and vessel contractors' HSE management systems upon contract award.<br>• Prepares Bridging Emergency Response Plan and OPEP.<br>• Reports recordable and reportable incidents to Western Gas via Western Gas Sasanof-1 Project Manager.<br>• Assists with review, investigation and reporting of environmental incidents. |
| Offshore HSE Coordinator | • Supports the AGR Drilling Supervisor to ensure the execution of all HSE commitments under the Sasanof-1 Drilling EP, Safety Case Revision, WOMP and HSE Management Plan.<br>• Supports the AGR Drilling Supervisor in incident investigation.<br>• Provides HSE technical support to the program and works with Rig HSE Officer. |
| MODU Contractor | |
| OIM | • Oversees all work activities and work programs ensuring work is undertaken in accordance with procedures, work instructions and in compliance with all legislative requirements and EP commitments.<br>• Ensures all offshore personnel understand their obligations with respect to the management of environmental risk.<br>• Ensures the MODU training matrix is fully implemented.<br>• Ensure rig-entry HSE inductions are conducted.<br>• Ensures waste disposal complies with MARPOL requirements.<br>• Monitors closeout of non-conformances, corrective actions and audit recommendations.<br>• Reports all incidents, near misses and dangerous occurrences to the AGR Drilling Supervisor in accordance with the incident reporting system. |

| Role | Responsibility |
|---|---|
| | • Manages and coordinates offshore emergency response activities. |
| VSP contractor | • Maintains watch for cetaceans during VSP and implement control measure 9.<br>• Implement the EPBC Act Policy Statement 2.1 - Part A (Standard Management Procedures) during VSP.<br>• Records megafauna sightings and interactions during VSP and provides these to AGR at the completion of VSP. |
| All MODU personnel | • Undertake work activities with reasonable care and in accordance with EP commitments to ensure no adverse impacts to the environment.<br>• Report all new hazards, incidents, near-misses and dangerous occurrences to immediate supervisor as soon as possible.<br>• Participate in the development of work procedures through job safety analysis (JSA) development.<br>• Participate in workplace inspections.<br>• Maintain high housekeeping standards. |
| **Support vessel contractor/s** | |
| Vessel Master/s | • Ensure full compliance with all applicable navigational safety standards and regulations.<br>• Conduct emergency drills.<br>• Supervise vessel crew to ensure they are fit for duty and undertaking work only within their area of qualification and training.<br>• Monitor, report and take appropriate action to remedy any vessel or equipment defects that may impact on safety and environmental performance of the vessel.<br>• Maintain logs of emissions and discharges in accordance with MARPOL regulations.<br>• Ensure that all crew are appropriately qualified, trained and equipped for their roles on the vessel.<br>• Ensure the vessel activities are in compliance with the requirements of this EP.<br>• Report all incidents and near-misses to the Vessel Manager and AGR Drilling Supervisor, recording the details and taking initial actions to render the situation safe. |
| | • Apply operating procedures in letter and in spirit.<br>• Follow good housekeeping procedures and work practices.<br>• Attend all necessary toolbox talks and HSE inductions.<br>• Encourage improvement in environmental performance wherever possible.<br>• Immediately report environmental incidents or near-misses to their Supervisor / Vessel Master. |

## 9.3 ENVIRONMENTAL MANAGEMENT SYSTEM

As required by Regulation 14(3) of the OPGGS (Environment) Regulations, Western Gas has prepared this implementation strategy for the design and execution of the Activity under the framework of Western Gas' Health, Safety and Environment Policy (WG-HSE-001) (Appendix A: Western Gas Health, Safety and Environment Policy) and HSEM MS (WG-HSE-002). The Western

Gas HSE Management System defines the defines the principles by which Western Gas conducts its activities with regards to health, safety, and the environment.

### 9.3.1 Western Gas HSE Management System

The Western Gas HSE MS (WG-HSE-002) is comprised of a number of interrelated components (Table 9-2). The Western Gas HSE MS is modelled on a continual improvement cycle comprised of five distinct phases (commit, plan, do, check, and review) to drive overall and ongoing improvements in HSE performance. A summary of the key components and its applicability to this EP is summarised in Table 9-2.

**Table 9-2: Western Gas HSE Management System applicability to Activity**

| Phase | Component | Applicability/Contribution |
|---|---|---|
| **Commit** | HSE Policy (WG-HSE-001) | Leadership fostering an environment focused on establishing a culture which delivers HSE excellence. |
| **Plan** | Regulatory Requirements (WG-HSE-003) | Compliance with specific legal and other regulatory requirements, while achieving HSE objectives through effective identification, assessment and communication of requirements to relevant Western Gas staff and contractor personnel. |
| | Risk Management (WG-HSE-004) | Effective management of risk is recognised as an essential component of the HSE Management System to ensure that activities are performed safely and effectively. Risk assessments are performed for all activities. |
| **Do** | Training and Competencies (WG-HSE-005) | Ensuring individuals have the training, qualifications and competencies appropriate with their roles and responsibilities and HSE expectations. |
| | Contractor Management (WG-HSE-006) | Effective management of contractors is required to ensure HSE performance throughout the life cycle of a contract, from contractor selection through post-contract performance. |
| | Management of Change (WG-HSE-007) | Changes to approved work programs (e.g.: Systems, Legislation, Procedures, Equipment, Products, Materials, Planning and Execution, etc.) are to be assessed to identify and manage internal and external implications and to be approved if acceptable, by the appropriate personnel. |
| | Emergency Response Arrangements (WG-HSE-008) | An effective emergency preparedness system shall be in place, in accordance with the Activity specific Emergency Response Plans (ERP) required prior to an activity commencing. The ERP shall provide identification, assessment and guidance in the management of potential adverse situations, including events such as medical emergencies, environmental incidents, fires, blowouts, security issues and natural disasters. |
| | Incident Reporting and Investigation (WG-HSE-009) | Incident investigation systems that identify, evaluate, communicate and whenever possible eliminate potential hazards. Timely and thorough incident investigation helps provide prompt corrective action and a means for information sharing to help prevent similar events from occurring elsewhere. |
| | Records Management (WG-HSE-010) | Document and Equipment Number Procedure |
| **Check** | Performance Measurement and | Assessment of HSE performance by gathering and analysing appropriate HSE data and reporting on performance. HSE information is effectively communicated as appropriate |

| Phase | Component | Applicability/Contribution |
|---|---|---|
| | Monitoring (WG-HSE-11) | within Western Gas to ensure adjustments to priorities, updates to Management System and allocation of resources necessary to achieve HSE objectives. |
| | Audit and Verification (WG-HSE-012) | Audits and management reviews to verify the adequacy of the HSE controls for activities to evaluate their effectiveness and to identify improvement opportunities.<br>Audits shall be conducted on a regular basis as defined in the appropriate activity plans. Audit finding are recorded, and appropriate action is taken to assure closure and track findings, best practices and key lessons learned. |
| **Review** | Management Review (WG-HSE-013) | Management reviews are conducted in a consistent and visible way as means of reviewing HSE performance and effectiveness the HSE Management System. |

### 9.3.2 AGR HSE Management System

AGR's management system is accredited with ISO 9001:2015 and ISO 14001:2015 and governs all of the group business as documented in the AGR Management System Manual (AGR-HSEQ-M-01).

AGR uses a standardised management system process to ensure that project activities are planned and managed efficiently and with due consideration to good oilfield practice, local and international standards as they relate to well design, operations planning, construction and then subsequent suspension or abandonment operations. This process is known as the WDP (see also Section 3.1.4). The AGR WDP is a central component of the AGR Management System and is being used by Western Gas for this drilling activity.

The AGR WDP is primarily split into 5 phases, namely:

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

***Well Operations***

The AGR WDP is supported by the AGR Well Standard (AP-WDP-S01), which details the standards that apply to all operations planned and conducted by AGR. These are the minimum standards to be applied to all wells within AGR unless standards stipulated by local legislation are more onerous. All well operations will be planned and performed in compliance with applicable legislation, regulations and industry guidelines.

All wells are designed, constructed and operated to maintain well life cycle integrity and to ensure prevention of major accidents in line with the AGR Corporate Major Accident Prevention Policy (CMAPP, AP-HSEQ-S04).

Safety & Environmentally Critical Elements (SECE) can be defined as installation and well equipment and systems (including software) whose purpose is to prevent, limit or control the effects of a major accident or environmental event, or whose failure could cause or increase the risk of a major accident or environmental event.

Within respect to well construction, AGR has identified the following SECE within its control and measures to assure its fitness for purpose:

- Drilling Fluids;
- Casing;
- Cement Fluids;
- Wellheads;
- Blow Out Preventer and drill-string internal BOP;
- Rig Selection and Intake;
- Managing Shallow Gas Potential;
- Weather and sea state conditions; and
- Well Abandonment.

Additional detail regarding the WDP will be provided in the WOMP.

During the activity, AGR will identify any new or increased environmental impacts and risks (that are not addressed in this EP) and communicate these to the Western Gas Drilling Advisor as soon as they are identified as part of the MoC (see Section 9.8) and risk management processes.

There are daily meetings, daily drilling reports (DDRs), weekly meetings and weekly reports between the AGR and Western Gas management teams that keep all management personnel appraised of project issues (technical or HSE) as they arise.

The alignment between Western Gas' and AGR's EMS components is summarised below in Table 9-3.

**Table 9-3 Western Gas-AGR EMS Alignment**

| ISO14001:2015 framework | Western Gas | AGR alignment |
|---|---|---|
| Environmental Policy | | |
| Environmental policy | The Western Gas HSE Policy (WG-HSE-001) details Western Gas' commitment to the sustainable development of their assets. The HSE Policy is signed by the Executive Directors and is to be reviewed by them as part of the annual WGMS review. The HSE Policy is to be communicated to all Western Gas employees and contractors. | AGR has an HSE Policy, last revised in June 2019 and is provided to all employees and contractors as part of their induction and is also provided on the AGR GO Intranet System. |
| Planning | | |
| Environmental aspects | An Environmental Aspects and Impacts Register has been developed by Western Gas during the preparation of the for the Sasanof-1 Exploration Drilling EP. | AGR has a corporate environmental aspects and risk register.<br><br>AGR, as the appointed Drilling Management Contractor (DMC), has reviewed the activity-specific aspects, impacts and risks addressed in this EP on behalf of Western Gas. |
| Legal and other requirements | Western Gas has prepared the activity-specific environmental legislative requirements addressed in this EP. The EP outlines various obligations of the | AGR has in place a corporate Legal Requirements Register. |

| ISO14001:2015 framework | Western Gas | AGR alignment |
|---|---|---|
| | titleholder which relates to the proposed drilling activities. The EP obligations are provided in the Western Gas Legal Obligations Register (WG-HSE-REG-001). | |
| Objectives, targets and programs | Objectives have been set against the significant environmental aspects and recorded in an Environmental Objectives and Targets within the EP. The register also lists actions, improvement programs and controls for achieving those objectives. | AGR has developed Annual HSEQ Objectives.<br>AGR has reviewed the activity-specific EPSs outlined in this EP on behalf of Western Gas and will incorporate them into the Sasanof-1 well delivery process. |
| Implementation | | |
| Resources, roles, responsibility and authority | The Western Gas resources including their roles, responsibilities and authority have been outlined in this EP. | AGR has an HSE Manager who is experienced in managing offshore petroleum activities and are responsible for advising the AGR Project Drilling Manager. They are also responsible for measuring and reporting on the performance against the EPO and EPS in this EP. Key subcontractor roles and responsibilities under AGR management are also outlined |
| Competence, training and awareness | Personnel and contractors are required to have the training, qualifications and competencies appropriate with their roles and responsibilities. These requirements are detailed in the Training Matrix (WG-HSE-REG-005) which is required to be updated as part of the selection process for new personnel or contractors.<br>Roles that require formal industry-recognised qualifications will be identified and the appropriate certificates verified through employment or contractor selection process. Verification of certifications are to be recorded in Western Gas's records systems. | The AGR HSE Manager is responsible for identifying the competency, training and awareness requirements for this activity and arranging induction sessions for relevant personnel. |
| Communication | The Western Gas Sasanof-1 Project Manager, AGR Project Drilling Manager, HSE Manager, attend weekly Sasanof-1 Project meetings to ensure that key environmental and stakeholder issues are identified and communicated to relevant project personnel to meet the EPO and EPS outlined in this EP. | |
| Documentation<br>Control of documents | The documents and records management process to detailed in the Western Gas Document and Records Management procedure (WG-HSE-010) to ensure current versions of key documents are available and promptly removed from service when obsolete. HSE documents and records are to be stored in a manner that makes retrieval practicable. | The AGR Document and Data Control system is in use to ensure that all relevant controlled drilling design, planning and execution documents have a MoC process in place and that all changes go through a defined level of review and approval before being issued for use. |
| Operational control | The Western Gas Environment Manager, AGR Project Drilling Manager, with the assistance of the AGR HSE Manager and the Offshore HSE Coordinator, are responsible for the ensuring the stated EPO and EPS are communicated to and implemented by MODU vessel personnel. | |
| Emergency preparedness and response | The Western Gas Crisis Management Team (CMT) forms to coordinate a company-wide strategic response to a crisis. Crisis events are those incidents which may threaten the company's reputation and/or the commercial viability of any of its activities/operations. A crisis may arise from a non-operational event (business) event, or from an operational emergency event threatening the | AGR is responsible for the preparation of the activity-specific ERP and OPEP and provides the Drilling Incident Management Team (DIMT) resources required to manage any environmental incident and provides resources where required to the Western Gas CMT to manage any oil spill response effort. |

| ISO14001:2015 framework | Western Gas | AGR alignment |
|---|---|---|
| | safety and security of Western Gas personnel, stakeholders and/or the environment. The Western Gas Crisis Management Plan (CMP) has been prepared to support and contribute to this commitment, by providing a standard mechanism for the Western Gas CMT. | |
| Checking | | |
| Monitoring and measurement | The Western Gas Performance Measurement and Monitoring (WG-HSE-011) process assesses HSE performance by gathering and analysing HSE data and reporting on performance. HSE information is effectively communicated as appropriate within Western Gas to ensure adjustments to priorities, updates to Management System and allocation of resources necessary to achieve HSE objectives.<br><br>As part of the planning process for an activity, HSE data requirements are to be identified and processes put in place to obtain the appropriate data. This includes data required to be reported to regulators. The Western Gas Sasanof-1 Project Manager is responsible for reviewing HSE data to effectively manage performance. | The AGR HSE Manager, supported by the AGR Offshore HSE Coordinator, is responsible for preparing the required monitoring program to ensure the activity-specific EPOs are achieved. He is also responsible for communicating these to the AGR Drilling Supervisor during the implementation phase. |
| Evaluation of compliance | The Western Gas Environment Manager is responsible for preparing the end-of-activity compliance report for submission to NOPSEMA. | The AGR HSE Manager supports the Western Gas compliance process by planning the drilling activity compliance assessment process and providing monitoring and audit reports to Western Gas on a timely basis. |
| Non-conformity, corrective and preventative action | Western Gas Incident Reporting, Investigation and Analysis (WG-HSE-009) is committed to preventing incidents and empowers personnel and contracts to "Stop the Job" if they feel there is a risk of harm to people, the environment or assets. When incidents or near-misses occur, Western Gas will ensure that they are reported, recorded, investigated and actions implemented to prevent re-occurrence. | The AGR Incident Reporting and Investigation procedure (AGR-HSEQ-P05) and the Non-conformance and Corrective Action procedure (AGR-HSEQ-P03) will be used to record and manage all incidents and non-conformances with this EP. AGR will record all incidents and non-conformances in its GO Intranet as well as supply the information to Western Gas who will record the incident in the Incident and Action Tracking Register (WG-HSE-REG-006). |
| Control of records | The documents and records management process to detailed in the Western Gas Document and Records Management procedure (WG-HSE-010) to ensure current versions of key documents are available and promptly removed from service when obsolete. HSE documents and records are to be stored in a manner that makes retrieval practicable. | The AGR Document and Data Control procedure will be used to record all supporting EMS documentation and records with copies supplied to Western Gas. |
| Internal audit | Western Gas undertakes audits (WG-HSE-012) to verify that legal and WGMS requirements are being undertaken by the company and its contractors. Audits will be scheduled based on legal requirements, as identified in the Obligations Register, or where there is a material risk to the company. | AGR has an internal audit schedule to ensure that the Well Delivery Process (WDP) is adhered to during activity management activities.<br><br>The HSE Manager is responsible for scoping and executing all internal audits for the activity. |

| ISO14001:2015 framework | Western Gas | AGR alignment |
|---|---|---|
| Management review | Western Gas Management reviews (WG-HSE-013) are conducted in a consistent and visible way as means of reviewing performance and effectiveness the Management System.<br>Management reviews of environmental performance and of the implementation strategy should occur at planned intervals to ensure that the EMS is effective, adequate resources are available for implementing the EP and to identify and address any necessary changes to the management of environmental impacts and risks for the activity.<br>An annual review is undertaken to evaluate the effectiveness of the management system in delivering performance outcomes and addressing any opportunities for improvement to the management system. The aim of the review is to ensure that the management system is effective, adequate resources are available for implementing the management system and any legal requirements such as the EP and WOMP and to identify and address any necessary changes to the management of the company's impacts and risks. The annual management review is undertaken using the Management Review Form (WG-FORM-004). | AGR has an annual Management System Review in accordance with its ISO 14001 certification requirements.<br>The AGR HSE Manager and AGR Offshore HSE Coordinator keep the Western Gas team informed of environmental issues for the planning and operations phase of the activity during weekly team meetings and internal reporting. |

### 9.3.3 MODU and Support Vessel Contractors

The MODU and support vessel contractors will be required to have an HSEMS that meets the requirements of the Western Gas and AGR HSE Policies as well as the requirements of the AGR Contractor HSE selection process.

Contractors have specific duties as outlined in the EP and OPEP, and their local management will be specifically briefed on these obligations, as well as being provided with copies of the EP, the OPEP, and extracts of the commitments register that highlight their obligations.

Service companies and marine contractors providing the vessel are required to be included in general induction processes. Where their work provides some additional environmental risk (beyond that covered by existing processes), they will be briefed on the applicability of the EP to their operations and any performance requirement obligations.

Western Gas will use the following processes to share the responsibilities with the contractors to assess their capability:

- Campaign briefings;
- Desk-top exercises;
- Provision of copies of the OPEP and EP; and
- General contractor management (setting up contracts, scope of work, face to face meetings).

Emergency response contractors are considered in the OPEP.

## 9.4 COMPETENCY, TRAINING AND AWARENESS

### 9.4.1 Competency and Training

A competent, fully resourced organisation, MODU and support vessels are a key component to ensure all personnel are aware of the environmental obligations.

The Western Gas Contractor Management Standard (WG-HSE-006) provides for effective management of contractors to ensure EHS performance throughout the life cycle of the contract, from contractor selection through post-contract performance. Roles that require formal industry-recognised qualifications will be identified and the appropriate certificates verified through audit of training records prior to the commencement of the Activity. Certifications are recorded in Western Gas's and its contractors' records systems.

Environmental performance monitoring and audit (Section 9.9) will be used to assure compliance, including demonstration of competency. Where incidents or non-conformances are identified, corrective actions to prevent reoccurrence will address, where appropriate, competency issues such as the need for additional training and awareness.

**Contractor Competency**

During its contractor selection process, AGR will conduct a due diligence review to ensure that the chosen MODU and support vessel contractors have policies and procedures in place to ensure the correct selection, placement, training and ongoing assessment of employees, with position descriptions (including a description of HSE responsibilities) for key personnel being readily available. This process is addressed in AGR's Contractor Evaluation Procedure (AGR-LCSM-P-02). The procedure has 55 questions that focus on areas of policies, organisation, risk assessment planning and performance.

**AGR Personnel Competencies**

AGR's Wells Competency Management System (AP-WDP-M16) describes how it manages the competence of individuals and teams to carry on their work and associated risks. This includes staff, consultants, associates and third-party suppliers.

Importantly, this system specifies the roles and responsibilities and qualifications and training requirements for safety and environmentally critical positions (SECP) including the Drilling Supervisor, HSE Manager, Principal Engineer, Senior Completions Engineer and so forth. Position-specific competence matrices are available for these roles and are used to guide and record assessments of skills.

**Drilling Supervisors**

AGR's Operations Supervision Manual (AP-WDP-M13) provides detailed guidance for all AGR Well Management Supervisors (i.e., Drilling Supervisors) to ensure that drilling is undertaken in accordance with AGR standards and policies. It specifies that people in this role have a Subsea Supervisor International Well Control Certificate, offshore survival training, industry safety training, oil spill training and offshore medical training at a minimum. This manual provides the minimum standards required to ensure well control is maintained, and provides specifications for optimising drilling parameters, adequate bulk and drilling fluids, coring operations, casing/wellhead operations, cementing, formation strength tests, wireline logging, well testing and completions, and well abandonment.

### 9.4.2 Environmental Induction and Awareness

In accordance with Regulation 14 (5) of the OPGGS(E)R, each employee responsible for the implementation of task-specific control measures during operational activities shall be aware of their specific responsibilities detailed in this EP. People who hold responsibilities relating to the implementation of this EP are hired by Western Gas on the basis of their particular qualifications, experience, and competencies.

Personnel with specific responsibilities under this EP will be made aware of the environmental requirements via a project-specific induction prior to commencing the activity.

All MODU and support vessel crews, including subcontractors, will attend an induction that includes an overview of this EP. This induction fosters environmental stewardship amongst all personnel and ensures that they are aware of the control measures implemented to minimise the potential impact on the environment, before commencing operations.

The induction will include:

**Activity-specific Induction**

An activity specific HSE induction for all personnel working on the activity will be undertaken prior to commencement. This is likely to take place during a pre-spud meeting (likely to be in Perth), with additional inductions undertaken on the MODU and support vessels to take account of any crew change-outs.

The environmental component of the induction will include information on the following environmental issues:

- Awareness of Western Gas HSE Policy,
- Description of the environmental sensitivities, conservation and heritage values of the EMBA;
- An outline of the control measures in this EP to achieve the environmental performance outcomes;
- Importance of following procedures and using JSAs to identify environmental risks and mitigation measures;
- Procedures for responding to and reporting environmental hazards or incidents;
- Overview of emergency response and spill management procedures;
- Overview of the waste management requirements; and
- Roles and environmental responsibilities of key personnel aboard the MODU and vessels.

The AGR Drilling Supervisor is responsible for ensuring personnel receive this induction prior to the commencement of the activity and will be supported by the Offshore HSE Coordinator. All personnel are required to sign an attendance sheet to confirm their participation in and understanding of the induction.

**Facility-specific Induction**

The MODU and support vessel contractors will conduct their own company and vessel-specific inductions independently of the activity-specific HSE induction.

### 9.4.3 Oil Spill Response Training

Quarterly training of MODU and vessel crews in SMPEP procedures is a MARPOL requirement for vessels over 400 GRT (Annex 1, Regulation 37).

During its contractor audit process, AGR will assess the MODU and support vessel contractors' implementation of their SMPEPs (or equivalent, relevant to class).

Oil spill response capability and competencies are detailed in Section 5.1 of the OPEP.

Oil spill response exercise of the activity-specific OPEP will be conducted as detailed in Section 7.3 of the OPEP.

### 9.4.4 Toolbox Talks and HSE Meetings

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

Environmental issues will also be addressed in daily operations meetings and weekly HSE meetings, where each shift will participate with the AGR Drilling Supervisor, Offshore HSE Coordinator and support vessel Masters in discussing HSE matters that have arisen in the previous week, and issues to consider for the following week.

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

### 9.4.5 Communications

The MODU contractor, support vessel Masters and AGR Drilling Supervisor are jointly responsible for keeping their personnel informed about HSE issues, acting as a focal point for personnel to raise issues and concerns, and consulting and involving all personnel in the following:

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

Table 9-4 outlines the key meetings proposed to take place onshore and offshore during the activity.

**Table 9-4 Key meetings proposed to take place onshore and offshore during the activity**

| Meeting | Indicative Frequency | Attendees |
|---|---|---|
| **Onshore** | | |
| Western Gas / AGR Project Management | Daily | Western Gas - Drilling Adviser, Environment Manager<br>AGR - Project Manager, Senior Drilling Engineer, Logistics Superintendent, HSE Manager, Drilling Supervisor, HSE Coordinator<br>MODU - OIM<br>Support vessels – Masters<br>Third Party Contractors – as required depending on phase. |

| Meeting | Indicative Frequency | Attendees |
|---|---|---|
| **Offshore** | | |
| Operations | Daily | OIM, MODU Department Heads, AGR Drilling Supervisor, HSE Coordinator |
| Pre-start safety meeting Toolbox | Daily, prior to each shift | All personnel |
| HSE | Before each task | All personnel involved in task All personnel |
| Time Out for Safety | Weekly | All personnel |
| Pre-start safety meeting Toolbox | As required, based on identified safety issues | All personnel |

## 9.5 ENVIRONMENTAL EMERGENCIES AND PREPAREDNESS

In the event of an emergency of any type, the MODU OIM and support vessel Master will assume overall onsite command and act as the Emergency Response Coordinator (ERC). All persons aboard the MODU and support vessels will be required to act under the ERC's directions. The AGR Drilling Supervisor will maintain communications with AGR Drilling Incident Management Team (DIMT) in the event of an emergency involving an oil spill who will in turn liaise with the Western Gas Crisis Management Team (CMT). Oil spill emergency response support will be provided by the AGR DIMT. Overall emergency management will be via AGR's DIMT based in AGR's office during program execution. For further details refer to the Sasanof-1 Drilling OPEP.

### 9.5.1 Adverse Weather Protocols

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

During adverse weather, the MODU OIM and support vessel Masters are responsible for the following:

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

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

In addition to using Very High Frequency (VHF) Marine Radio Weather Services, the MODU and support vessel contractors will obtain daily weather forecasting from the Bureau of Meteorology (BoM) to monitor weather within the activity area in the lead up to and for the duration of the activity.

### 9.5.2 MODU and Support Vessel Emergencies and Oil Spills

Activity-specific emergency response procedures will be included in the MODU and support vessel contractors' ERPs. The ERPs will contain instructions for MODU and support vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification and emergency contact information.

AGR will ensure that the MODU and support vessel contractors have appropriate emergency plans in place for all relevant environmental emergency events (including the assignment of emergency management roles for particular events). Environmental emergencies that will be considered will include (but not be limited to):

- Introduction of animal diseases into aquaculture (no aquaculture operations in or around activity area);
- IMS incursions (addressed in this EP);
- Cetacean stranding and vessel strike (addressed in this EP);
- Maritime casualties requiring salvage and intervention, emergency towage and requests for a place of refuge;
- Marine pollution from floating or sunken containers of hazardous materials;
- Debris originating from a maritime casualty;
- Physical damage caused by vessels;
- Fire or explosion on the vessel;
- Hijack/terrorism; and
- Adverse weather.

SMPEPs and ERPs typically include MODU- and vessel-specific procedures for the following:

- Fire and explosion;
- Incidents – collision, grounding, hull damage, man overboard, equipment failure;
- Helicopter crash;
- Waste management;
- Hazardous materials and handling; and
- Hydrocarbon and chemical spills.

The SMPEP includes information about initial response, reporting requirements and arrangements for the involvement of third-parties having the appropriate skills and facilities necessary to respond effectively to oil spill issues. The MODU ERP and support vessels' SMPEPs will be the principal working documents for the MODU and support vessel crews in the event of a marine oil spill incident. These documents will include specific emergency procedures including steps to control discharges for bunkering spills, hull damage, grounding and stranding, fire and explosion, collisions, MODU/vessel list, tank failure, sinking and vapour releases. The SMPEP also includes requirements for regular drills of the plan and revision following drills or incidents.

The Sasanof-1 Drilling OPEP (WG-EHS-PLN-003) will be implemented (and supplements the MODU- and support vessel-specific SMPEPs) in the event of a Level 2 or Level 3 hydrocarbon spill that requires response resources beyond those immediately available to the vessels. The Sasanof-1 Drilling OPEP details the response actions aimed at minimising the impacts of subsea well loss of containment or an MDO spill on sensitive resources.

The MODU OIM and support vessel Masters will ensure that their crews are fully aware of their requirements and that exercises for MODU or vessel-related incidents are conducted.

### 9.5.3 Emergency Response Training

**Activity-specific training**

The readiness and competency of Western Gas, AGR, the MODU contractor and support vessel contractors to respond to incidents and emergencies will be tested by conducting a desktop emergency response exercise as detailed in Section 7.3 of the OPEP.

A scenario will be chosen that combines an emergency with risk to human life (such as fire) and risk to the environment (large hydrocarbon spill). This way several plans (i.e., the ERP and OPEP) can be tested simultaneously.

**MODU-specific training**

The MODU OIM is responsible for ensuring that personnel fulfilling emergency response roles are competent in crisis and emergency procedures related to the protection of health, safety, environment and integrity. The level of training and associated competency demonstration is dependent on individual roles in a crisis or emergency situation.

The MODU OIM is also responsible for ensuring relevant personnel undertake oil spill preparedness and response training in line with the MODU's personnel training and qualifications matrix. This includes identification and development of approved competency and non-competency-based courses, and ensuring training is undertaken to schedule and records are maintained.

## 9.6 MONITORING, RECORDING, AUDITING AND REVIEW

### 9.6.1 Internal Recording and Reporting

Routine internal recording and reporting of activity HSE matters will encompass the following:

- Daily teleconferences – held between the MODU OIM, support vessel Masters, AGR and Western Gas personnel each morning for an update on progress from the previous day and the forward plan, including any HSE matters that have arisen.
- Daily operations reports – the AGR Drilling Supervisor will prepare a DDR, including data on activities conducted for the day and any HSE issues arising and distributed to the extended project team.
- HSE reporting – the AGR Offshore HSE Coordinator will collate key HSE performance statistics on a daily basis and report those to the wider project team during daily teleconferences.

- Monthly environmental report – Western Gas will prepare and submit a monthly environmental report not later than 15 days after the end of the calendar month that details all recordable incidents (in accordance with OPGGS(E) Regulation 26B(4)).
- Completion performance report – Western Gas will prepare an end-of-activity performance report that details the outcomes of each EPS in the EP (in accordance with OPGGS(E) Regulation 26C(1)). This will be submitted to NOPSEMA within 3 months of completion of the activity.

### 9.6.2 External Recording and Reporting

Regulation 11A of the OPGGS(E) specifies that consultation with relevant authorities, persons and organisations must take place. This consultation includes an implicit obligation to report on the progress of the activity. Table 9-5 outlines the routine reporting obligations that Western Gas will undertake with external organisations.

**Table 9-5 External routine reporting obligations**

| Requirement | Timing | Contact details | OPGGS(E) |
|---|---|---|---|
| **Pre-activity** | | | |
| Notify AMSA JRCC in order to issue daily AusCoast warnings. | 24-48 hours prior to the activity starting. | rccaus@amsa.gov.au | Reg 11A |
| Notify NOPSEMA with the activity start date. | At least 10 days prior to the activity starting. | submissions@nopsema. gov.au | Reg 29 |
| Notify the AHO of the activity start date and duration to enable Notices to Mariners to be issued. | Four weeks prior to the activity starting. | datacentre@hydro.gov.au<br>02 4223 6590 | Reg 11A |
| Notify all other stakeholders in the stakeholder register with the activity start date. | Two weeks prior to the activity starting. | Via email addresses recorded in Stakeholder Consultation Register. | Reg 11A |
| **Activity completion** | | | |
| Notify AMSA in order to cease daily AusCoast warnings. | Within 24 hours of activity completion. | rccaus@amsa.gov.au | Reg 11A |
| Notify all stakeholders in the stakeholder register. | Within 2 days of activity completion. | Via email addresses recorded in Stakeholder Consultation Register. | Reg 11A |
| Notify the AHO in order to cease the issuing of Notices to Mariners. | Within 2 days of activity completion. | datacentre@hydro.gov.au<br>02 4223 6590 | |
| Notify NOPSEMA of the activity end date. | Within 10 days of activity completion. | submissions@nopsema. gov.au | Reg 29 |
| **Performance reporting** | | | |

| Requirement | Timing | Contact details | OPGGS(E) |
|---|---|---|---|
| Submit an end-of- program EP Performance Report. | Within 3 months of activity completion. | Submit to NOPSEMA within 3 months of activity completion. | Reg 26C |
| Notify NOPSEMA of the end of the operation of the EP. | Within 1 month of submitting the EP Performance Report. | submissions@nopsema. gov.au | Reg 25A |
| Provide marine fauna observation data to the DAWE. | Within 3 months of activity completion. | Upload information via the online Cetacean Sightings Application (https://data. marinemammals.gov.au/ csa). | EPBC Act |

### 9.6.3 Incident Recording and Reporting

All environmental near-misses and incidents, including non-compliances with the EP EPO and EPS, must be communicated immediately to AGR's HSE Manager, who will report to the Western Gas Drilling Advisor. This expectation will be reinforced at inductions, daily toolbox meetings and weekly HSE meetings.

All environmental near-misses and incidents will be recorded in the by the Western Gas Environment Manager within 8 hours of being notified of the incident. The MODU OIM and/or support vessel Master will lead an investigation into the cause, effects and learnings of the incident as per the contractor's investigation procedures. Where circumstances warrant it, this investigation will be conducted jointly with the AGR Drilling Supervisor. Following an investigation, the MODU and/or vessel contractor and AGR (with input from Western Gas as required) will develop remedial actions and communicate these to project personnel (and wider organisations, as appropriate) to prevent recurrence. These actions will be tracked to completion.

Regulation 4 of the OPGGS(E) defines the following incident types:

- Recordable incident – a breach of an EPO or EPS in the EP that is not a reportable incident.
- Reportable incident – an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage.

Western Gas interprets 'moderate to significant' environmental damage as being those hazards identified through the impact and risk assessment process (see Chapter 6) as having an inherent or residual impact consequence of 'medium', 'significant' or 'high', or an inherent or residual risk ranking of 'significant' or 'high.' Impacts and risks with these ratings (as outlined throughout Chapter 7) are:

- The introduction of IMS;
- An MDO spill;
- Loss of well containment.

As such, incidents relating to these matters are defined as reportable incidents.

Part 3 of the OPGGS(E) describes the requirements for verbal notifications and written reporting of recordable and reportable incidents. Table 9-6 outlines the incident reporting obligations that Western Gas will undertake with external organisations.

**Table 9-6: Incident Reporting**

<table>
<tr><th colspan="2">Recordable Incident Reporting – Regulation 26B</th></tr>
<tr><td colspan="2">Legislative definition of ‘recordable incident’:<br><br>*‘Recordable incident, for an activity, means a breach of an environmental performance outcome or environmental performance standard, in the environment plan that applies to the activity, that is not a reportable incident’*<br><br>Recordable incidents are breaches of environmental performance outcomes and standards.</td></tr>
<tr><th>Reporting Requirements</th><th>Report to / Timing</th></tr>
<tr><td>Written notification to NOPSEMA by the 15th of each month<br><br>As a minimum, the written incident report must describe:<br>• The incidents and all material facts and circumstances concerning the incidents.<br>• Any actions taken to avoid or mitigate any adverse environmental impacts.<br>• Any corrective actions already taken, or that may be taken, to prevent a repeat of similar incidents.<br>• If no recordable incidents occur during the reporting month, a ‘nil report’ will be submitted.</td><td>Submit written report to NOPSEMA by the 15th of each month.</td></tr>
<tr><th colspan="2">Reportable Incident Reporting – Regulation 26, 26A and 26AA</th></tr>
<tr><td colspan="2">Legislative definition of ‘reportable incident’:<br><br>*‘Reportable incident, for an activity means an incident relating to an activity that has caused or has the potential to cause an adverse environmental impact; and under the environmental risk assessment process the environmental impact is categorised as moderate to significant environmental damage.’*<br><br>Therefore, reportable incidents under this EP are those unplanned events that have a severe or greater impact severity or medium or greater risk level. In accordance with this definition, the reportable incidents identified under this EP are:<br>• Introduction of IMS<br>• Accidental Release – Loss of Well Control<br>• Accidental Release - Vessel Collision</td></tr>
<tr><th>Reporting Requirements</th><th>Report to / Timing</th></tr>
<tr><td>Verbal or written notification must be undertaken within two hours of the incident or as soon as practicable.<br><br>This information is required:<br>• The incident and all material facts and circumstances known at the time,<br>• Any actions taken to avoid or mitigate any adverse environmental impacts.</td><td>Report verbally to NOPSEMA within two hours or as soon as practicable and provide written record of notification by email.<br><br>Phone: (08) 6461 7090<br><br>Email: submissions@nopsema.gov.au</td></tr>
</table>

| | |
|---|---|
| Verbal notifications must be followed by a written report as soon as practicable, and not later than 3 days following the incident.<br>At a minimum, the written incident report will include:<br>• The incident and all material facts and circumstances,<br>• Actions taken to avoid or mitigate any adverse environmental impacts,<br>• Any corrective actions already taken, or that may be taken, to prevent a recurrence.<br>If the initial notification of the reportable incident was verbal, this information must be included in the written report. | Written report to be provided to NOPSEMA, the National Offshore Petroleum Titles Authority, and the WA Department of Mines, Industry Regulation and Safety.<br>Email: submissions@nopsema.gov.au<br>Email: info@nopta.gov.au<br>Email: petroleum.environment@dmp.wa.gov.au |
| **Additional Reporting Requirements** | |
| **Reporting Requirements** | **Report to** |
| Death or injury to individual(s) from an EPBC Act Listed Species as a result of the petroleum activities | Report injury to or mortality of EPBC Act Listed Threatened or Migratory species within seven business days of observation to DAWE or equivalent:<br>Phone: +61 2 6274 1111<br>Email: EPBC.Permits@environment.gov.au |
| Vessel collision with marine mammals (whales) | Reported as soon as practicable.<br>https://data.marinemammals.gov.au/report/shipstrike |
| Presence of any suspected marine pest or disease within 24 hours | DPIRD by email (mailto:biosecurity@fish.wa.gov.au) or phone via the FishWatch 24-hour hotline on 1800 815 507. |
| Identification of any historic shipwrecks or relics | Written notification provided to the Western Australian Museum – Maritime Archaeology Department, within one week.<br>Email: reception@museum.wa.gov.au |

## 9.7 RECORD KEEEPING

All records relevant to the EP will be stored and made available in accordance with Regulation 27 and 28 of the OPGGS (Environment) Regulations. Western Gas will generate and store records for a period of five years upon completion of the Activity including the items detailed in Regulation 27 of the OPGGS (Environment) Regulations.

## 9.8 MANAGEMENT OF CHANGE

### 9.8.1 Changes to EP Scope

Identification and potential approval of changes to scope (e.g., timing or operational details described in this EP) is the responsibility of Western Gas Sasanof-1 Project Manager, in conjunction with the Western Gas Project Director. A risk assessment will be undertaken for any change in scope in order to assess potential impacts of the change. If the change represents a significant modification that is not provided for in the accepted EP in force for the Activity, a revision of the EP will be conducted in accordance with Regulation 17(6) of the OPGGS (Environment) Regulations.

Western Gas' Management of Change (MoC) (WG-HSE-007) provides direction for Management of Change for Western Gas activities. It shall be used to ensure changes to approved work programs (e.g., systems, legislation, procedures, equipment, products, materials and planning etc.) are properly considered, and approved if acceptable, by the appropriate personnel.

### 9.8.2 Western Gas MoC Process

Changes to management systems, approved work programs and any related information (including details of the environment, legislative requirements etc) are to be routinely reviewed and assessed to identify and manage internal and external implications and to be approved if acceptable. Relevant changes are required to be assessed to ensure that new or increased company or HSE impacts and risk are identified and managed. Relevant changes include:

- new activities, assets, equipment, processes or procedures proposed to be undertaken or implemented that have company or HSE impacts or risks and have not been:
    - Previously assessed, in accordance with the requirements of the WHMS; and
    - Authorised in the WGMS or existing approvals, management plans, procedures, work instructions, or other plans.
- proposed changes to activities, assets, equipment, processes or procedures that have potential to impact on the company, people, the environment, community or stakeholders.
- changes to requirements of an existing external approval (e.g., WOMP, Environment Plan).
- new information or changes of information from research, stakeholders, legal and other requirements, and any other sources used to inform internal processes, procedures or decision and external approvals.

Relevant changes are to be assessed using the Management of Change Assessment Form (WG-FORM-001). If a change is identified that is relevant to an accepted Environment Plan the Offshore Environment Management of Change Procedure (WG-HSE-PRO-002) is to also be followed and the Offshore Environment MoC Form (WG-FORM-002) completed to determine if the change triggers a legislative requirement to resubmit the Environment Plan.

### 9.8.3 AGR MoC Process

AGR will utilise the AGR Management of Change (AP-WDP-M 09) for all activity changes during the planning for and drilling of Sasanof-1 well, including changes to regulatory documentation such as this EP, any changes to the program that may impact on environmental performance, any new environmental impacts and risks, and will evaluate if there is any impact from these changes that may trigger a revision to the EP. AGR, in conjunction with the Western Gas Drilling Manager, will ensure any changes triggering an EP revision as per the regulations (see Section 1.6) are captured as part of the MoC process. Western Gas has evaluated the AGR MoC procedure and verified that it meets its requirements as the Titleholder and those of the OPGGS(E).

The process is applied to all changes and deviations for the activity after the approval of the Detailed Drilling Guideline (2021-004-18-02), until the completion of activity.

Permanent or temporary changes to organisation, equipment, plant, standards or procedures that have potential HSE and/or integrity impacts are subject to formal review and approval prior to initiating the change to ensure risks remain acceptable and are reduced to ALARP. The level of management approval for each change is commensurate with the risk.

Changes are classified as minor, significant or major and are described below.

**Minor Change**

A minor change is a change to an approved plan, work programme (or a procedure referenced in it) that has no safety, environmental or well integrity implication, adds less than AUD$100,000 to the cost of the operation and has no impact on the operation's objectives (e.g., additional core sample/s).

Minor changes to the activity will be discussed and agreed at the daily operations meeting. All activity changes will be confirmed by email from the AGR Project Manager, or designate, to the AGR Drilling Supervisor.

When operations are being conducted, the AGR Project Manager must provide approval. All minor changes must be confirmed via email and approved by the AGR Project Manager.

**Significant Change**

A significant change is defined as a change to an approved plan or work programme that does not impact the operation's objectives but could have a direct safety, environmental implication (i.e., increase in risk profile above that of the originally planned program) and/or increase the cost of the operation by more than AUD$100,000 but less than AUD$250,000.

Significant changes to the plan or programme, or significant operations not included in the programme, will be discussed, risk assessed and agreed by the onshore and offshore teams and confirmed in writing with an approved Programme Supplement or Amendment. This will be issued prior to commencing the change in programme. The AGR Project Manager will discuss the proposed change with the Western Gas Drilling Manager, the MODU Manager/OIM and the support vessel Masters. The Supplement or Amendment is developed by the relevant engineer and approved by the AGR Project Manager, or his delegate and the Western Gas Drilling Manager and issued to the team.

All changes are assessed to ensure any new impacts or risks, or significant change in risk level, are identified.

In the event that the change influences environmental aspects of the activity, the Western Gas Drilling Manager, Western Gas Environment Manager and the AGR HSE Manager must be consulted to determine whether an EP revision is triggered and to follow Western Gas's process for environmental change.

Following this MoC process, Western Gas will assess and undertake the necessary revision/resubmission of the EP as described in Section 9.8.1 and assisted by the AGR project team as required.

**Major Change**

A major deviation from plan is one that results in a deviation from the Sasanof-1 drilling activity, Western Gas policies and standards, has a direct safety or environmental implication (i.e., an increase in risk profile above that of the originally planned program), an EP revision being triggered, the design of the investigation program changing and/or will result in the Authority for Expenditure being exceeded.

Changes affecting the approved activity require an approved Program Supplement or Amendment to be issued. The AGR Project Manager will discuss the proposed change with the Western Gas Drilling Manager and the MODU Manager/OIM. The Supplement or Amendment is developed by the relevant engineer and approved by the Western Gas Drilling Manager and the AGR Project Manager, or his delegate.

Exceptionally, if conditions demand an immediate response to safeguard the MODU or support vessel, then the AGR Drilling Supervisor is authorised to implement any necessary changes to the program with the agreement of the MODU Manager/OIM or support vessel Masters. Contact with the AGR Project Manager or his delegate should be made as soon as reasonably practicable. A Programme Supplement or Amendment should be prepared the next working day.

All changes are assessed to ensure any new impacts or risks, or significant change in risk level are identified.

In the event the change influences environmental aspect of the activity, the Western Gas Environment Manager and the AGR HSE Manager must be consulted to determine whether an EP revision is triggered.

Following this MoC process, Western Gas will assess and undertake the necessary revision and resubmission of the EP as described in Section 9.8.1.

## 9.9 MONITORING

This section describes the environmental monitoring requirements of the Sasanof-1 Drilling activity.

### 9.9.1 Field Environmental Monitoring

Western Gas will maintain a quantitative record of emissions and discharges, and other environmental matters generated on location during the activity, as required under Regulation 14(7) of the OPGGS(E).

The MODU contractor is responsible for collecting this data and reporting it to the AGR Drilling Supervisor. This is facilitated, in part, by completing a daily environmental monitoring register that will be provided by AGR to the contractor, which captures the commitments made in Section 6.6. These results will be reported in the end-of-program EP performance report submitted to NOPSEMA.

**Table 9-7: Monitoring and recording requirements for the Activity**

| Activity | Monitoring | Record keeping |
|---|---|---|
| Training | Details of crew environmental inductions. | Induction Record Sheets. |
| Waste management | Quantities of waste landfilled, recycled and discharged. | Waste Log, Rubbish record book, Spill response operations – waste transfer logs, ODS Record Book. |
| Fauna interactions | Cetacean and turtle sightings.<br>Any interactions between marine fauna and vessels. | DEE cetacean sightings report forms and records of transmittal to DEE and NOPSEMA.<br>Turtle sighting records.<br>Vessel-marine fauna interaction records. |
| Incident reporting | Number and details of environmental incidents. | EHS incident reports. |

| Activity | Monitoring | Record keeping |
|---|---|---|
| Compliance reporting | Compliance with EP performance outcomes. | Completed environmental inspection / audit check sheet. |
| Maintenance | Maintenance schedule for applicable equipment. | PMS records. |
| On-going Consultation | Records of consultation with stakeholders. | Transmittals to stakeholders and responses. |

**Table 9-8: Emissions and discharges to be recorded and reported to NOPSEMA at end of Activity**

| Emission or discharge | Information recorded | By whom and when | Records and reporting |
|---|---|---|---|
| Oil in water discharged overboard from vessels >400 tonnes | Volume and concentration of oil discharged. | Chief Engineer, after each batch discharge or daily for ongoing. | Oil record book.<br><br>Data provided at end of activity. |
| Waste from vessels | Quantities and types of waste backloaded to shore. | Chief Engineer, after each backload | Waste records maintained on vessels.<br><br>Data provided at end of activity. |
| Dropped objects | Type, location, quantity. | Vessel Master / OIM, as required. | Incident reports completed and copied to Western Gas Project Manager. |
| Fuel use and associated atmospheric emissions | Volume of fuel used. | Vessel Master / OIM, Daily records | Data provided at end of activity. Emissions calculated using emissions factors by Western Gas Project HSE Specialist. |
| Sewage from vessels >400 tonnes | Volumes discharged overboard. | Chief Engineer estimates at end of Activity. | Data provided at end of Activity. |
| Drill cuttings and mud | Fluid type, fluid volume and % oil on cuttings | Drilling Contractor, after each batch discharge or daily for ongoing. | Daily drilling report |
| Cement | Nature of discharge, volume and location | Drilling Contractor, after each batch discharge or daily for ongoing. | Daily drilling report |
| Bilge water | Volume, location and vessel speed | Vessel Master, as required. | Oil Record Book |
| Ballast Water discharges | Volume, location | Vessel Master, as required. | Ballast Water Record System. |
| Chemical discharges to marine environment | Chemical name, type, use and volume | Drilling Contractor, after each batch discharge or daily for ongoing. | Daily Report |
| Accidental release or losses overboard | Nature of the discharge material, and volume / amount | Vessel Master / OIM, as required. | Daily Report<br><br>Incident Report |

| Emission or discharge | Information recorded | By whom and when | Records and reporting |
|---|---|---|---|
| Spill | Volume, chemical / oil type | Vessel Master / OIM, as required. | Daily Report<br>Incident Report |

### 9.9.2 Auditing, Assurance and Inspections

Western Gas conducts reviews and audits of contractors at various stages including pre-award of contract, and prior to and during the Activity in accordance with its HSE Management System.

The audits will be documented, and corrective actions will be tracked to completion in accordance with the Western Gas Audit and Verification Standard (WG-HSE-012).

Each contractor's internal environmental performance monitoring and auditing commitments are detailed in its EHS Management System, including identification and management of non-conformance. These processes will ensure that continual monitoring and improvement occurs so that EHS performance meets the requirements of the organisation's EHS policies and Safety Case (if relevant), as well as applicable requirements from the EP (as documented in the Commitments Register).

Environmental performance assurance of the activity will be undertaken in a number of ways. Performance assurance is undertaken to ensure that:

- EPS to achieve the EPO are being implemented;
- Potential non-compliances and opportunities for improvement are identified; and
- All environmental monitoring requirements have been met before completing the activity.

The following arrangements will be established to ensure environmental performance is in line with this EP.

**Pre-activity HSE Due Diligence Inspection**

AGR will undertake pre-activity (and post- award) inspections of the MODU and support vessels to ensure that procedures and equipment for managing routine discharges and emissions are in place to enable compliance with the EP. This will be undertaken in accordance with AGR's Contractor Evaluation Procedure (AGR-LCSM- P-02).

**Onboard Environmental Audit**

AGR will undertake an environmental compliance audit onboard the MODU during drilling operations to assess compliance with this EP. This will be undertaken by appropriately qualified and experienced personnel familiar with MODU operations and environmental management.

An AGR representative will undertake an audit on one or both support vessels while in dock, or if logistics do not allow for this, AGR will provide EP commitments checklists to the vessel Masters to complete during the activity. Given that most impacts and risks from the activity are related to MODU-related discharges and emissions, logistics related to auditing will focus on the MODU.

**Onboard Inspections**

The AGR Drilling Supervisor will continuously supervise the activity, ensuring adherence to the environmental controls specified in this EP. This will be facilitated by completing an environmental inspection checklist developed by the AGR HSE Manager. A completed checklist will be provided to the AGR HSE Manager on a weekly basis so that environmental compliance is continuously monitored. This provides ongoing assurance that the EP commitments are met, as a one-off audit only provides a 'snapshot in time' perspective of environmental management.

Any non-compliance with the EPS outlined in this EP will be internally and externally reported and subject to investigation and follow-up action as detailed in Section 9.6.1 and Section 9.6.2.

The findings and recommendations of inspections and audits will be documented and distributed to relevant personnel for comments. Any non-compliances or opportunities for improvement will be communicated to the MODU OIM, support vessel Masters and AGR Drilling Supervisor at the time of the inspection or audit to ensure there is adequate time to implement corrective actions. Results will be summarised in the EP performance report submitted to NOPSEMA after the completion of the activity.

### 9.9.3 Contractor Monitoring and Review

The MODU and vessel contractors will have specific contractual compliance obligations associated with implementing the EP, OPEP and other applicable plans. Western Gas will monitor the contractors against these obligations both in terms of deliverables and quality.

AGR will have in place commitments registers to assist in monitoring against these plans.

### 9.9.4 Management of Non-Conformance

Non-conformances comprise incidents, audit findings, failures to meet defined outcomes and objectives, and deviations from standards and procedures. Other potential improvements may be identified via observations of potential reductions to risk(s) or improved performance. Mechanisms for identifying and managing non-conformances associated with the Activity include:

- Audits and inspections (e.g., those conducted prior to or during the Activity);
- Incident reports;
- Reports from personnel (e.g., hazard observations); and
- Incidents such as spills.

A key mechanism to resolve potential non-conformances is the daily meeting ('Morning Call'), whereby the Western Gas Project Offshore Representative will communicate these items to Western Gas onshore management. Depending on the nature and level of non-conformance, the issue may be recorded in the Drilling Contractor's and/or Western Gas' non-conformance process (Corrective Actions Register). For example, a low risk observation around waste segregation identified offshore by a Vessel Contractor may only be recorded in the contractor's non-conformance process. A spill of oil to sea will be of greater concern (risk) and benefit in Western Gas following up and recording through its own systems. It is the responsibility of the Western Gas Project Offshore Representative and Western Gas Sasanof-1 Project Manager (with input from the Western Gas Project HSE Specialist and with consideration of the level of risk) to determine the appropriate recording of the incident with regard to Western Gas' HSE Management System.

## 9.10 OIL POLLUTION EMERGENCY PLAN

Regulation 14(8) of the OPGGS (E) Regulations 2009 requires the implementation strategy to contain an OPEP and the provision for the OPEP to be updated. A summary of the regulatory requirements and a reference to where the obligations are met is provided below. The OPEP is presented in Appendix D.

### 9.10.1 Review of OPEP

The OPEP should be reviewed internally at least annually, in addition, the OPEP will be reviewed under the following circumstances:

- Prior to undertaking a new activity not currently provided for, and prior to the submission or re-submission of a new Environment Plan for activities, in accordance with the MoC process.
- Following any exercises or other means of testing of the arrangements, as required, to capture learnings.
- Following activation, to capture lessons learned.

Changes to the OPEP or the OSMP resulting from exercise outcomes, altered contractual arrangements, corrective actions, routine information updates (i.e., contact details change), or other items will be managed as per the MoC process.

### 9.10.2 Testing Arrangements

In accordance with Regulation 14 (8A) & (8C) of the OPGGS(E)R, the response arrangements will be tested:

- When they are introduced;
- When they are significantly amended;
- Not later than 12 months after the most recent test;
- If a new location for the activity is added to the EP after the response arrangements have been tested, and before the next test is conducted – testing the response arrangement in relation to the new location as soon as practicable after it is added to the plan; and
- If a facility becomes operational after the response arrangements have been tested and before the next test is conducted – testing the response arrangements in relation to the facility when it becomes operational.

As required by the Environment Regulation 14(8A), the testing must relate to the nature and scale of the risk of oil pollution relevant to this exploration drilling activity.

Testing arrangements and objectives appropriate to the nature and scale of Western Gas's activities are detailed in Section 7.3 of the OPEP. Exercises will be facilitated by an experienced facilitator. At the completion of the exercise, the facilitator will hold a debrief session during which the exercise is reviewed, and lessons learned and areas for improvement are identified.

Any learnings, findings or recommendations identified as part of the testing exercises will be addressed and incorporated into the relevant emergency response plans and procedures to ensure they remain effective. Undertaking the exercises 3 months prior to the activity commencement ensures there is sufficient time to manage responses to any recommendations or outcomes of the testing prior to the activity commencing.

### 9.10.3 Equipment Maintenance and Inspection

Up-to-date information about the location, quantity, and specifications of all response equipment is maintained by the equipment owners and monitored by Western Gas. Oil spill response equipment is stored and maintained in accordance with manufacturers' specifications, and regular inspections are undertaken by the equipment owner and verified by Western Gas.

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# APPENDIX A: WESTERN GAS HEALTH, SAFETY AND ENVIRONMENT POLICY

WESTERN GAS

# Health, Safety & Environment Policy

*Western Gas are a proud Western Australian company and one that's focused on providing customers with secure, reliable and clean energy.*

*Western Gas recognise that excellence in Environmental, Health and Safety performance is an essential part of our mission to provide sustainable growth.*

## To accomplish this, we will:

- *Identify, assess and manage the Environmental, Health and Safety risks and impacts of our existing and planned operations*
- *Set our objectives and targets that result in continuous improvement of our Environmental, Health and Safety performance*
- *Provide the leadership and resources that will enable our workforce to meet improvement objectives and targets*
- *Require every employee, contractor and other service providers to take personal responsibility towards meeting Environmental, Health and Safety objectives*
- *Comply with applicable Environmental, Health and Safety laws and regulations*
- *Eliminate or minimise all workplace hazards and risks as far as is reasonably practicable*
- *Communicate regularly with the communities where we operate to develop and maintain a mutual understanding of goals and expectations*
- *Promote the conservation of energy and natural resources and reduce waste*
- *Routinely monitor, assess and report on the company's Environmental Health and Safety performance and on our conformity with this policy.*

Andrew Leibovitch, Executive Director
*Date: November 2017*

Will Barker, Executive Director
*Date: November 2017*

# APPENDIX B: EPBC PROTECTED MATTERS SEARCH TOOL RESULTS

## Bird species or species habitat that may occur within the Project EMBA

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure | EMBA |
| *Actitis hypoleucos* | Common Sandpiper | | (W) | yes | (MO) | (KO) | (KO) |
| *Anous stolidus* | Common Noddy | | (M) | yes | (MO) | (LO) | (FLO) |
| *Anous tenuirostris melanops* | Australian Lesser Noddy | V | | yes | | | (BKO) |
| *Apus pacificus* | Fork-tailed Swift | | (M) | yes | | (LO) | (LO) |
| *Ardea alba* | Great Egret | | | yes | | (LO) | (KO) |
| *Ardea ibis* | Cattle Egret | | | yes | | (MO) | (MO) |
| *Ardenna carneipes* | Flesh-footed Shearwater | | (M) | | | (FLO) | (FLO) |
| *Ardenna pacifica* * | Wedge-tailed Shearwater | | (M) | | | | (KO) |
| *Calidris acuminate* | Sharp-tailed Sandpiper | | (W) | yes | (MO) | | (KO) |
| *Calidris canutus* | Red knot | E | (W) | yes | (MO) | (LO) | (KO) |
| *Calidris ferruginea* | Curlew Sandpiper | CE | (W) | yes | | (KO) | (KO) |
| *Calidris melanotos* | Pectoral Sandpiper | | (W) | yes | (MO) | (MO) | (MO) |
| *Calonectris leucomelas* | Streaked Shearwater | | (M) | yes | | (LO) | (KO) |
| *Calyptorhynchus latirostris* | Carnaby's Cockatoo | E | | | | | (LO) |
| *Catharacta skua* | Great Skua | | | yes | | | (MO) |
| *Charadrius veredus* | Oriental Plover | | (W) | yes | | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure | EMBA |
| *Chrysococcyx osculans* | Black-eared Cuckoo | | | yes | | (LO) | (KO) |
| *Diomedea amsterdamensis* | Amsterdam Albatross | E | (M) | yes | | | (LO) |
| *Diomedea epomophora* | Southern Royal Albatross | V | (M) | yes | | | (FLO) |
| *Diomedea exulans* | Wandering Albatross | V | (M) | yes | | | (FLO) |
| *Diomedea sanfordi* | Northern Royal Albatross | E | (M) | yes | | | (FLO) |
| *Fregata andrewsi* | Christmas Island Frigatebird | E | (M) | yes | | | (FKO) |
| *Fregata ariel* | Lesser Frigatebird | | (M) | yes | (MO) | (LO) | (KO) |
| *Fregata minor* | Great Frigatebird | | (M) | yes | | (MO) | (MO) |
| *Glareola maldivarum* | Oriental Pratincole | | (W) | yes | | (MO) | (MO) |
| *Haliaeetus leucogaster* | White-bellied Sea-Eagle | | | yes | | (MO) | (KO) |
| *Halobaena caerulea* | Blue Petrel | V | | yes | | | (MO) |
| *Hirundo rustica* | Barn Swallow | | (T) | yes | | (MO) | (MO) |
| *Hydroprogne caspia* * | Caspian Tern | | (M) | | | (BKO) | (BKO) |
| *Larus novaehollandiae* | Silver Gull | | | yes | | | (BKO) |
| *Larus pacificus* | Pacific Gull | | | yes | | | (BKO) |
| *Leipoa ocellata* | Malleefow | V | | | | | (LO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure | EMBA |
| *Limosa lapponica* | Bar-tailed Godwit | | (W) | yes | | (KO) | (KO) |
| *Limosa lapponica bauera* | Bar-tailed Godwit (baueri) | V | | | | | (MO) |
| *Limosa lapponica menzbieri* | Northern Siberian Bar-tailed Godwit | CE | | | | (MO) | (MO) |
| *Macronectes giganteus* | Southern Giant-Petrel | E | (M) | yes | | (MO) | (MO) |
| *Malurus leucopterus edouardi* | White-winged Fairy-wren | V | | | | | (LO) |
| *Macronectes giganteus* | Southern Giant-Petrel | E | (M) | yes | (MO) | (MO) | (MO) |
| *Macronectes halli* | Northern Giant Petrel | V | (M) | yes | | (MO) | (MO) |
| *Merops ornatus* | Rainbow Bee-eater | | | yes | | (MO) | (MO) |
| *Motacilla cinerea* | Grey Wagtail | | (T) | yes | | (MO) | (MO) |
| *Motacilla flava* | Yellow Wagtail | | (T) | yes | | (MO) | (MO) |
| *Numenius madagascariensis* | Eastern Curlew | CE | (W) | yes | | (KO) | (KO) |
| *Onychoprion anaethetus* | Bridled Tern | | (M) | | | (FLO) | (BKO) |
| *Pachyptila turtur* | Fairy Prion | | | yes | | | (MO) |
| *Pachyptila turtur* (subantarctica) | Fairy Prion (southern) | V | | | | | (MO) |
| *Pandion haliaetus* | Osprey | | (W) | yes | | (BKO) | (KO) |
| *Papasula abbotti* | Abbott's Booby | E | | yes | | (MO) | (LO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure | EMBA |
| *Pelagodroma marina* | White-faced Storm-Petrel | | | yes | | | (BKO) |
| *Pezoporus occidentalis* | Night Parrot | E | | | | | (MO) |
| *Phaethon lepturus* | White-tailed Tropicbird | | (M) | yes | | | (FLO) |
| *Phaethon rubricauda* | Red-tailed Tropicbird | | (M) | yes | | | (BKO) |
| *Phalacrocorax fuscescens* | Black-faced Cormorant | | | yes | | | (BLO) |
| *Phoebetria fusca* | Sooty Albatross | V | (M) | yes | | | (MO) |
| *Pterodroma arminjoniana* | Round Island Petrel | CE | | | | | (MO) |
| *Pterodroma macroptera* | Great-winged Petrel | | | yes | | | (FKO) |
| *Pterodroma mollis* | Soft-plumaged Petrel | V | | yes | | (FLO) | (FKO) |
| *Puffinus assimilis* | Little Shearwater | | | yes | | | (BKO) |
| *Puffinus carneipes* | Flesh-footed Shearwater | | | yes | | (FLO) | (FLO) |
| *Puffinus huttoni* | Hutton's Shearwater | | | yes | | | (FKO) |
| *Puffinus pacificus* * | Wedge-tailed Shearwater | | (M) | yes | | | (BKO) |
| *Rostratula australis* | Australian Painted-snipe | E | | yes | | (MO) | (LO) |
| *Rostratula benghalensis (sensu lato)* * | Painted Snipe | E | | yes | | (MO) | (LO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure | EMBA |
| *Sterna albifrons* | Little Tern | | (M) | yes | | | (CKO) |
| *Sterna anaethetus* | Bridled Tern | | | yes | | (FLO) | (BKO) |
| *Sterna bengalensis* | Lesser Crested Tern | | | yes | | | (BKO) |
| *Sterna bergii* | Crested Tern | | (M) | yes | | (BKO) | (BKO) |
| *Sterna caspia** | Caspian Tern | | | yes | | (BKO) | (BKO) |
| *Sterna dougallii* | Roseate Tern | | (M) | | | (BKO) | (BKO) |
| *Sterna fuscata* * | Sooty Tern | | | yes | | (FLO) | (BKO) |
| *Sterna nereis* | Fairy Tern | | | yes | | | (BKO) |
| *Sternula albifrons** | Little Tern | | (M) | yes | | | (CKO) |
| *Sternula nereis nereis* | Australian Fairy Tern | V | | | | (BKO) | (BKO) |
| *Thalasseus bergii** | Crested Tern | | (W) | yes | | (BKO) | (BKO) |
| *Thalassarche carteri* | Indian Yellow-nosed Albatross | V | (M) | yes | | (FMO) | (FMO) |
| *Thalassarche cauta** | Shy Albatross | V | (M) | yes | | (MO) | (MO) |
| *Thalassarche cauta cauta* | Shy Albatross | V | (M) | yes | | (MO) | (MO) |
| *Thalassarche cauta steadi** | White-capped Albatross | V | (M) | yes | | (FLO) | (FLO) |
| *Thalassarche impavida* | Campbell Albatross | V | (M) | yes | | (MO) | (MO) |
| *Thalassarche melanophris* | Black-browed Albatross | V | (M) | yes | | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure | EMBA |
| *Thalassarche steadi** | White-capped Albatross | V | (M) | yes | | (FLO) | (FLO) |
| *Thinornis rubricollis* | Hooded Plover | | | yes | | | (KO) |
| *Tringa nebularia* | Common Greenshank | | (W) | yes | | | (LO) |
| *Turnix varius scintillans* | Painted Button-quail | V | | | | | (LO) |

*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 known to occur within area*

* Species name provided in PMST search however species has multiple different scientific name

## Sharks and ray species or species habitat that may occur within the Project Areas

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| **Sharks** | | | | | | | |
| *Carcharias taurus (west coast population)* | Grey Nurse Shark (west coast population) | V | | | | (KO) | (KO) |
| *Carcharodon Carcharias* | Great White Shark | V | M | | (MO) | (KO) | (FKO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Isurus oxyrinchus* | Shortfin Mako | | M | | (LO) | (LO) | (LO) |
| *Isurus paucus* | Longfin Mako | | M | | (LO) | (LO) | (LO) |
| *Lamna nasus* | Mackerel Shark | | M | | | (MO) | (MO) |
| *Rhincodon typus* | Whale Shark | V | M | | | (FKO) | (MO) |
| **Sawfish** | | | | | | | |
| *Anoxypristis cuspidata* | Narrow Sawfish | | M | | | (KO) | (KO) |
| *Pristis clavata* | Dwarf Sawfish | V | M | | | (KO) | (KO) |
| *Pristis pristis* | Freshwater Sawfish | V | M | | | | (KO) |
| *Pristis zijsron* | Green Sawfish | V | M | | | (KO) | (KO) |
| **Ray** | | | | | | | |
| *Manta alfredi* | Reef Manta Ray | | M | | | (KO) | (KO) |
| *Manta birostris* | Giant Manta Ray | | M | | (MO) | (KO) | (KO) |

## Other fish species or species habitat that may occur within the Project Areas

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| **Pipehores, Seahorse, seadragon** | | | | | | | |
| *Acentronura australe* | Southern Pygmy Pipehorse | | | Yes | | | (MO) |
| *Acentronura larsonae* | Helen's Pygmy Pipehorse | | | Yes | | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Bhanotia fasciolata* | Corrugated Pipefish | | | Yes | | | (MO) |
| *Bulbonaricus brauni* | Braun's Pughead Pipefish | | | Yes | | (MO) | (MO) |
| *Campichthys galei* | Gale's Pipefish | | | Yes | | | (MO) |
| *Campichthys tricarinatus* | Three-keel Pipefish | | | Yes | | (MO) | (MO) |
| *Choeroichthys brachysoma* | Pacific Short-bodied Pipefish | | | Yes | | (MO) | (MO) |
| *Choeroichthys latispinosus* | Muiron Island Pipefish | | | Yes | | (MO) | (MO) |
| *Choeroichthys suillus* | Pig-snouted Pipefish | | | Yes | | (MO) | (MO) |
| *Corythoichthys amplexus* | Fijian Banded Pipefish | | | Yes | | | (MO) |
| *Corythoichthys flavofasciatus* | Reticulate Pipefish | | | Yes | | (MO) | (MO) |
| *Corythoichthys intestinalis* | Australian Messmate Pipefish | | | Yes | | | (MO) |
| *Corythoichthys schultzi* | Schultz's Pipefish | | | Yes | | | (MO) |
| *Cosmocampus banneri* | Roughridge Pipefish | | | Yes | | (MO) | (MO) |
| *Doryrhamphus dactyliophorus* | Banded Pipefish | | | Yes | | (MO) | (MO) |
| *Doryrhamphus excisus* | Bluestripe Pipefish | | | Yes | | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Doryrhamphus janssi* | Cleaner Pipefish | | | Yes | | (MO) | (MO) |
| *Doryrhamphus multiannulatus* | Many-banded Pipefish | | | Yes | | (MO) | (MO) |
| *Doryrhamphus negrosensis* | Flagtail Pipefish | | | Yes | | (MO) | (MO) |
| *Festucalex scalaris* | Ladder Pipefish | | | Yes | | (MO) | (MO) |
| *Filicampus tigris* | Tiger Pipefish | | | Yes | | (MO) | (MO) |
| *Halicampus brocki* | Brock's Pipefish | | | Yes | | (MO) | (MO) |
| *Halicampus dunckeri* | Red-hair Pipefish | | | Yes | | | (MO) |
| *Halicampus grayi* | Mud Pipefish | | | Yes | | (MO) | (MO) |
| *Halicampus nitidus* | Glittering Pipefish | | | Yes | | (MO) | (MO) |
| *Halicampus spinirostris* | Spiny-snout Pipefish | | | Yes | | (MO) | (MO) |
| *Haliichthys taeniophorus* | Ribboned Pipehorse | | | Yes | | (MO) | (MO) |
| *Hippichthys penicillus* | Beady Pipefish | | | Yes | | (MO) | (MO) |
| *Hippocampus angustus* | Western Spiny Seahorse | | | Yes | | (MO) | (MO) |
| *Hippocampus breviceps* | Short-head Seahorse | | | Yes | | | (MO) |
| *Hippocampus histrix* | Spiny Seahorse | | | Yes | | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Hippocampus kuda* | Spotted Seahorse | | | Yes | | (MO) | (MO) |
| *Hippocampus planifrons* | Flat-face Seahorse | | | Yes | | (MO) | (MO) |
| *Hippocampus spinosissimus* | Hedgehog Seahorse | | | Yes | | (MO) | (MO) |
| *Hippocampus subelongatus* | West Australian Seahorse | | | Yes | | | (MO) |
| *Hippocampus trimaculatus* | Three-spot Seahorse | | | Yes | | (MO) | (MO) |
| *Lissocampus fatiloquus* | Prophet's Pipefish | | | Yes | | | (MO) |
| *Maroubra perserrata* | Sawtooth Pipefish | | | Yes | | | (MO) |
| *Micrognathus micronotopterus* | Tidepool Pipefish | | | Yes | | (MO) | (MO) |
| *Mitotichthys meraculus* | Western Crested Pipefish | | | Yes | | | (MO) |
| *Nannocampus subosseus* | Bonyhead Pipefish | | | Yes | | | (MO) |
| *Phoxocampus belcheri* | Black Rock Pipefish | | | Yes | | (MO) | (MO) |
| *Phycodurus eques* | Leafy Seadragon | | | Yes | | | (MO) |
| *Phyllopteryx taeniolatus* | Common Seadragon | | | Yes | | | (MO) |
| *Pugnaso curtirostris* | Pugnose Pipefish | | | Yes | | | (MO) |
| *Solegnathus hardwickii* | Pallid Pipehorse | | | Yes | | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Solegnathus lettiensis* | Gunther's Pipehorse | | | Yes | | (MO) | (MO) |
| *Solenostomus cyanopterus* | Robust Ghostpipefish | | | Yes | | (MO) | (MO) |
| *Stigmatopora argus* | Spotted Pipefish | | | Yes | | | (MO) |
| *Stigmatopora nigra* | Widebody Pipefish | | | Yes | | | (MO) |
| *Syngnathoides biaculeatus* | Double-end Pipehorse | | | Yes | | (MO) | (MO) |
| *Trachyrhamphus bicoarctatus* | Bentstick Pipefish | | | Yes | | (MO) | (MO) |
| *Trachyrhamphus longirostris* | Straightstick Pipefish | | | Yes | | (MO) | (MO) |
| *Urocampus carinirostris* | Hairy Pipefish | | | Yes | | | (MO) |
| *Vanacampus margaritifer* | Mother-of-pearl Pipefish | | | Yes | | | (MO) |
| ***Eel*** | | | | | | | |
| *Milyeringa veritas* | Blind Gudgeon | V | | | | (MO) | (KO) |
| *Ophisternon candidum* | Blind Cave Eel | V | | | | | (KO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Threatened Species:*<br>*V Vulnerable*<br>*E Endangered*<br>*CE Critically Endangered*<br>*Migratory Species:*<br>*M Marine*<br>*W Wetland*<br>*T Terrestrial* | | | | | *Type of Presence:*<br>*MO Species of species habitat may occur within area*<br>*LO Species or species habitat likely to occur within area*<br>*KO Species or species habitat known to occur within area*<br>*FMO Foraging, feeding or related behaviour may occur within area*<br>*FLO Foraging, feeding or related behaviour likely to occur within area*<br>*FKO Foraging, feeding or related behaviour known to occur within area*<br>*BLO Breeding likely to occur within area*<br>*BKO Breeding known to occur within area*<br>*CKO Congregation known to occur within area* | | |

## 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 | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| **Whales** | | | | | | | |
| *Balaenoptera acutorostrata* | Minke Whale | | | Yes | (MO) | (MO) | (MO) |
| *Balaenoptera bonaerensis* | Antarctic Minke Whale | | Marine | Yes | (LO) | (LO) | (LO) |
| *Balaenoptera borealis* | Sei Whale | V | Marine | Yes | (LO) | (FLO) | (FLO) |
| *Balaenoptera edeni* | Bryde's Whale | | Marine | Yes | (LO) | (LO) | (LO) |
| *Balaenoptera musculus* | Blue Whale | E | Marine | Yes | (LO) | (MKO) | (MKO) |
| *Balaenoptera physalus* | Fin Whale | V | Marine | Yes | (LO) | (FLO) | (FLO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Caperea marginata* | Pygmy Right Whale | | Marine | Yes | | | (MO) |
| *Eubalaena australis* | Southern Right Whale | E | Marine | Yes | | (LO) | (LO) |
| *Feresa attenuata* | Pygmy Killer Whale | | | Yes | (MO) | (MO) | (MO) |
| *Globicephala macrorhynchus* | Short-finned Pilot Whale | | | Yes | (MO) | (MO) | (MO) |
| *Globicephala melas* | Long-finned Pilot Whale | | | Yes | | | (MO) |
| *Hyperoodon planifrons* | Southern Bottlenose Whale | | | Yes | | | (MO) |
| *Indopacetus pacificus* | Longman's Beaked Whale | | | Yes | | (MO) | (MO) |
| *Kogia breviceps* | Pygmy Sperm Whale | | | Yes | (MO) | (MO) | (MO) |
| *Kogia simus* | Dwarf Sperm Whale | | | Yes | (MO) | (MO) | (MO) |
| *Megaptera novaeangliae* | Humpback Whale | V | Marine | Yes | (MO) | (KO) | (CKO) |
| *Mesoplodon bowdoini* | Andrew's Beaked Whale | | | Yes | | | (MO) |
| *Mesoplodon densirostris* | Blainville's Beaked Whale | | | Yes | (MO) | (MO) | (MO) |
| *Mesoplodon ginkgodens* | Gingko-toothed Beaked Whale | | | Yes | | (MO) | (MO) |
| *Mesoplodon grayi* | Gray's Beaked Whale | | | Yes | | (MO) | (MO) |
| *Mesoplodon layardii* | Strap-toothed Beaked Whale | | | Yes | | | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Mesoplodon mirus* | True's Beaked Whale | | | Yes | | | (MO) |
| *Peponocephala electra* | Melon-headed Whale | | | Yes | (MO) | (MO) | (MO) |
| *Physeter macrocephalus* | Sperm Whale | | Marine | Yes | (MO) | (MO) | (FKO) |
| *Ziphius cavirostris* | Cuvier's Beaked Whale | | | Yes | (MO) | (MO) | (MO) |
| **Dolphins** | | | | | | | |
| *Delphinus delphis* | Common Dophin | | | Yes | (MO) | (MO) | (MO) |
| *Grampus griseus* | Risso's Dolphin | | | Yes | (MO) | (MO) | (MO) |
| *Lagenodelphis hosei* | Fraser's Dolphin | | | Yes | (MO) | (MO) | (MO) |
| *Lagenorhynchus obscurus* | Dusky Dolphin | | Marine | Yes | | | (LO) |
| *Lissodelphis peronii* | Southern Right Whale Dolphin | | | Yes | | | (MO) |
| *Orcinus orca* | Killer Whale | | Marine | Yes | (MO) | (MO) | (MO) |
| *Pseudorca crassidens* | False Killer Whale | | | Yes | (LO) | (LO) | (LO) |
| *Sousa chinensis* | Indo-Pacific Humpback Dolphin | | Marine | Yes | | (MO) | (KO) |
| *Stenella attenuate* | Spotted Dolphin | | | Yes | | | (MO) |
| *Stenella coeruleoalba* | Striped Dolphin | | | Yes | (MO) | (MO) | (MO) |
| *Stenella longirostris* | Long-snouted Spinner Dolphin | | | Yes | (MO) | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Steno bredanensis* | Rough-toothed Dolphin | | | Yes | (MO) | (MO) | (MO) |
| *Tursiops aduncus* | Indian Ocean Bottlenose Dolphin | | | Yes | | (LO) | (LO) |
| *Tursiops aduncus (Arafura/Timor Sea populations)* | Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) | | Marine | Yes | | (KO) | (KO) |
| *Tursiops truncatus s. str.* | Bottlenose Dolphin | | | Yes | (MO) | (MO) | (MO) |
| **Pinnipeds** | | | | | | | |
| *Arctocephalus forsteri* | Long-nosed Fur-seal | | | Yes | | | (MO) |
| *Neophoca cinerea* | Australian Sea-lion | V | | Yes | | | (CKO) |
| **Dugong** | | | | | | | |
| *Dugong dugon* | Dugong | | Marine | Yes | | (BKO) | (BKO) |
| *Threatened Species:*<br>*V Vulnerable*<br>*E Endangered*<br>*CE Critically Endangered*<br><br>*Migratory Species:*<br>*M Marine*<br>*W Wetland*<br>*T Terrestrial* | *Type of Presence:*<br>*MO Species of species habitat may occur within area*<br>*LO Species or species habitat likely to occur within area*<br>*KO Species or species habitat known to occur within area*<br>*FMO Foraging, feeding or related behaviour may occur within area*<br>*FLO Foraging, feeding or related behaviour likely to occur within area*<br>*FKO Foraging, feeding or related behaviour known to occur within area*<br>*BLO Breeding likely to occur within area*<br>*BKO Breeding known to occur within area*<br>*CKO Congregation known to occur within area* | | | | | | |

**Marine reptile species or species habitat that may occur within the Project EMBA**

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| **Turtles** | | | | | | | |
| *Caretta caretta* | Loggerhead Turtle | E | Marine | Yes | (LO) | (BKO) | (BKO) |
| *Chelonia mydas* | Green Turtle | V | Marine | Yes | (LO) | (BKO) | (BKO) |
| *Dermochelys coriacea* | Leatherback Turtle | E | Marine | Yes | (LO) | (KO) | (FKO) |
| *Eretmochelys imbricata* | Hawksbill Turtle | V | Marine | Yes | (LO) | (BKO) | (BKO) |
| *Lepidochelys olivacea* | Olive Ridley Turtle | E | Marine | Yes | | | (LO) |
| *Natator depressus* | Flatback Turtle | V | Marine | Yes | (LO) | (BKO) | (BKO) |
| **Seasnakes** | | | | | | | |
| *Acalyptophis peronii* | Horned Seasnake | | | Yes | | (MO) | (MO) |
| *Aipysurus apraefrontalis* | Short-nosed Seasnake | CE | | Yes | | (LO) | (KO) |
| *Aipysurus duboisii* | Dubois' Seasnake | | | Yes | | (MO) | (MO) |
| *Aipysurus eydouxii* | Spine-tailed Seasnake | | | Yes | | (MO) | (MO) |
| *Aipysurus laevis* | Olive Seasnake | | | Yes | (MO) | (MO) | (MO) |
| *Aipysurus pooleorum* | Shark Bay Seasnake | | | Yes | | (MO) | (MO) |
| *Aipysurus tenuis* | Brown-lined Seasnake | | | Yes | | | (MO) |
| *Astrotia stokesii* | Stokes' Seasnake | | | Yes | | (MO) | (MO) |
| *Disteira kingii* | Spectacled Seasnake | | | Yes | (MO) | (MO) | (MO) |

| Scientific Name | Common Name | EPBC Status | | | Project Areas | | |
|---|---|---|---|---|---|---|---|
| | | Threatened Species | Migratory Species | Marine Species | Operational Area | Hydrocarbon Exposure Area | EMBA |
| *Disteira major* | Olive-headed Seasnake | | | Yes | | (MO) | (MO) |
| *Emydocephalus annulatus* | Turtle-headed Seasnake | | | Yes | | (MO) | (MO) |
| *Ephalophis greyi* | North-western Mangrove Seasnake | | | Yes | | (MO) | (MO) |
| *Hydrelaps darwiniensis* | Black-ringed Seasnake | | | Yes | | | (MO) |
| *Hydrophis czeblukovi* | Fine-spined Seasnake | | | Yes | | (MO) | (MO) |
| *Hydrophis elegans* | Elegant Seasnake | | | Yes | | | (MO) |
| *Hydrophis mcdowelli* | *Hydrophis mcdowelli* | | | Yes | | (MO) | (MO) |
| *Hydrophis ornatus* | Spotted Seasnake | | | Yes | | (MO) | (MO) |
| *Lapemis hardwickii* | Spine-bellied Seasnake | | | Yes | | | (MO) |
| *Pelamis platurus* | Yellow-bellied Seasnake | | | Yes | (MO) | (MO) | (MO) |

Australian Government

Department of Agriculture, Water and the Environment

# EPBC Act Protected Matters Report

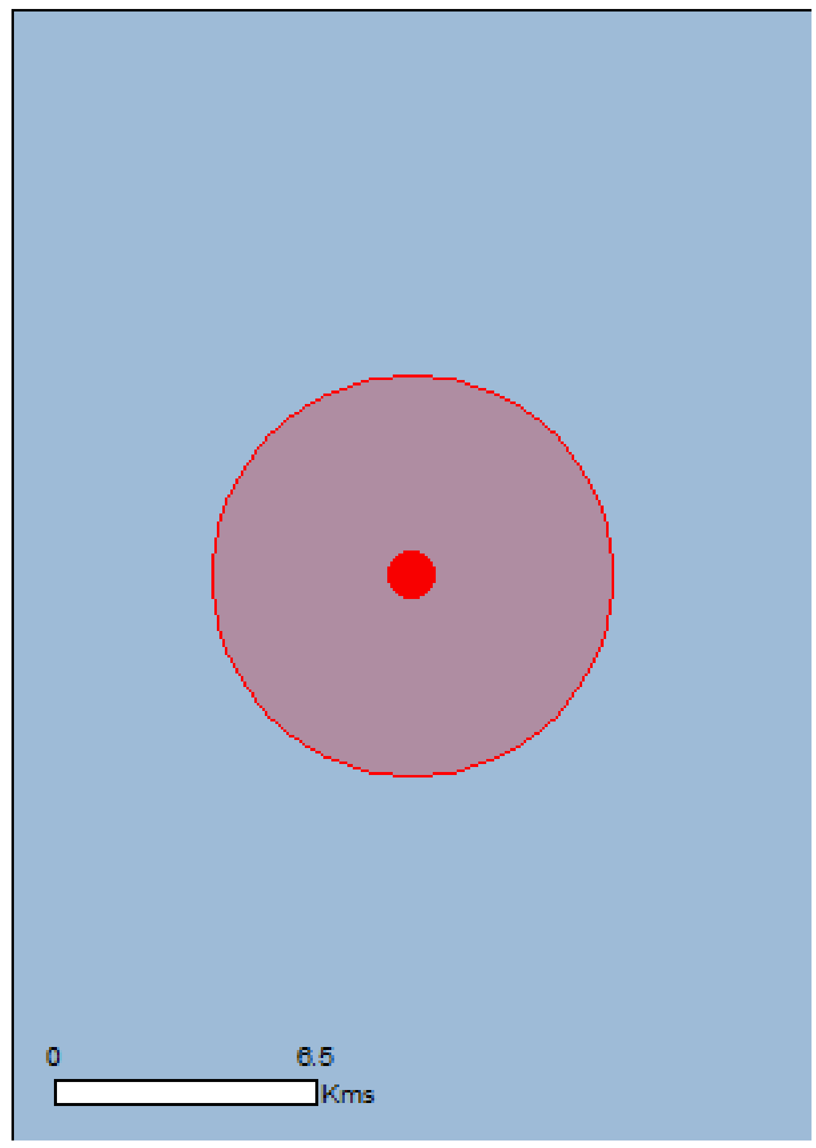
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

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

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

Report created: 14/06/21 15:41:30

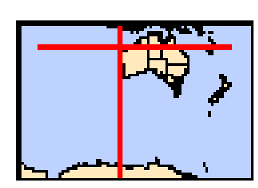







Coordinates

Buffer: 5.0Km



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International Importance: | None |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | 1 |
| Listed Threatened Ecological Communities: | None |
| Listed Threatened Species: | 12 |
| Listed Migratory Species: | 25 |

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|---|
| Commonwealth Land: | None |
| Commonwealth Heritage Places: | None |
| Listed Marine Species: | 15 |
| Whales and Other Cetaceans: | 25 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Australian Marine Parks: | None |

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

| | |
|---|---|
| State and Territory Reserves: | None |
| Regional Forest Agreements: | None |
| Invasive Species: | None |
| Nationally Important Wetlands: | None |
| Key Ecological Features (Marine) | 1 |

# Details

## Matters of National Environmental Significance

### Commonwealth Marine Area [ Resource Information ]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

| Name |
| --- |
| EEZ and Territorial Sea |

### Marine Regions [ Resource Information ]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

| Name |
| --- |
| North-west |

### Listed Threatened Species [ Resource Information ]

| Name | Status | Type of Presence |
| --- | --- | --- |
| **Birds** | | |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| **Mammals** | | |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Species or species habitat likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Migration route known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Species or species habitat likely to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Species or species habitat may occur within area |
| **Reptiles** | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Species or species habitat likely to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat likely to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Species or species habitat likely to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Species or species habitat likely to occur within area |
| Sharks | | |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat may occur within area |

## Listed Migratory Species

[ Resource Information ]

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

| Name | Threatened | Type of Presence |
|---|---|---|
| Migratory Marine Birds | | |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat may occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat may occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Migratory Marine Species | | |
| Balaenoptera bonaerensis<br>Antarctic Minke Whale, Dark-shoulder Minke Whale [67812] | | Species or species habitat likely to occur within area |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Species or species habitat likely to occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Migration route known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Species or species habitat likely to occur within area |
| Carcharhinus longimanus<br>Oceanic Whitetip Shark [84108] | | Species or species habitat may occur within area |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat may occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Species or species habitat likely to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat likely to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat likely to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Species or species habitat likely to occur within area |
| Isurus oxyrinchus<br>Shortfin Mako, Mako Shark [79073] | | Species or species habitat likely to occur within area |
| Isurus paucus<br>Longfin Mako [82947] | | Species or species habitat likely to occur within area |
| Manta birostris<br>Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995] | | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Species or species habitat may occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Species or species habitat likely to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Physeter macrocephalus<br>Sperm Whale [59] | | Species or species habitat may occur within area |
| Migratory Wetlands Species | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat may occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Species or species habitat may occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat may occur within area |

## Other Matters Protected by the EPBC Act

### Listed Marine Species [ Resource Information ]

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

| Name | Threatened | Type of Presence |
|---|---|---|
| Birds | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat may occur within area |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat may occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat may occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat may occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| **Reptiles** | | |
| Aipysurus laevis<br>Olive Seasnake [1120] | | Species or species habitat may occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Species or species habitat likely to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Species or species habitat likely to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat likely to occur within area |
| Disteira kingii<br>Spectacled Seasnake [1123] | | Species or species habitat may occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Species or species habitat likely to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Species or species habitat likely to occur within area |
| Pelamis platurus<br>Yellow-bellied Seasnake [1091] | | Species or species habitat may occur within area |

## Whales and other Cetaceans [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| **Mammals** | | |
| Balaenoptera acutorostrata<br>Minke Whale [33] | | Species or species habitat may occur within area |
| Balaenoptera bonaerensis<br>Antarctic Minke Whale, Dark-shoulder Minke Whale [67812] | | Species or species habitat likely to occur within area |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Species or species habitat likely to occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Migration route known to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Species or species habitat likely to occur within area |
| Delphinus delphis<br>Common Dolphin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area |
| Feresa attenuata<br>Pygmy Killer Whale [61] | | Species or species habitat may occur within area |
| Globicephala macrorhynchus<br>Short-finned Pilot Whale [62] | | Species or species habitat may occur within area |
| Grampus griseus<br>Risso's Dolphin, Grampus [64] | | Species or species habitat may occur within area |
| Kogia breviceps<br>Pygmy Sperm Whale [57] | | Species or species habitat may occur within area |
| Kogia simus<br>Dwarf Sperm Whale [58] | | Species or species habitat may occur within area |
| Lagenodelphis hosei<br>Fraser's Dolphin, Sarawak Dolphin [41] | | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Species or species habitat may occur within area |
| Mesoplodon densirostris<br>Blainville's Beaked Whale, Dense-beaked Whale [74] | | Species or species habitat may occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Peponocephala electra<br>Melon-headed Whale [47] | | Species or species habitat may occur within area |
| Physeter macrocephalus<br>Sperm Whale [59] | | Species or species habitat may occur within area |
| Pseudorca crassidens<br>False Killer Whale [48] | | Species or species habitat likely to occur within area |
| Stenella attenuata<br>Spotted Dolphin, Pantropical Spotted Dolphin [51] | | Species or species habitat may occur within area |
| Stenella coeruleoalba<br>Striped Dolphin, Euphrosyne Dolphin [52] | | Species or species habitat may occur within area |
| Stenella longirostris<br>Long-snouted Spinner Dolphin [29] | | Species or species habitat may occur within area |
| Steno bredanensis<br>Rough-toothed Dolphin [30] | | Species or species habitat may occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Tursiops truncatus s. str.<br>Bottlenose Dolphin [68417] | | Species or species habitat may occur within area |
| Ziphius cavirostris<br>Cuvier's Beaked Whale, Goose-beaked Whale [56] | | Species or species habitat may occur within area |

# Extra Information

## Key Ecological Features (Marine) [ Resource Information ]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

| Name | Region |
|---|---|
| Exmouth Plateau | North-west |

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-20.4871 113.544

# Acknowledgements

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

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

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

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



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Australian Government

Department of Agriculture, Water and the Environment

# EPBC Act Protected Matters Report

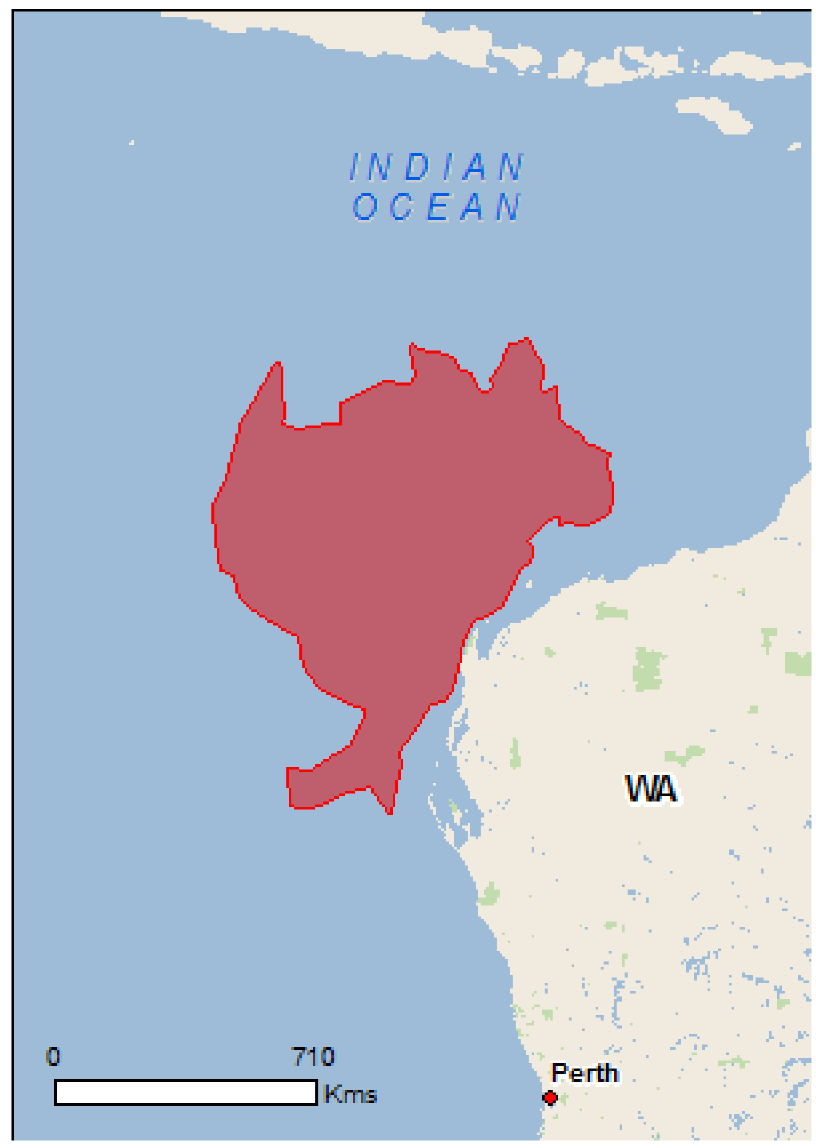
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

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

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

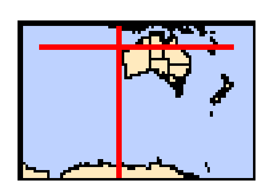
Report created: 14/06/21 16:09:31








Coordinates
Buffer: 0.0Km



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

| | |
|---|---|
| World Heritage Properties: | 1 |
| National Heritage Places: | 1 |
| Wetlands of International Importance: | None |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | 2 |
| Listed Threatened Ecological Communities: | None |
| Listed Threatened Species: | 33 |
| Listed Migratory Species: | 53 |

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|---|
| Commonwealth Land: | None |
| Commonwealth Heritage Places: | 1 |
| Listed Marine Species: | 88 |
| Whales and Other Cetaceans: | 32 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Australian Marine Parks: | 9 |

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

| | |
|---|---|
| State and Territory Reserves: | None |
| Regional Forest Agreements: | None |
| Invasive Species: | None |
| Nationally Important Wetlands: | None |
| Key Ecological Features (Marine) | 7 |

# Details

## Matters of National Environmental Significance

### World Heritage Properties [ Resource Information ]

| Name | State | Status |
|---|---|---|
| The Ningaloo Coast | WA | Declared property |

### National Heritage Properties [ Resource Information ]

| Name | State | Status |
|---|---|---|
| Natural | | |
| The Ningaloo Coast | WA | Listed place |

### Commonwealth Marine Area [ Resource Information ]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

| Name |
|---|
| EEZ and Territorial Sea |
| Extended Continental Shelf |

### Marine Regions [ Resource Information ]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

| Name |
|---|
| North-west |
| South-west |

### Listed Threatened Species [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| Birds | | |
| Anous tenuirostris melanops<br>Australian Lesser Noddy [26000] | Vulnerable | Species or species habitat may occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat may occur within area |
| Limosa lapponica menzbieri<br>Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432] | Critically Endangered | Species or species habitat known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat may occur within |

| Name | Status | Type of Presence |
|---|---|---|
| | | area |
| Papasula abbotti<br>Abbott's Booby [59297] | Endangered | Species or species habitat may occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Rostratula australis<br>Australian Painted Snipe [77037] | Endangered | Species or species habitat may occur within area |
| Sternula nereis  nereis<br>Australian Fairy Tern [82950] | Vulnerable | Breeding known to occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed  Albatross [64464] | Vulnerable | Foraging, feeding or related behaviour may occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Mammals | | |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Migration route known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Species or species habitat likely to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Breeding known to occur within area |
| Reptiles | | |
| Aipysurus apraefrontalis<br>Short-nosed Seasnake [1115] | Critically Endangered | Species or species habitat likely to occur within area |
| Aipysurus foliosquama<br>Leaf-scaled Seasnake [1118] | Critically Endangered | Species or species habitat likely to occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |

| Name | Status | Type of Presence |
| --- | --- | --- |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Sharks | | |
| Carcharias taurus (west coast population)<br>Grey Nurse Shark (west coast population) [68752] | Vulnerable | Species or species habitat known to occur within area |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat known to occur within area |
| Pristis clavata<br>Dwarf Sawfish, Queensland Sawfish [68447] | Vulnerable | Species or species habitat known to occur within area |
| Pristis zijsron<br>Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Species or species habitat known to occur within area |
| Rhincodon typus<br>Whale Shark [66680] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |

## Listed Migratory Species [ Resource Information ]

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

| Name | Threatened | Type of Presence |
| --- | --- | --- |
| Migratory Marine Birds | | |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat may occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardenna carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [82404] | | Foraging, feeding or related behaviour likely to occur within area |
| Calonectris leucomelas<br>Streaked Shearwater [1077] | | Species or species habitat likely to occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat likely to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat may occur within area |
| Hydroprogne caspia<br>Caspian Tern [808] | | Breeding known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Onychoprion anaethetus<br>Bridled Tern [82845] | | Foraging, feeding or related behaviour likely to occur within area |
| Sterna dougallii<br>Roseate Tern [817] | | Breeding known to occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed  Albatross [64464] | Vulnerable | Foraging, feeding or related behaviour may occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Migratory Marine Species | | |
| Anoxypristis cuspidata<br>Narrow Sawfish, Knifetooth Sawfish [68448] | | Species or species habitat known to occur within area |
| Balaena glacialis  australis<br>Southern Right Whale [75529] | Endangered* | Species or species habitat likely to occur within area |
| Balaenoptera bonaerensis<br>Antarctic Minke Whale, Dark-shoulder Minke Whale [67812] | | Species or species habitat likely to occur within area |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Migration route known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Carcharhinus longimanus<br>Oceanic Whitetip Shark [84108] | | Species or species habitat likely to occur within area |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat known to occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat known to occur within area |
| Dugong dugon<br>Dugong [28] | | Breeding known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Isurus oxyrinchus<br>Shortfin Mako, Mako Shark [79073] | | Species or species habitat likely to occur within area |
| Isurus paucus<br>Longfin Mako [82947] | | Species or species habitat likely to occur within area |
| Lamna nasus<br>Porbeagle, Mackerel Shark [83288] | | Species or species habitat may occur within area |
| Manta alfredi<br>Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994] | | Species or species habitat known to occur within area |
| Manta birostris<br>Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995] | | Species or species habitat known to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Breeding known to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Physeter macrocephalus<br>Sperm Whale [59] | | Species or species habitat may occur within area |
| Pristis clavata<br>Dwarf Sawfish, Queensland Sawfish [68447] | Vulnerable | Species or species habitat known to occur within area |
| Pristis zijsron<br>Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Species or species habitat known to occur within area |
| Rhincodon typus<br>Whale Shark [66680] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Sousa chinensis<br>Indo-Pacific Humpback Dolphin [50] | | Species or species habitat may occur within area |
| Tursiops aduncus (Arafura/Timor Sea populations)<br>Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900] | | Species or species habitat known to occur within area |
| **Migratory Wetlands Species** | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat may occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat may occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat may occur within area |
| Pandion haliaetus<br>Osprey [952] | | Breeding known to occur within area |
| Thalasseus bergii<br>Greater Crested Tern [83000] | | Breeding known to occur within area |

## Other Matters Protected by the EPBC Act

### Commonwealth Heritage Places [ Resource Information ]

| Name | State | Status |
|---|---|---|
| Natural | | |
| Ningaloo Marine Area - Commonwealth Waters | WA | Listed place |

### Listed Marine Species [ Resource Information ]

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

| Name | Threatened | Type of Presence |
|---|---|---|
| Birds | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat may occur within area |
| Anous tenuirostris melanops<br>Australian Lesser Noddy [26000] | Vulnerable | Species or species habitat may occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat may occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Calonectris leucomelas<br>Streaked Shearwater [1077] | | Species or species habitat likely to occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat likely to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat may occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat may occur within area |
| Pandion haliaetus<br>Osprey [952] | | Breeding known to occur within area |
| Papasula abbotti<br>Abbott's Booby [59297] | Endangered | Species or species habitat may occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Puffinus carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [1043] | | Foraging, feeding or related behaviour likely to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Endangered* | Species or species habitat may occur within area |
| Sterna anaethetus<br>Bridled Tern [814] | | Foraging, feeding or related behaviour likely to occur within area |
| Sterna bergii<br>Crested Tern [816] | | Breeding known to occur within area |
| Sterna caspia<br>Caspian Tern [59467] | | Breeding known to occur within area |
| Sterna dougallii<br>Roseate Tern [817] | | Breeding known to occur within area |
| Sterna fuscata<br>Sooty Tern [794] | | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Foraging, feeding or related behaviour may occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Fish | | |
| Acentronura larsonae<br>Helen's Pygmy Pipehorse [66186] | | Species or species habitat may occur within area |
| Bulbonaricus brauni<br>Braun's Pughead Pipefish, Pug-headed Pipefish [66189] | | Species or species habitat may occur within area |
| Campichthys tricarinatus<br>Three-keel Pipefish [66192] | | Species or species habitat may occur within area |
| Choeroichthys brachysoma<br>Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194] | | Species or species habitat may occur within area |
| Choeroichthys latispinosus<br>Muiron Island Pipefish [66196] | | Species or species habitat may occur within area |
| Choeroichthys suillus<br>Pig-snouted Pipefish [66198] | | Species or species habitat may occur within area |
| Corythoichthys flavofasciatus<br>Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200] | | Species or species habitat may occur within area |
| Cosmocampus banneri<br>Roughridge Pipefish [66206] | | Species or species habitat may occur within area |
| Doryrhamphus dactyliophorus<br>Banded Pipefish, Ringed Pipefish [66210] | | Species or species habitat may occur within area |
| Doryrhamphus excisus<br>Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211] | | Species or species habitat may occur within area |
| Doryrhamphus janssi<br>Cleaner Pipefish, Janss' Pipefish [66212] | | Species or species habitat may occur within area |
| Doryrhamphus multiannulatus<br>Many-banded Pipefish [66717] | | Species or species habitat may occur within area |
| Doryrhamphus negrosensis<br>Flagtail Pipefish, Masthead Island Pipefish [66213] | | Species or species habitat may occur within area |
| Festucalex scalaris<br>Ladder Pipefish [66216] | | Species or species habitat may occur within area |
| Filicampus tigris<br>Tiger Pipefish [66217] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Halicampus brocki<br>Brock's Pipefish [66219] | | Species or species habitat may occur within area |
| Halicampus grayi<br>Mud Pipefish, Gray's Pipefish [66221] | | Species or species habitat may occur within area |
| Halicampus nitidus<br>Glittering Pipefish [66224] | | Species or species habitat may occur within area |
| Halicampus spinirostris<br>Spiny-snout Pipefish [66225] | | Species or species habitat may occur within area |
| Haliichthys taeniophorus<br>Ribboned Pipehorse, Ribboned Seadragon [66226] | | Species or species habitat may occur within area |
| Hippichthys penicillus<br>Beady Pipefish, Steep-nosed Pipefish [66231] | | Species or species habitat may occur within area |
| Hippocampus angustus<br>Western Spiny Seahorse, Narrow-bellied Seahorse [66234] | | Species or species habitat may occur within area |
| Hippocampus histrix<br>Spiny Seahorse, Thorny Seahorse [66236] | | Species or species habitat may occur within area |
| Hippocampus kuda<br>Spotted Seahorse, Yellow Seahorse [66237] | | Species or species habitat may occur within area |
| Hippocampus planifrons<br>Flat-face Seahorse [66238] | | Species or species habitat may occur within area |
| Hippocampus spinosissimus<br>Hedgehog Seahorse [66239] | | Species or species habitat may occur within area |
| Hippocampus trimaculatus<br>Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720] | | Species or species habitat may occur within area |
| Micrognathus micronotopterus<br>Tidepool Pipefish [66255] | | Species or species habitat may occur within area |
| Phoxocampus belcheri<br>Black Rock Pipefish [66719] | | Species or species habitat may occur within area |
| Solegnathus hardwickii<br>Pallid Pipehorse, Hardwick's Pipehorse [66272] | | Species or species habitat may occur within area |
| Solegnathus lettiensis<br>Gunther's Pipehorse, Indonesian Pipefish [66273] | | Species or species habitat may occur within area |
| Solenostomus cyanopterus<br>Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183] | | Species or species habitat may occur within area |
| Syngnathoides biaculeatus<br>Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Trachyrhamphus bicoarctatus<br>Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280] | | Species or species habitat may occur within area |
| Trachyrhamphus longirostris<br>Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281] | | Species or species habitat may occur within area |
| Mammals | | |
| Dugong dugon<br>Dugong [28] | | Breeding known to occur within area |
| Reptiles | | |
| Acalyptophis peronii<br>Horned Seasnake [1114] | | Species or species habitat may occur within area |
| Aipysurus apraefrontalis<br>Short-nosed Seasnake [1115] | Critically Endangered | Species or species habitat likely to occur within area |
| Aipysurus duboisii<br>Dubois' Seasnake [1116] | | Species or species habitat may occur within area |
| Aipysurus eydouxii<br>Spine-tailed Seasnake [1117] | | Species or species habitat may occur within area |
| Aipysurus foliosquama<br>Leaf-scaled Seasnake [1118] | Critically Endangered | Species or species habitat likely to occur within area |
| Aipysurus laevis<br>Olive Seasnake [1120] | | Species or species habitat may occur within area |
| Aipysurus pooleorum<br>Shark Bay Seasnake [66061] | | Species or species habitat may occur within area |
| Astrotia stokesii<br>Stokes' Seasnake [1122] | | Species or species habitat may occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Disteira kingii<br>Spectacled Seasnake [1123] | | Species or species habitat may occur within area |
| Disteira major<br>Olive-headed Seasnake [1124] | | Species or species habitat may occur within area |
| Emydocephalus annulatus<br>Turtle-headed Seasnake [1125] | | Species or species habitat may occur within area |
| Ephalophis greyi<br>North-western Mangrove Seasnake [1127] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Hydrophis czeblukovi<br>Fine-spined Seasnake [59233] | | Species or species habitat may occur within area |
| Hydrophis elegans<br>Elegant Seasnake [1104] | | Species or species habitat may occur within area |
| Hydrophis mcdowelli<br>null [25926] | | Species or species habitat may occur within area |
| Hydrophis ornatus<br>Spotted Seasnake, Ornate Reef Seasnake [1111] | | Species or species habitat may occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Pelamis platurus<br>Yellow-bellied Seasnake [1091] | | Species or species habitat may occur within area |

## Whales and other Cetaceans [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| Mammals | | |
| Balaenoptera acutorostrata<br>Minke Whale [33] | | Species or species habitat may occur within area |
| Balaenoptera bonaerensis<br>Antarctic Minke Whale, Dark-shoulder Minke Whale [67812] | | Species or species habitat likely to occur within area |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Migration route known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Delphinus delphis<br>Common Dolphin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Species or species habitat likely to occur within area |
| Feresa attenuata<br>Pygmy Killer Whale [61] | | Species or species habitat may occur within area |
| Globicephala macrorhynchus<br>Short-finned Pilot Whale [62] | | Species or species habitat may occur within area |
| Grampus griseus<br>Risso's Dolphin, Grampus [64] | | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| | | habitat may occur within area |
| Indopacetus pacificus<br>Longman's Beaked Whale [72] | | Species or species habitat may occur within area |
| Kogia breviceps<br>Pygmy Sperm Whale [57] | | Species or species habitat may occur within area |
| Kogia simus<br>Dwarf Sperm Whale [58] | | Species or species habitat may occur within area |
| Lagenodelphis hosei<br>Fraser's Dolphin, Sarawak Dolphin [41] | | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Breeding known to occur within area |
| Mesoplodon densirostris<br>Blainville's Beaked Whale, Dense-beaked Whale [74] | | Species or species habitat may occur within area |
| Mesoplodon ginkgodens<br>Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564] | | Species or species habitat may occur within area |
| Mesoplodon grayi<br>Gray's Beaked Whale, Scamperdown Whale [75] | | Species or species habitat may occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Peponocephala electra<br>Melon-headed Whale [47] | | Species or species habitat may occur within area |
| Physeter macrocephalus<br>Sperm Whale [59] | | Species or species habitat may occur within area |
| Pseudorca crassidens<br>False Killer Whale [48] | | Species or species habitat likely to occur within area |
| Sousa chinensis<br>Indo-Pacific Humpback Dolphin [50] | | Species or species habitat may occur within area |
| Stenella attenuata<br>Spotted Dolphin, Pantropical Spotted Dolphin [51] | | Species or species habitat may occur within area |
| Stenella coeruleoalba<br>Striped Dolphin, Euphrosyne Dolphin [52] | | Species or species habitat may occur within area |
| Stenella longirostris<br>Long-snouted Spinner Dolphin [29] | | Species or species habitat may occur within area |
| Steno bredanensis<br>Rough-toothed Dolphin [30] | | Species or species habitat may occur within area |
| Tursiops aduncus<br>Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418] | | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Tursiops aduncus (Arafura/Timor Sea populations)<br>Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900] | | Species or species habitat known to occur within area |
| Tursiops truncatus s. str.<br>Bottlenose Dolphin [68417] | | Species or species habitat may occur within area |
| Ziphius cavirostris<br>Cuvier's Beaked Whale, Goose-beaked Whale [56] | | Species or species habitat may occur within area |

## Australian Marine Parks [ Resource Information ]

| Name | Label |
|---|---|
| Abrolhos | Habitat Protection Zone (IUCN IV) |
| Argo-Rowley Terrace | Multiple Use Zone (IUCN VI) |
| Carnarvon Canyon | Habitat Protection Zone (IUCN IV) |
| Gascoyne | Habitat Protection Zone (IUCN IV) |
| Gascoyne | Multiple Use Zone (IUCN VI) |
| Gascoyne | National Park Zone (IUCN II) |
| Montebello | Multiple Use Zone (IUCN VI) |
| Ningaloo | National Park Zone (IUCN II) |
| Ningaloo | Recreational Use Zone (IUCN IV) |

# Extra Information

## Key Ecological Features (Marine) [ Resource Information ]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

| Name | Region |
|---|---|
| Ancient coastline at 125 m depth contour | North-west |
| Canyons linking the Cuvier Abyssal Plain and the | North-west |
| Commonwealth waters adjacent to Ningaloo Reef | North-west |
| Continental Slope Demersal Fish Communities | North-west |
| Exmouth Plateau | North-west |
| Wallaby Saddle | North-west |
| Western demersal slope and associated fish | South-west |

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods.  Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc).  In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-15.635 109.259,-15.813 109.315,-16.151 109.322,-16.881 109.391,-17.075 109.319,-17.187 109.72,-17.104 110.147,-17.068 110.449,-17.062 110.745,-16.562 110.791,-16.148 111.764,-16.095 111.82,-16.109 112.441,-16.043 112.507,-15.928 112.571,-15.318 112.441,-15.205 112.498,-15.198 112.518,-15.305 112.633,-15.461 113.346,-15.57 113.542,-15.79 113.706,-15.819 113.759,-15.903 113.93,-15.985 113.999,-16.224 114.125,-16.339 114.209,-16.289 114.36,-16.22 114.444,-15.997 114.439,-15.699 114.679,-15.21 114.87,-15.172 114.964,-15.073 115.3,-15.137 115.355,-15.422 115.522,-15.594 115.631,-15.77 115.692,-15.91 115.698,-16.148 115.654,-16.321 115.695,-16.219 116.043,-16.943 116.114,-17.075 116.213,-17.305 116.62,-17.55 116.799,-17.55 116.939,-17.75 117.33,-17.773 117.333,-17.964 117.266,-18.072 117.302,-18.483 117.401,-18.802 117.379,-19.085 117.338,-19.213 117.233,-19.358 116.931,-19.392 116.753,-19.389 116.656,-19.328 116.285,-19.425 116.093,-19.4 116.084,-19.252 116.112,-19.195 116.027,-19.265 115.931,-19.338 115.8,-19.473 115.614,-19.568 115.542,-19.643 115.46,-19.685 115.368,-19.795 115.333,-19.893 115.465,-20.081 115.44,-20.248 115.374,-20.316 115.296,-20.371 115.169,-20.579 115.084,-20.902 114.957,-21.206 114.758,-21.43 114.502,-21.548 114.134,-21.597 114.019,-21.722 113.982,-21.811 113.897,-22.041 113.743,-22.353 113.697,-22.666 113.624,-23.165 113.493,-23.402 113.305,-23.461 112.957,-24.112 112.523,-24.533 112.201,-24.822 112.247,-25.302 112.168,-25.854 111.997,-25.873 111.912,-25.305 111.504,-25.443 110.765,-25.699 110.285,-25.768 110.032,-25.788 109.716,-25.683 109.552,-24.901 109.486,-24.914 110.084,-24.759 110.344,-24.348 111.028,-23.783 111.36,-23.599 111.356,-23.435 110.992,-23.303 110.63,-23.122 110.255,-22.6 109.867,-21.982 109.723,-21.555 108.967,-21.272 108.579,-21.042 108.329,-20.588 108.145,-20.431 107.836,-19.734 107.698,-18.991 107.652,-18.288 107.955,-16.911 108.346,-16.871 108.431,-15.823 109.085,-15.681 109.128,-15.635 109.259

# Acknowledgements

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

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

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

Please feel free to provide feedback via the Contact Us page.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# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

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

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

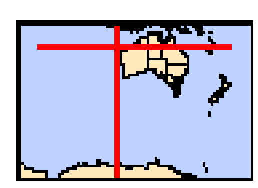
Report created: 10/06/21 16:41:22






Coordinates

Buffer: 0.0Km



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

| | |
|---|---|
| World Heritage Properties: | 1 |
| National Heritage Places: | 3 |
| Wetlands of International Importance: | None |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | 2 |
| Listed Threatened Ecological Communities: | 6 |
| Listed Threatened Species: | 71 |
| Listed Migratory Species: | 73 |

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|---|
| Commonwealth Land: | 1 |
| Commonwealth Heritage Places: | 2 |
| Listed Marine Species: | 147 |
| Whales and Other Cetaceans: | 40 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Australian Marine Parks: | 21 |

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

| | |
|---|---|
| State and Territory Reserves: | 18 |
| Regional Forest Agreements: | None |
| Invasive Species: | 23 |
| Nationally Important Wetlands: | None |
| Key Ecological Features (Marine) | 15 |

# Details

## Matters of National Environmental Significance

| World Heritage Properties | | [ Resource Information ] |
|---|---|---|
| Name | State | Status |
| The Ningaloo Coast | WA | Declared property |

| National Heritage Properties | | [ Resource Information ] |
|---|---|---|
| Name | State | Status |
| Natural | | |
| The Ningaloo Coast | WA | Listed place |
| Historic | | |
| Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos | WA | Listed place |
| HMAS Sydney II and HSK Kormoran Shipwreck Sites | EXT | Listed place |

### Commonwealth Marine Area [ Resource Information ]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

| Name |
|---|
| EEZ and Territorial Sea |
| Extended Continental Shelf |

### Marine Regions [ Resource Information ]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

| Name |
|---|
| North-west |
| South-west |

### Listed Threatened Ecological Communities [ Resource Information ]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

| Name | Status | Type of Presence |
|---|---|---|
| Banksia Woodlands of the Swan Coastal Plain ecological community | Endangered | Community may occur within area |
| Banksia Woodlands of the Swan Coastal Plain ecological community | Endangered | Community may occur within area |
| Banksia Woodlands of the Swan Coastal Plain ecological community | Endangered | Community may occur within area |
| Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community | Critically Endangered | Community may occur within area |
| Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community | Critically Endangered | Community may occur within area |
| Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community | Critically Endangered | Community may occur within area |

| Listed Threatened Species | | [ Resource Information ] |
|---|---|---|
| Name | Status | Type of Presence |
| Birds | | |
| Anous tenuirostris melanops | | |
| Australian Lesser Noddy [26000] | Vulnerable | Breeding known to occur within area |

| Name | Status | Type of Presence |
| --- | --- | --- |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calyptorhynchus latirostris<br>Carnaby's Cockatoo,  Short-billed Black-Cockatoo [59523] | Endangered | Species or species habitat likely to occur within area |
| Diomedea amsterdamensis<br>Amsterdam Albatross [64405] | Endangered | Species or species habitat likely to occur within area |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Falco hypoleucos<br>Grey Falcon [929] | Vulnerable | Species or species habitat known to occur within area |
| Fregata andrewsi<br>Christmas Island Frigatebird, Andrew's Frigatebird [1011] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Halobaena caerulea<br>Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |
| Leipoa ocellata<br>Malleefowl [934] | Vulnerable | Species or species habitat likely to occur within area |
| Limosa lapponica  menzbieri<br>Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432] | Critically Endangered | Species or species habitat known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Malurus leucopterus  edouardi<br>White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194] | Vulnerable | Species or species habitat likely to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pachyptila turtur  subantarctica<br>Fairy Prion (southern) [64445] | Vulnerable | Species or species habitat may occur within area |
| Papasula abbotti<br>Abbott's Booby [59297] | Endangered | Species or species habitat may occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Pezoporus occidentalis<br>Night Parrot [59350] | Endangered | Species or species habitat may occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat may occur within area |
| Pterodroma arminjoniana<br>Round Island Petrel, Trinidade Petrel [89284] | Critically Endangered | Species or species habitat may occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Rostratula australis<br>Australian Painted Snipe [77037] | Endangered | Species or species habitat likely to occur within area |
| Sternula nereis nereis<br>Australian Fairy Tern [82950] | Vulnerable | Breeding known to occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed Albatross [64464] | Vulnerable | Foraging, feeding or related behaviour may occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Turnix varius scintillans<br>Painted Button-quail (Houtman Abrolhos) [82451] | Vulnerable | Species or species habitat likely to occur within area |
| Fish | | |
| Milyeringa veritas<br>Blind Gudgeon [66676] | Vulnerable | Species or species habitat likely to occur within area |
| Mammals | | |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Bettongia lesueur Barrow and Boodie Islands subspecies<br>Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021] | Vulnerable | Species or species habitat known to occur within area |
| Dasyurus geoffroii<br>Chuditch, Western Quoll [330] | Vulnerable | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Dasyurus hallucatus<br>Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331] | Endangered | Species or species habitat may occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Species or species habitat likely to occur within area |
| Isoodon auratus  barrowensis<br>Golden Bandicoot (Barrow Island) [66666] | Vulnerable | Species or species habitat known to occur within area |
| Lagorchestes conspicillatus  conspicillatus<br>Spectacled Hare-wallaby (Barrow Island) [66661] | Vulnerable | Species or species habitat known to occur within area |
| Lagorchestes hirsutus  Central Australian subspecies<br>Mala, Rufous Hare-Wallaby (Central Australia) [88019] | Endangered | Translocated population known to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Breeding known to occur within area |
| Neophoca cinerea<br>Australian Sea-lion, Australian Sea Lion [22] | Endangered | Breeding known to occur within area |
| Osphranter robustus  isabellinus<br>Barrow Island Wallaroo, Barrow Island Euro [89262] | Vulnerable | Species or species habitat likely to occur within area |
| Parantechinus apicalis<br>Dibbler [313] | Endangered | Species or species habitat known to occur within area |
| Petrogale lateralis  lateralis<br>Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647] | Endangered | Species or species habitat known to occur within area |
| Rhinonicteris aurantia (Pilbara form)<br>Pilbara Leaf-nosed Bat [82790] | Vulnerable | Species or species habitat known to occur within area |
| **Plants** | | |
| Andersonia gracilis<br>Slender Andersonia [14470] | Endangered | Species or species habitat may occur within area |
| Eucalyptus argutifolia<br>Yanchep Mallee, Wabling Hill Mallee [24263] | Vulnerable | Species or species habitat may occur within area |
| Hemiandra gardneri<br>Red Snakebush [7945] | Endangered | Species or species habitat likely to occur within area |
| Leucopogon obtectus<br>Hidden Beard-heath [19614] | Endangered | Species or species habitat may occur within area |
| Thelymitra stellata<br>Star Sun-orchid [7060] | Endangered | Species or species habitat may occur within area |
| **Reptiles** | | |
| Aipysurus apraefrontalis<br>Short-nosed Seasnake [1115] | Critically Endangered | Species or species habitat known to occur within area |
| Aipysurus foliosquama<br>Leaf-scaled Seasnake [1118] | Critically Endangered | Species or species habitat known to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Breeding known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Breeding known to occur within area |
| Ctenotus lancelini<br>Lancelin Island Skink [1482] | Vulnerable | Translocated population known to occur within area |
| Ctenotus zastictus<br>Hamelin Ctenotus [25570] | Vulnerable | Species or species habitat known to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Egernia stokesii  badia<br>Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483] | Endangered | Species or species habitat may occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Breeding known to occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Species or species habitat likely to occur within area |
| Liopholis pulchra  longicauda<br>Jurien Bay Skink, Jurien Bay Rock-skink [83162] | Vulnerable | Species or species habitat known to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Breeding known to occur within area |
| Sharks | | |
| Carcharias taurus  (west coast population)<br>Grey Nurse Shark (west coast population) [68752] | Vulnerable | Species or species habitat known to occur within area |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Pristis clavata<br>Dwarf Sawfish, Queensland Sawfish [68447] | Vulnerable | Species or species habitat known to occur within area |
| Pristis pristis<br>Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756] | Vulnerable | Species or species habitat known to occur within area |
| Pristis zijsron<br>Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Species or species habitat known to occur within area |
| Rhincodon typus<br>Whale Shark [66680] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |

## Listed Migratory Species [ Resource Information ]

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

| Name | Threatened | Type of Presence |
|---|---|---|
| Migratory Marine Birds | | |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat likely to occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |
| Ardenna carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [82404] | | Foraging, feeding or related behaviour likely to occur within area |
| Ardenna pacifica<br>Wedge-tailed Shearwater [84292] | | Breeding known to occur within area |
| Calonectris leucomelas<br>Streaked Shearwater [1077] | | Species or species habitat known to occur within area |
| Diomedea amsterdamensis<br>Amsterdam Albatross [64405] | Endangered | Species or species habitat likely to occur within area |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Fregata andrewsi<br>Christmas Island Frigatebird, Andrew's Frigatebird [1011] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat known to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat may occur within area |
| Hydroprogne caspia<br>Caspian Tern [808] | | Breeding known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Onychoprion anaethetus<br>Bridled Tern [82845] | | Breeding known to occur within area |
| Phaethon lepturus<br>White-tailed Tropicbird [1014] | | Breeding likely to occur within area |
| Phaethon rubricauda<br>Red-tailed Tropicbird [994] | | Breeding known to occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat may occur within area |
| Sterna dougallii<br>Roseate Tern [817] | | Breeding known to occur within area |
| Sternula albifrons<br>Little Tern [82849] | | Congregation or aggregation known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Thalassarche carteri<br>Indian Yellow-nosed  Albatross [64464] | Vulnerable | Foraging, feeding or related behaviour may occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Migratory Marine Species | | |
| Anoxypristis cuspidata<br>Narrow Sawfish, Knifetooth Sawfish [68448] | | Species or species habitat known to occur within area |
| Balaena glacialis  australis<br>Southern Right Whale [75529] | Endangered* | Species or species habitat likely to occur within area |
| Balaenoptera bonaerensis<br>Antarctic Minke Whale, Dark-shoulder Minke Whale [67812] | | Species or species habitat likely to occur within area |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Caperea marginata<br>Pygmy Right Whale [39] | | Species or species habitat may occur within area |
| Carcharhinus longimanus<br>Oceanic Whitetip Shark [84108] | | Species or species habitat likely to occur within area |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Breeding known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Breeding known to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Dugong dugon<br>Dugong [28] | | Breeding known to occur |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Breeding known to occur within area |
| Isurus oxyrinchus<br>Shortfin Mako, Mako Shark [79073] | | Species or species habitat likely to occur within area |
| Isurus paucus<br>Longfin Mako [82947] | | Species or species habitat likely to occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat likely to occur within area |
| Lamna nasus<br>Porbeagle, Mackerel Shark [83288] | | Species or species habitat may occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Species or species habitat likely to occur within area |
| Manta alfredi<br>Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994] | | Species or species habitat known to occur within area |
| Manta birostris<br>Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995] | | Species or species habitat known to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Breeding known to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Breeding known to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Physeter macrocephalus<br>Sperm Whale [59] | | Foraging, feeding or related behaviour known to occur within area |
| Pristis clavata<br>Dwarf Sawfish, Queensland Sawfish [68447] | Vulnerable | Species or species habitat known to occur within area |
| Pristis pristis<br>Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756] | Vulnerable | Species or species habitat known to occur within area |
| Pristis zijsron<br>Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Species or species habitat known to occur within area |
| Rhincodon typus<br>Whale Shark [66680] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Sousa chinensis<br>Indo-Pacific Humpback Dolphin [50] | | Species or species habitat known to occur within area |
| Tursiops aduncus (Arafura/Timor Sea populations)<br>Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900] | | Species or species habitat known to occur within area |
| **Migratory Terrestrial Species** | | |
| Hirundo rustica<br>Barn Swallow [662] | | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat may occur within area |
| Motacilla cinerea<br>Grey Wagtail [642] | | Species or species habitat may occur within area |
| Motacilla flava<br>Yellow Wagtail [644] | | Species or species habitat may occur within area |
| **Migratory Wetlands Species** | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat may occur within area |
| Charadrius veredus<br>Oriental Plover, Oriental Dotterel [882] | | Species or species habitat may occur within area |
| Glareola maldivarum<br>Oriental Pratincole [840] | | Species or species habitat may occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Breeding known to occur within area |
| Thalasseus bergii<br>Greater Crested Tern [83000] | | Breeding known to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | | Species or species habitat likely to occur within area |

## Other Matters Protected by the EPBC Act

### Commonwealth Land [ Resource Information ]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

| Name |
| --- |
| Commonwealth Land - |

### Commonwealth Heritage Places [ Resource Information ]

| Name | State | Status |
| --- | --- | --- |
| Natural | | |
| Ningaloo Marine Area - Commonwealth Waters | WA | Listed place |
| Historic | | |
| HMAS Sydney II and HSK Kormoran Shipwreck Sites | EXT | Listed place |

### Listed Marine Species [ Resource Information ]

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

| Name | Threatened | Type of Presence |
| --- | --- | --- |
| Birds | | |
| Actitis hypoleucos | | |
| Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Anous stolidus | | |
| Common Noddy [825] | | Species or species habitat likely to occur within area |
| Anous tenuirostris melanops | | |
| Australian Lesser Noddy [26000] | Vulnerable | Breeding known to occur within area |
| Apus pacificus | | |
| Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardea ibis | | |
| Cattle Egret [59542] | | Species or species habitat may occur within area |
| Calidris acuminata | | |
| Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |
| Calidris canutus | | |
| Red Knot, Knot [855] | Endangered | Species or species habitat known to occur within area |
| Calidris ferruginea | | |
| Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calidris melanotos | | |
| Pectoral Sandpiper [858] | | Species or species habitat may occur within area |
| Calonectris leucomelas | | |
| Streaked Shearwater [1077] | | Species or species habitat known to occur within area |
| Catharacta skua | | |
| Great Skua [59472] | | Species or species habitat may occur within area |
| Charadrius veredus | | |
| Oriental Plover, Oriental Dotterel [882] | | Species or species habitat may occur within area |
| Chrysococcyx osculans | | |
| Black-eared Cuckoo [705] | | Species or species habitat likely to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Diomedea amsterdamensis<br>Amsterdam Albatross [64405] | Endangered | Species or species habitat likely to occur within area |
| Diomedea epomophora<br>Southern Royal Albatross [89221] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Fregata andrewsi<br>Christmas Island Frigatebird, Andrew's Frigatebird [1011] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat known to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat may occur within area |
| Glareola maldivarum<br>Oriental Pratincole [840] | | Species or species habitat may occur within area |
| Haliaeetus leucogaster<br>White-bellied Sea-Eagle [943] | | Species or species habitat known to occur within area |
| Halobaena caerulea<br>Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |
| Hirundo rustica<br>Barn Swallow [662] | | Species or species habitat may occur within area |
| Larus novaehollandiae<br>Silver Gull [810] | | Breeding known to occur within area |
| Larus pacificus<br>Pacific Gull [811] | | Breeding known to occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area |
| Motacilla cinerea<br>Grey Wagtail [642] | | Species or species habitat may occur within area |
| Motacilla flava<br>Yellow Wagtail [644] | | Species or species habitat may occur within |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pachyptila turtur<br>Fairy Prion [1066] | | Species or species habitat may occur within area |
| Pandion haliaetus<br>Osprey [952] | | Breeding known to occur within area |
| Papasula abbotti<br>Abbott's Booby [59297] | Endangered | Species or species habitat may occur within area |
| Pelagodroma marina<br>White-faced Storm-Petrel [1016] | | Breeding known to occur within area |
| Phaethon lepturus<br>White-tailed Tropicbird [1014] | | Breeding likely to occur within area |
| Phaethon rubricauda<br>Red-tailed Tropicbird [994] | | Breeding known to occur within area |
| Phalacrocorax fuscescens<br>Black-faced Cormorant [59660] | | Breeding likely to occur within area |
| Phoebetria fusca<br>Sooty Albatross [1075] | Vulnerable | Species or species habitat may occur within area |
| Pterodroma macroptera<br>Great-winged Petrel [1035] | | Foraging, feeding or related behaviour known to occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Puffinus assimilis<br>Little Shearwater [59363] | | Breeding known to occur within area |
| Puffinus carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [1043] | | Foraging, feeding or related behaviour likely to occur within area |
| Puffinus huttoni<br>Hutton's Shearwater [1025] | | Foraging, feeding or related behaviour known to occur within area |
| Puffinus pacificus<br>Wedge-tailed Shearwater [1027] | | Breeding known to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Endangered* | Species or species habitat likely to occur within area |
| Sterna albifrons<br>Little Tern [813] | | Congregation or aggregation known to occur within area |
| Sterna anaethetus<br>Bridled Tern [814] | | Breeding known to occur within area |
| Sterna bengalensis<br>Lesser Crested Tern [815] | | Breeding known to occur within area |
| Sterna bergii<br>Crested Tern [816] | | Breeding known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Sterna caspia<br>Caspian Tern [59467] | | Breeding known to occur within area |
| Sterna dougallii<br>Roseate Tern [817] | | Breeding known to occur within area |
| Sterna fuscata<br>Sooty Tern [794] | | Breeding known to occur within area |
| Sterna nereis<br>Fairy Tern [796] | | Breeding known to occur within area |
| Thalassarche carteri<br>Indian Yellow-nosed  Albatross [64464] | Vulnerable | Foraging, feeding or related behaviour may occur within area |
| Thalassarche cauta<br>Shy Albatross [89224] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thinornis rubricollis<br>Hooded Plover [59510] | | Species or species habitat likely to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | | Species or species habitat likely to occur within area |
| Fish | | |
| Acentronura australe<br>Southern Pygmy Pipehorse [66185] | | Species or species habitat may occur within area |
| Acentronura larsonae<br>Helen's Pygmy Pipehorse [66186] | | Species or species habitat may occur within area |
| Bhanotia fasciolata<br>Corrugated Pipefish, Barbed Pipefish [66188] | | Species or species habitat may occur within area |
| Bulbonaricus brauni<br>Braun's Pughead Pipefish, Pug-headed Pipefish [66189] | | Species or species habitat may occur within area |
| Campichthys galei<br>Gale's Pipefish [66191] | | Species or species habitat may occur within area |
| Campichthys tricarinatus<br>Three-keel Pipefish [66192] | | Species or species habitat may occur within area |
| Choeroichthys brachysoma<br>Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194] | | Species or species habitat may occur within area |
| Choeroichthys latispinosus<br>Muiron Island Pipefish [66196] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Choeroichthys suillus<br>Pig-snouted Pipefish [66198] | | Species or species habitat may occur within area |
| Corythoichthys amplexus<br>Fijian Banded Pipefish, Brown-banded Pipefish [66199] | | Species or species habitat may occur within area |
| Corythoichthys flavofasciatus<br>Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200] | | Species or species habitat may occur within area |
| Corythoichthys intestinalis<br>Australian Messmate Pipefish, Banded Pipefish [66202] | | Species or species habitat may occur within area |
| Corythoichthys schultzi<br>Schultz's Pipefish [66205] | | Species or species habitat may occur within area |
| Cosmocampus banneri<br>Roughridge Pipefish [66206] | | Species or species habitat may occur within area |
| Doryrhamphus dactyliophorus<br>Banded Pipefish, Ringed Pipefish [66210] | | Species or species habitat may occur within area |
| Doryrhamphus excisus<br>Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211] | | Species or species habitat may occur within area |
| Doryrhamphus janssi<br>Cleaner Pipefish, Janss' Pipefish [66212] | | Species or species habitat may occur within area |
| Doryrhamphus multiannulatus<br>Many-banded Pipefish [66717] | | Species or species habitat may occur within area |
| Doryrhamphus negrosensis<br>Flagtail Pipefish, Masthead Island Pipefish [66213] | | Species or species habitat may occur within area |
| Festucalex scalaris<br>Ladder Pipefish [66216] | | Species or species habitat may occur within area |
| Filicampus tigris<br>Tiger Pipefish [66217] | | Species or species habitat may occur within area |
| Halicampus brocki<br>Brock's Pipefish [66219] | | Species or species habitat may occur within area |
| Halicampus dunckeri<br>Red-hair Pipefish, Duncker's Pipefish [66220] | | Species or species habitat may occur within area |
| Halicampus grayi<br>Mud Pipefish, Gray's Pipefish [66221] | | Species or species habitat may occur within area |
| Halicampus nitidus<br>Glittering Pipefish [66224] | | Species or species habitat may occur within area |
| Halicampus spinirostris<br>Spiny-snout Pipefish [66225] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Haliichthys taeniophorus<br>Ribboned Pipehorse, Ribboned Seadragon [66226] | | Species or species habitat may occur within area |
| Hippichthys penicillus<br>Beady Pipefish, Steep-nosed Pipefish [66231] | | Species or species habitat may occur within area |
| Hippocampus angustus<br>Western Spiny Seahorse, Narrow-bellied Seahorse [66234] | | Species or species habitat may occur within area |
| Hippocampus breviceps<br>Short-head Seahorse, Short-snouted Seahorse [66235] | | Species or species habitat may occur within area |
| Hippocampus histrix<br>Spiny Seahorse, Thorny Seahorse [66236] | | Species or species habitat may occur within area |
| Hippocampus kuda<br>Spotted Seahorse, Yellow Seahorse [66237] | | Species or species habitat may occur within area |
| Hippocampus planifrons<br>Flat-face Seahorse [66238] | | Species or species habitat may occur within area |
| Hippocampus spinosissimus<br>Hedgehog Seahorse [66239] | | Species or species habitat may occur within area |
| Hippocampus subelongatus<br>West Australian Seahorse [66722] | | Species or species habitat may occur within area |
| Hippocampus trimaculatus<br>Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720] | | Species or species habitat may occur within area |
| Lissocampus fatiloquus<br>Prophet's Pipefish [66250] | | Species or species habitat may occur within area |
| Maroubra perserrata<br>Sawtooth Pipefish [66252] | | Species or species habitat may occur within area |
| Micrognathus micronotopterus<br>Tidepool Pipefish [66255] | | Species or species habitat may occur within area |
| Mitotichthys meraculus<br>Western Crested Pipefish [66259] | | Species or species habitat may occur within area |
| Nannocampus subosseus<br>Bonyhead Pipefish, Bony-headed Pipefish [66264] | | Species or species habitat may occur within area |
| Phoxocampus belcheri<br>Black Rock  Pipefish [66719] | | Species or species habitat may occur within area |
| Phycodurus eques<br>Leafy Seadragon [66267] | | Species or species habitat may occur within area |
| Phyllopteryx taeniolatus<br>Common Seadragon, Weedy Seadragon [66268] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Pugnaso curtirostris<br>Pugnose Pipefish, Pug-nosed Pipefish [66269] | | Species or species habitat may occur within area |
| Solegnathus hardwickii<br>Pallid Pipehorse, Hardwick's Pipehorse [66272] | | Species or species habitat may occur within area |
| Solegnathus lettiensis<br>Gunther's Pipehorse, Indonesian Pipefish [66273] | | Species or species habitat may occur within area |
| Solenostomus cyanopterus<br>Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183] | | Species or species habitat may occur within area |
| Stigmatopora argus<br>Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276] | | Species or species habitat may occur within area |
| Stigmatopora nigra<br>Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277] | | Species or species habitat may occur within area |
| Syngnathoides biaculeatus<br>Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279] | | Species or species habitat may occur within area |
| Trachyrhamphus bicoarctatus<br>Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280] | | Species or species habitat may occur within area |
| Trachyrhamphus longirostris<br>Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281] | | Species or species habitat may occur within area |
| Urocampus carinirostris<br>Hairy Pipefish [66282] | | Species or species habitat may occur within area |
| Vanacampus margaritifer<br>Mother-of-pearl Pipefish [66283] | | Species or species habitat may occur within area |
| Mammals | | |
| Arctocephalus forsteri<br>Long-nosed Fur-seal, New Zealand Fur-seal [20] | | Species or species habitat may occur within area |
| Dugong dugon<br>Dugong [28] | | Breeding known to occur within area |
| Neophoca cinerea<br>Australian Sea-lion, Australian Sea Lion [22] | Endangered | Breeding known to occur within area |
| Reptiles | | |
| Acalyptophis peronii<br>Horned Seasnake [1114] | | Species or species habitat may occur within area |
| Aipysurus apraefrontalis<br>Short-nosed Seasnake [1115] | Critically Endangered | Species or species habitat known to occur within area |
| Aipysurus duboisii<br>Dubois' Seasnake [1116] | | Species or species habitat may occur within area |
| Aipysurus eydouxii<br>Spine-tailed Seasnake [1117] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Aipysurus foliosquama<br>Leaf-scaled Seasnake [1118] | Critically Endangered | Species or species habitat known to occur within area |
| Aipysurus laevis<br>Olive Seasnake [1120] | | Species or species habitat may occur within area |
| Aipysurus pooleorum<br>Shark Bay Seasnake [66061] | | Species or species habitat may occur within area |
| Aipysurus tenuis<br>Brown-lined Seasnake [1121] | | Species or species habitat may occur within area |
| Astrotia stokesii<br>Stokes' Seasnake [1122] | | Species or species habitat may occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Breeding known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Breeding known to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Disteira kingii<br>Spectacled Seasnake [1123] | | Species or species habitat may occur within area |
| Disteira major<br>Olive-headed Seasnake [1124] | | Species or species habitat may occur within area |
| Emydocephalus annulatus<br>Turtle-headed Seasnake [1125] | | Species or species habitat may occur within area |
| Ephalophis greyi<br>North-western Mangrove Seasnake [1127] | | Species or species habitat may occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Breeding known to occur within area |
| Hydrelaps darwiniensis<br>Black-ringed Seasnake [1100] | | Species or species habitat may occur within area |
| Hydrophis czeblukovi<br>Fine-spined Seasnake [59233] | | Species or species habitat may occur within area |
| Hydrophis elegans<br>Elegant Seasnake [1104] | | Species or species habitat may occur within area |
| Hydrophis mcdowelli<br>null [25926] | | Species or species habitat may occur within area |
| Hydrophis ornatus<br>Spotted Seasnake, Ornate Reef Seasnake [1111] | | Species or species habitat may occur within area |
| Lapemis hardwickii<br>Spine-bellied Seasnake [1113] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Species or species habitat likely to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Breeding known to occur within area |
| Pelamis platurus<br>Yellow-bellied Seasnake [1091] | | Species or species habitat may occur within area |

## Whales and other Cetaceans [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| Mammals | | |
| Balaenoptera acutorostrata<br>Minke Whale [33] | | Species or species habitat may occur within area |
| Balaenoptera bonaerensis<br>Antarctic Minke Whale, Dark-shoulder Minke Whale [67812] | | Species or species habitat likely to occur within area |
| Balaenoptera borealis<br>Sei Whale [34] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat likely to occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Balaenoptera physalus<br>Fin Whale [37] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Caperea marginata<br>Pygmy Right Whale [39] | | Species or species habitat may occur within area |
| Delphinus delphis<br>Common Dolphin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Species or species habitat likely to occur within area |
| Feresa attenuata<br>Pygmy Killer Whale [61] | | Species or species habitat may occur within area |
| Globicephala macrorhynchus<br>Short-finned Pilot Whale [62] | | Species or species habitat may occur within area |
| Globicephala melas<br>Long-finned Pilot Whale [59282] | | Species or species habitat may occur within area |
| Grampus griseus<br>Risso's Dolphin, Grampus [64] | | Species or species habitat may occur within area |
| Hyperoodon planifrons<br>Southern Bottlenose Whale [71] | | Species or species habitat may occur within area |
| Indopacetus pacificus<br>Longman's Beaked Whale [72] | | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| | | habitat may occur within area |
| Kogia breviceps<br>Pygmy Sperm Whale [57] | | Species or species habitat may occur within area |
| Kogia simus<br>Dwarf Sperm Whale [58] | | Species or species habitat may occur within area |
| Lagenodelphis hosei<br>Fraser's Dolphin, Sarawak Dolphin [41] | | Species or species habitat may occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat likely to occur within area |
| Lissodelphis peronii<br>Southern Right Whale Dolphin [44] | | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Breeding known to occur within area |
| Mesoplodon bowdoini<br>Andrew's Beaked Whale [73] | | Species or species habitat may occur within area |
| Mesoplodon densirostris<br>Blainville's Beaked Whale, Dense-beaked Whale [74] | | Species or species habitat may occur within area |
| Mesoplodon ginkgodens<br>Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564] | | Species or species habitat may occur within area |
| Mesoplodon grayi<br>Gray's Beaked Whale, Scamperdown Whale [75] | | Species or species habitat may occur within area |
| Mesoplodon layardii<br>Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556] | | Species or species habitat may occur within area |
| Mesoplodon mirus<br>True's Beaked Whale [54] | | Species or species habitat may occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Peponocephala electra<br>Melon-headed Whale [47] | | Species or species habitat may occur within area |
| Physeter macrocephalus<br>Sperm Whale [59] | | Foraging, feeding or related behaviour known to occur within area |
| Pseudorca crassidens<br>False Killer Whale [48] | | Species or species habitat likely to occur within area |
| Sousa chinensis<br>Indo-Pacific Humpback Dolphin [50] | | Species or species habitat known to occur within area |
| Stenella attenuata<br>Spotted Dolphin, Pantropical Spotted Dolphin [51] | | Species or species habitat may occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Stenella coeruleoalba<br>Striped Dolphin, Euphrosyne Dolphin [52] | | Species or species habitat may occur within area |
| Stenella longirostris<br>Long-snouted Spinner Dolphin [29] | | Species or species habitat may occur within area |
| Steno bredanensis<br>Rough-toothed Dolphin [30] | | Species or species habitat may occur within area |
| Tursiops aduncus<br>Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418] | | Species or species habitat likely to occur within area |
| Tursiops aduncus (Arafura/Timor Sea populations)<br>Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900] | | Species or species habitat known to occur within area |
| Tursiops truncatus s. str.<br>Bottlenose Dolphin [68417] | | Species or species habitat may occur within area |
| Ziphius cavirostris<br>Cuvier's Beaked Whale, Goose-beaked Whale [56] | | Species or species habitat may occur within area |

## Australian Marine Parks [ Resource Information ]

| Name | Label |
|---|---|
| Abrolhos | Habitat Protection Zone (IUCN IV) |
| Abrolhos | Multiple Use Zone (IUCN VI) |
| Abrolhos | National Park Zone (IUCN II) |
| Abrolhos | Special Purpose Zone (IUCN VI) |
| Argo-Rowley Terrace | Multiple Use Zone (IUCN VI) |
| Argo-Rowley Terrace | National Park Zone (IUCN II) |
| Argo-Rowley Terrace | Special Purpose Zone (Trawl) (IUCN VI) |
| Carnarvon Canyon | Habitat Protection Zone (IUCN IV) |
| Gascoyne | Habitat Protection Zone (IUCN IV) |
| Gascoyne | Multiple Use Zone (IUCN VI) |
| Gascoyne | National Park Zone (IUCN II) |
| Jurien | National Park Zone (IUCN II) |
| Jurien | Special Purpose Zone (IUCN VI) |
| Kimberley | Multiple Use Zone (IUCN VI) |
| Mermaid Reef | National Park Zone (IUCN II) |
| Montebello | Multiple Use Zone (IUCN VI) |
| Ningaloo | National Park Zone (IUCN II) |
| Ningaloo | Recreational Use Zone (IUCN IV) |
| Perth Canyon | Habitat Protection Zone (IUCN IV) |
| Perth Canyon | National Park Zone (IUCN II) |
| Shark Bay | Multiple Use Zone (IUCN VI) |

# Extra Information

## State and Territory Reserves [ Resource Information ]

| Name | State |
|---|---|
| Airlie Island | WA |
| Barrow Island | WA |
| Bessieres Island | WA |
| Boodie, Double Middle Islands | WA |
| Boullanger, Whitlock, Favourite, Tern And Osprey Islands | WA |
| Cape Range | WA |
| Escape Island | WA |
| Houtman Abrolhos Islands | WA |

| Name | State |
|---|---|
| Lowendal Islands | WA |
| Montebello Islands | WA |
| Muiron Islands | WA |
| Round Island | WA |
| Serrurier Island | WA |
| Unnamed WA40322 | WA |
| Unnamed WA40828 | WA |
| Unnamed WA41080 | WA |
| Unnamed WA44665 | WA |
| Unnamed WA44682 | WA |

## Invasive Species [ Resource Information ]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

| Name | Status | Type of Presence |
|---|---|---|
| Birds | | |
| Columba livia<br>Rock Pigeon, Rock Dove, Domestic Pigeon [803] | | Species or species habitat likely to occur within area |
| Streptopelia senegalensis<br>Laughing Turtle-dove, Laughing Dove [781] | | Species or species habitat likely to occur within area |
| Mammals | | |
| Canis lupus familiaris<br>Domestic Dog [82654] | | Species or species habitat likely to occur within area |
| Capra hircus<br>Goat [2] | | Species or species habitat likely to occur within area |
| Equus caballus<br>Horse [5] | | Species or species habitat likely to occur within area |
| Felis catus<br>Cat, House Cat, Domestic Cat [19] | | Species or species habitat likely to occur within area |
| Feral deer<br>Feral deer species in Australia [85733] | | Species or species habitat likely to occur within area |
| Mus musculus<br>House Mouse [120] | | Species or species habitat likely to occur within area |
| Oryctolagus cuniculus<br>Rabbit, European Rabbit [128] | | Species or species habitat likely to occur within area |
| Rattus rattus<br>Black Rat, Ship Rat [84] | | Species or species habitat likely to occur within area |
| Sus scrofa<br>Pig [6] | | Species or species habitat likely to occur within area |
| Vulpes vulpes<br>Red Fox, Fox [18] | | Species or species habitat likely to occur within area |
| Plants | | |

| Name | Status | Type of Presence |
|---|---|---|
| Asparagus asparagoides<br>Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473] | | Species or species habitat likely to occur within area |
| Brachiaria mutica<br>Para Grass [5879] | | Species or species habitat may occur within area |
| Cenchrus ciliaris<br>Buffel-grass, Black Buffel-grass [20213] | | Species or species habitat likely to occur within area |
| Chrysanthemoides monilifera<br>Bitou Bush, Boneseed [18983] | | Species or species habitat may occur within area |
| Genista sp. X Genista monspessulana<br>Broom [67538] | | Species or species habitat may occur within area |
| Lycium ferocissimum<br>African Boxthorn, Boxthorn [19235] | | Species or species habitat likely to occur within area |
| Olea europaea<br>Olive, Common Olive [9160] | | Species or species habitat may occur within area |
| Opuntia spp.<br>Prickly Pears [82753] | | Species or species habitat likely to occur within area |
| Pinus radiata<br>Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780] | | Species or species habitat may occur within area |
| Tamarix aphylla<br>Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018] | | Species or species habitat likely to occur within area |
| Reptiles | | |
| Hemidactylus frenatus<br>Asian House Gecko [1708] | | Species or species habitat likely to occur within area |

## Key Ecological Features (Marine) [ Resource Information ]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

| Name | Region |
|---|---|
| Ancient coastline at 125 m depth contour | North-west |
| Canyons linking the Argo Abyssal Plain with the | North-west |
| Canyons linking the Cuvier Abyssal Plain and the | North-west |
| Commonwealth waters adjacent to Ningaloo Reef | North-west |
| Continental Slope Demersal Fish Communities | North-west |
| Exmouth Plateau | North-west |
| Glomar Shoals | North-west |
| Mermaid Reef and Commonwealth waters | North-west |
| Wallaby Saddle | North-west |
| Ancient coastline at 90-120m depth | South-west |
| Commonwealth marine environment surrounding | South-west |
| Commonwealth marine environment within and | South-west |
| Perth Canyon and adjacent shelf break, and other | South-west |
| Western demersal slope and associated fish | South-west |
| Western rock lobster | South-west |

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-20.896093 115.702567,-21.155433 115.450776,-21.261924 115.480073,-21.411167 115.393947,-21.52672 115.200726,-21.576411 114.855378,-21.691937 114.602933,-21.719749 114.433923,-21.882341 114.292725,-21.913162 114.156955,-21.901796 114.147483,-21.86391 114.15506,-21.816552 114.194841,-21.776771 114.160743,-21.797609 114.098231,-21.860121 113.997832,-21.945366 113.942896,-22.256034 113.827343,-22.403792 113.743992,-22.559126 113.653065,-22.725826 113.672008,-22.746664 113.749675,-23.129317 113.723155,-23.593834 113.569619,-24.539434 112.902136,-25.48017 112.724847,-27.230524 113.300721,-28.511086 113.725049,-28.852064 114.3085,-29.011187 114.710097,-29.70072 114.960147,-30.06443 114.944992,-30.392741 115.047921,-31.731984 114.827566,-31.834674 112.970596,-31.338341 110.146632,-30.516824 109.282328,-28.069389 106.834893,-27.521711 106.235871,-25.433689 105.080613,-24.073052 104.892348,-23.645179 104.139291,-24.68919 101.435132,-23.974641 100.412515,-23.38505 100.188224,-22.437889 100.157915,-22.198967 100.245644,-21.452842 100.184436,-21.339183 100.324615,-21.028514 101.775666,-20.316249 101.711259,-19.760089 101.845891,-18.324574 100.110864,-18.025063 99.995339,-17.190617 99.9268083,-15.470573 100.108663,-14.61434 100.055622,-15.220523 101.548347,-15.713046 103.851843,-15.152327 103.897307,-14.796194 104.071584,-13.399753 102.836417,-12.381414 101.937883,-11.795588 99.9950038,-10.848427 99.9495401,-10.833273 101.078556,-10.984819 102.442467,-12.083525 105.064209,-12.720018 105.821938,-12.750327 106.481162,-12.030484 106.708481,-11.136364 107.049458,-10.714848 107.433916,-9.988405 107.382859,-9.548923 107.4359,-8.491891 108.193629,-8.722998 108.424736,-8.977682 109.233123,-8.253206 109.186254,-7.805309 109.429232,-7.776784 109.563299,-7.805309 109.690947,-7.865212 109.725177,-8.806533 109.669554,-8.357266 111.368211,-9.636061 112.974898,-8.654803 113.596235,-8.556298 113.72126,-8.787405 114.554762,-8.738153 114.607803,-8.442639 114.585071,-8.594184 115.047286,-8.859389 115.096538,-8.821503 115.827747,-8.916219 115.971715,-8.94274 116.392254,-9.105651 117.009803,-8.901064 118.457065,-8.806348 119.33982,-8.91243 120.271826,-8.965471 121.006823,-8.920008 121.631949,-8.730575 122.503337,-8.597973 123.33305,-8.563875 124.079413,-8.336557 125.155388,-8.032082 125.389619,-8.288806 125.500866,-8.476736 125.409227,-8.596875 125.175682,-8.926337 124.929655,-9.020469 124.668652,-9.003354 123.725192,-9.127438 122.638393,-9.426949 122.124945,-9.546754 121.684236,-9.512524 121.234969,-9.302866 120.404895,-9.272915 119.484967,-9.548923 118.616189,-10.333172 119.313299,-10.753711 119.968734,-11.48502 120.036924,-12.60257 119.885384,-13.693699 120.029353,-14.405255 120.103244,-15.053822 120.143012,-15.406166 119.817189,-16.023715 121.056075,-16.756419 121.145116,-16.914732 119.773782,-17.111056 119.137127,-17.573271 119.165542,-17.900988 119.023468,-18.31395 119.265941,-18.465772 119.116996,-18.833743 118.577876,-19.188878 117.916812,-19.477693 117.339183,-19.822131 116.4706,-19.950493 116.526223,-20.202938 116.500551,-20.335579 116.365771,-20.508867 116.106907,-20.587137 115.812592,-20.896093 115.702567

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

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


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# APPENDIX C: SPILL MODELLING REPORT

# EQUUS WA-390-P GAS PROJECT

## Oil Spill Modelling

MAQ0899J
Equus WA-390-P Oil Spill Modelling
Rev1
15 January 2020

rpsgroup.com/mst

## Document status

| Version | Purpose of document | Authored by | Reviewed by | Approved by | Review date |
|---|---|---|---|---|---|
| RevA | Daft issued for internal review | Jordan Glen<br>Jeremie Bernard | Jeremie Bernard | | 16 December 2019 |
| Rev0 | Draft issued for client review | | Dr Sasha Zigic | Dr Sasha Zigic | 17 December 2019 |
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## Approval for issue

| | | |
|---|---|---|
| Dr. Sasha Zigic |  | 15 January 2021 |



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# Contents

## Tables

## Figures

# TERMS AND ABBREVIATIONS

| | |
|---|---|
| ° | Degrees |
| ‘ | Minutes |
| “ | Seconds |
| Actionable oil | Oil which is thick enough for the effective use of mitigation strategies |
| ARMCANZ | Agriculture and Resource Management Council of Australia and New Zealand |
| AMSA | Australian Maritime Safety Authority |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| API | American Petroleum Institute gravity. A measure of how heavy or light a petroleum liquid is compared to water. |
| ASTM | American Society for Testing and Materials |
| Bonn Agreement | An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union. |
| Biodegradation | Decomposition of organic material by microorganism |
| BTEX | Benzene, toluene, ethylbenzene, and xylenes |
| ºC | degree Celsius (unit of temperature) |
| CFSR | Climate Forecast System Reanalysis |
| CNES | The National Centre for Space Studies (France) |
| cP | Centipoise (unit of dynamic viscosity) |
| Decay | The process where oil components are changed either chemically or biologically (biodegradation) to another compound. It includes breakdown to simpler organic carbon compounds by bacteria and other organisms, photo-oxidation by solar energy, and other chemical reactions. |
| DEWHA | Department of the Environment, Water, Heritage and the Arts |
| Dissolved hydrocarbons | Hydrocarbon droplets which are dissolved in water. |
| Dynamic viscosity | The dynamic viscosity of a fluid expresses its resistance to shearing flows, where adjacent layers move parallel to each other with different speeds. |
| Entrained hydrocarbons | Hydrocarbon droplets that are suspended into the water column, though not dissolved. |
| EP | Environmental plan |
| Evaporation | The process whereby components of the oil mixture are transferred from the sea-surface to the atmosphere as vapours. |
| $g/m^2$ | Grams per square meter (unit of surface area density) |
| GODAE | Global Ocean Data Assimilation Experiment |
| HYCOM | Hybrid Coordinate Ocean Model. A data-assimilative, three-dimensional ocean model. |
| HYDROMAP | Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction. |
| Isopycnal layer | Water layer characterised by the same density |
| ITOPF | International Tankers Owners Pollution Federation |

| | |
|---|---|
| km | Kilometer (unit of length) |
| $km^2$ | Square Kilometers (unit of area) |
| Knots | unit of speed (1 knot = 0.514 m/s) |
| KP0 | Kilometer point 380 |
| $LC_{50}$ | Median lethal dose required for mortality of 50% of a tested population after a specified exposure duration. |
| m | Meter (unit of length) |
| MAHs | Monoaromatic hydrocarbons |
| MGO | Marine gas oil |
| mm | Millimeter (unit of length) |
| µm | Micrometer (unit of length; 1 µm = 0.001 mm) |
| m/s | Meter per Second (unit of speed) |
| $m^3$ | Cubic meter (unit of volume) |
| NASA | National Aeronautics and Space Administration |
| NCEP | National Centres for Environmental Prediction |
| NOAA | National Oceanic and Atmospheric Administration |
| NOPSEMA | National Offshore Petroleum Safety and Environmental Management Authority |
| NRC | National Research Council |
| PAHs | Polynuclear aromatic hydrocarbons |
| ppb | parts per billion (concentration) |
| Pour Point | The pour point of a liquid is the temperature below which the liquid loses its flow characteristics. |
| PSU | Practical salinity units |
| Sea surface exposure | Contact by floating oil on the sea surface at concentrations equal to or exceeding defined threshold concentrations. The consequence will vary depending on the threshold and the receptors. |
| SIMAP | Spill Impact Mapping Analysis Program |
| Shoreline contact | Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. Shoreline contact is judged for floating oil arriving within a 1 km buffer zone from any shoreline as a conservative measure |
| Single Oil spill modelling | Oil spill modelling involving a computer simulation of a single hypothetical oil spill event subject to a single sequence of wind, current and other sea conditions over time. Single oil spill modelling, also referred to as “deterministic modelling” provides a simulation of one possible outcome of a given spill scenario, subject to the metocean conditions that are imposed. Single oil spill modelling is commonly used to consider the fate and effects of ‘worst-case’ oil spill scenarios that are carefully selected in consideration of the nature and scale of the offshore petroleum activity and the local environment (NOPSEMA, 2018). Because the outcomes of a single oil spill simulation can only represent the outcome of that scenario under one sequence of metocean conditions, worst-case conditions are often identified from stochastic modelling. It is impossible to calculate the likelihood of any outcome from a single oil spill simulation. Single oil spill modelling is generally used for response planning, preparedness planning and for supporting oil spill response operations in the event of an actual spill. |
| Stochastic Oil spill modelling | Stochastic oil spill modelling is created by overlaying and statistically analysing the outcomes of many single oil-spill simulations of a defined spill scenario, where each simulation was subject to a different sequence of metocean conditions, selected objectively (typically by random selection) from a long sequence of historic conditions for the study area. Analysis of this larger set of simulations provides a more accurate indication of the area that maybe affected (EMBA) and also indicates which particular locations are more likely to be affected (as well as other statistics). |

| | |
|---|---|
| | Stochastic oil spill modelling avoids biases that affect single oil spill modelling (due to the reliance on only one possible sequence of conditions). However, when interpreting stochastic modelling, which is based on a wide range of potential conditions that might happen to occur, it is essential to understand that calculations for the Risk EMBA will enclose a much larger area than could be affected in any single spill event, where a more limited set of conditions will occur. Consequently, it is misleading to imply that the Risk EMBA contours derived from stochastic modelling indicate the outcomes expected from a single spill event (NOPSEMA, 2018). Stochastic modelling is generally used for risk assessment and preparedness planning by indicating locations that could be exposed and may require response or subsequent impact assessment. |
| TOPEX/Poseidon | A joint satellite mission between NASA and CNES to map ocean surface topography using an array of satellites equipped with detailed altimeters |
| Weathered oil | Oil that no longer contains volatile or soluble components |

# EXECUTIVE SUMMARY

## Background

Western Gas Corporation Pty Ltd (Western Gas) is currently developing the Equus Gas Project located offshore about 200 km north west of Onslow, Western Australia. The planned development consists of a floating production storage and offloading (FPSO) facility in the offshore permit to process condensate for export, a gas pipeline to a nearshore floating liquefied natural gas facility (FLNG), to process gas for export; and the option for a DomGas pipeline from the FLNG to the shore for connection into the Dampier to Bunbury pipeline.

To support the development of the environmental plan (EP) and oil pollution emergency plan (OPEP), RPS was commissioned to undertake a comprehensive oil spill modelling study, which considered the following two hypothetical spill scenarios:

- **Scenario 1:** A 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days resulting from a loss of well control at Mentorc-1;
- **Scenario 2:** A 1,000 m$^3$ surface release of marine gas oil (MGO) over 6 hours resulting from a vessel collision along the pipeline route straddling the State/Commonwealth boundary. The potential risk of exposure was assessed at two locations:
  - Point 1 was selected as it is closest to several islands and closest to North West Cape and Exmouth Gulf; and
  - Point 4 was selected as it is the most northerly location closest to Thevenard Island.

The potential risk of exposure to the surrounding waters and contact to shorelines was assessed for three distinct seasons; (i) summer (September to the following March), (ii) the transitional periods (April and August) and (iii) winter (May to July). This approach assists with identifying the environmental values and sensitivities that would be at risk of exposure on a seasonal basis.

The purpose of the modelling is to further improve understanding of a conservative ‘outer envelope’ of the potential area that may be affected in the unlikely event of hydrocarbon release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbons may influence.

## Methodology

The modelling study was carried out in several stages. Firstly, a ten-year current dataset (2009–2018) that includes the combined influence of large-scale ocean and nearshore tidal currents was developed. Secondly, the currents, local winds and detailed hydrocarbon characteristics were used as inputs in the three-dimensional oil spill model (SIMAP) to simulate the drift, spread, weathering and fate of the spilled oil.

As spills can occur during any set of wind and current conditions, modelling was conducted using a stochastic (or probabilistic) approach, which involved running 100 randomly selected single trajectory simulations per season (3 seasons per scenario), with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start time. This ensured that each spill trajectory was subjected to varying wind and current conditions.

## Oil Properties

Mentorc condensate has a density of 728 kg/m$^3$ (API of 62.8), dynamic viscosity of 0.5 cP at 15°C and a low pour point (-100°C). This condensate is comprised of 95.9% components which will evaporate and 4.1% of residuals, which are unlikely to evaporate. These properties classify the condensate as a group I oil (or non-persistent oil), according to the International Tanker Owners Pollution Federation (ITOPF, 2014),

Marine gas oil is characterised by a density of 830 kg/m$^3$ (API gravity of 36.4), a pour point of -36°C and a dynamic viscosity of 4 cP at 25°C. These properties classify it as a group II oil (light persistence) according to ITOPF (2014). This oil is likely to spread quickly when spilt at sea and thin out to low thickness levels; which increases the rate of evaporation. Due to its chemical composition, up to 65% will generally evaporate over the first two days depending upon the prevailing conditions and spill volume. Approximately 2.7% of the oil is considered “persistent hydrocarbons”, which are unlikely to evaporate.

# Key Findings

## Scenario 1: 2,727,570 bbl Subsea Release of Condensate at Mentorc-1

- The maximum distance from the release location to the low (≥ 1 g/m$^2$), moderate (≥ 10 g/m$^2$) and high (≥ 50 g/m$^2$) exposure thresholds was 134.7 km north-northwest (transitional), 62.9 km south-southwest (summer) and 5.2 km south-southwest (transitional), respectively.

- No shoreline contact was predicted above the low threshold for this scenario.

- No dissolved hydrocarbon exposure was predicted above the low threshold in the top 30 m of the water column for this scenario.

- For the 0 – 10 m depth layer, the Gascoyne AMP was predicted to record 100% probability of entrained hydrocarbon exposure at the low threshold during every season. Additionally, the Argo-Rowley Terrace, the Carnarvon Canyon and the Ningaloo AMPs, the Ningaloo, Northwest Shelf, and the Pilbarra (offshore) IMCRAs and the Canyons and the Commonwealth waters adjacent to Ningaloo Reef KEFs all recorded probabilities of low entrained hydrocarbon exposure at or above 30% for each season. At the high entrained hydrocarbon exposure threshold, the Gascoyne AMP recorded the greatest probabilities of exposure ranging from 91% in summer to 100% during transitional and winter conditions. The Canyons KEF was also predicted to be exposed at the high entrained hydrocarbon threshold with predicted probabilities of 60% in summer, 72% during transitional conditions and 61% during winter.

## Scenario 2: 1,000 m$^3$ Surface Release of Marine Gas Oil at Point 1

- The maximum distance from the release location to the low (≥ 1 g/m$^2$), moderate (≥ 10 g/m$^2$) and high (≥ 50 g/m$^2$) exposure thresholds was 69.5 km west-southwest (transitional), 35.3 km west (transitional) and 7.6 km west-southwest (summer and transitional), respectively.

- The probability of contact to any shoreline at, or above, the low threshold (≥ 10 g/m$^2$) was 3% in summer and winter, and 9% during transitional conditions. The minimum time before shoreline contact was approximately 0.4 days (~9 hours) during winter and the maximum volume of oil ashore was 147.8 m$^3$, recorded during transitional conditions.

- The probability of shoreline contact (at the low threshold) for nearby islands ranged from 1%, recorded by Peak Island in summer, Bessieres Island, Exmouth and Table Island in transitional conditions, to 6% at Flat Island during transitional conditions.

- In the surface (0-10 m) depth layer, the Ningaloo IMCRA, Ancient coastline at 125 m depth contour and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) Key Ecological Features (KEF) were all predicted to be exposed at the low dissolved hydrocarbon threshold during every season with probabilities of exposure ranging from 3% to 9% in summer, 4% to 13% during transitional conditions and 3% to 8% in winter. No receptors were predicted to be exposed at or above the moderate threshold.

- At the surface layer (0-10 m), the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF were predicted to be exposed at the low threshold with probabilities ranging from 53% to 58% in summer, 46% to 48% in transitional conditions and 51% to 52% in winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 42% at the Ancient coastline at 125 m depth contour KEF during summer while it also recorded 38% and 42% probabilities of high entrained hydrocarbon exposure during transitional and winter conditions.

## Scenario 2: 1,000 $m^3$ Surface Release of Marine Gas Oil at Point 4

- The maximum distance from the release location to the low (≥ 1 $g/m^2$), moderate (≥ 10 $g/m^2$) and high (≥ 50 $g/m^2$) exposure thresholds was 97.5 km west-southwest, 26.8 km west and 8.8 km west, all during transitional conditions, respectively.

- The probability of contact to any shoreline at, or above, the low threshold was 5% during both transitional and winter conditions, and there was no contact predicted in summer months. The minimum time before shoreline contact was approximately 1.1 days (26 hours) in transitional conditions and 0.8 days (20 hours) during winter and the maximum volume of oil ashore was predicted during winter with 6.5 $m^3$.

- Oil contact was predicted to impact Bessieres Island and Flat Island shorelines at the low threshold during transitional and winter conditions with probabilities of exposure ranging from 1% to 3%. Additionally, Peak Island was predicted to be contacted during winter conditions at the low and moderate thresholds with probabilities of 2% and 1%, respectively. No receptors were predicted to be contacted during summer conditions.

- The Ancient coastline at 125 m depth contour KEF recorded the greatest probability of dissolved hydrocarbon exposure at the low threshold in the 0- 10 m layer during all seasons with 6%, 5% and 4% in summer, transitional and winter conditions, respectively. The Ningaloo IMCRA and the Canyons KEF were also predicted to be exposed at the low threshold during summer, transitional and winter conditions with probabilities ranging between 1% to 3%.

- Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEFs were predicted to be exposed at the low entrained hydrocarbon threshold (0-10 m depth) with probabilities ranging from 37% to 54% in summer, 36% to 49% in transitional conditions and 45% to 49% during winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 31% at the Ancient coastline at 125 m depth contour KEF during transitional conditions, while it also recorded 26% and 28% probabilities of high entrained hydrocarbon exposure during summer and winter conditions.

# 1 INTRODUCTION

Western Gas Corporation Pty Ltd (Western Gas) is currently developing the Equus Gas Project located offshore about 200 km north west of Onslow, Western Australia. The Equus Gas Project is a greenfield development, targeting the Equus resource in WA-390-P, in water depths of approximately 1,000 m – 1,200 m below sea surface. The planned development consists of a floating production storage and offloading (FPSO) facility in the offshore permit to process condensate for export, a gas pipeline to a nearshore floating liquefied natural gas facility (FLNG), to process gas for export; and the option for a DomGas pipeline from the FLNG to the shore for connection into the Dampier to Bunbury pipeline.

To support the development of the environmental plan (EP) and oil pollution emergency plan (OPEP), RPS was commissioned to undertake a comprehensive oil spill modelling study, which considered the following two hypothetical spill scenarios:

- **Scenario 1:** A 2,727,570 bbl (22,542 bbl/day) <u>subsea release of Mentorc condensate over 121 days</u> resulting from a loss of well control at Mentorc-1;
- **Scenario 2:** A 1,000 $m^3$ <u>surface</u> release of marine gas oil (MGO) over 6 hours resulting from a vessel collision along the pipeline route straddling the State/Commonwealth boundary. The potential risk of exposure was assessed at two locations:
  - Point 1 was selected as it is closest to several islands and closest to North West Cape and Exmouth Gulf; and
  - Point 4 was selected as it is the most northerly location closest to Thevenard Island.

The release locations used for the oil spill assessment are presented in Table 1.1 and illustrated in Figure 1.1.

The potential risk of exposure to the surrounding waters and contact to shorelines was assessed for three distinct seasons; (i) summer (September to the following March), (ii) the transitional periods (April and August) and (iii) winter (May to July). This approach assists with identifying the environmental values and sensitivities that would be at risk of exposure on a seasonal basis.

The purpose of the modelling is to further improve understanding of a conservative 'outer envelope' of the potential area that may be affected in the unlikely event of hydrocarbon release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbons may influence.

The spill modelling was performed using the advanced three-dimensional trajectory and fates model; Spill Impact Mapping Analysis Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

**Table 1.1 Coordinates of the oil spill modelling release locations for the Equus Gas Project.**

| Scenario | Location | Latitude | Longitude | Depth (mLAT) |
|---|---|---|---|---|
| 1 | Mentorc-1 | 20° 29' 21.9"S | 113° 32' 13.2"E | 1,000 |
| 2 | Point 1 | 21° 31' 22.59" S | 114° 35' 4.69" E | 65 |
| | Point 4 | 21° 23' 44.29' S | 114° 48' 53.70" E | 55 |

The hydrocarbon spill model, the method and analysis applied herein uses modelling algorithms which have been peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the American Society for Testing and Materials (ASTM) Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

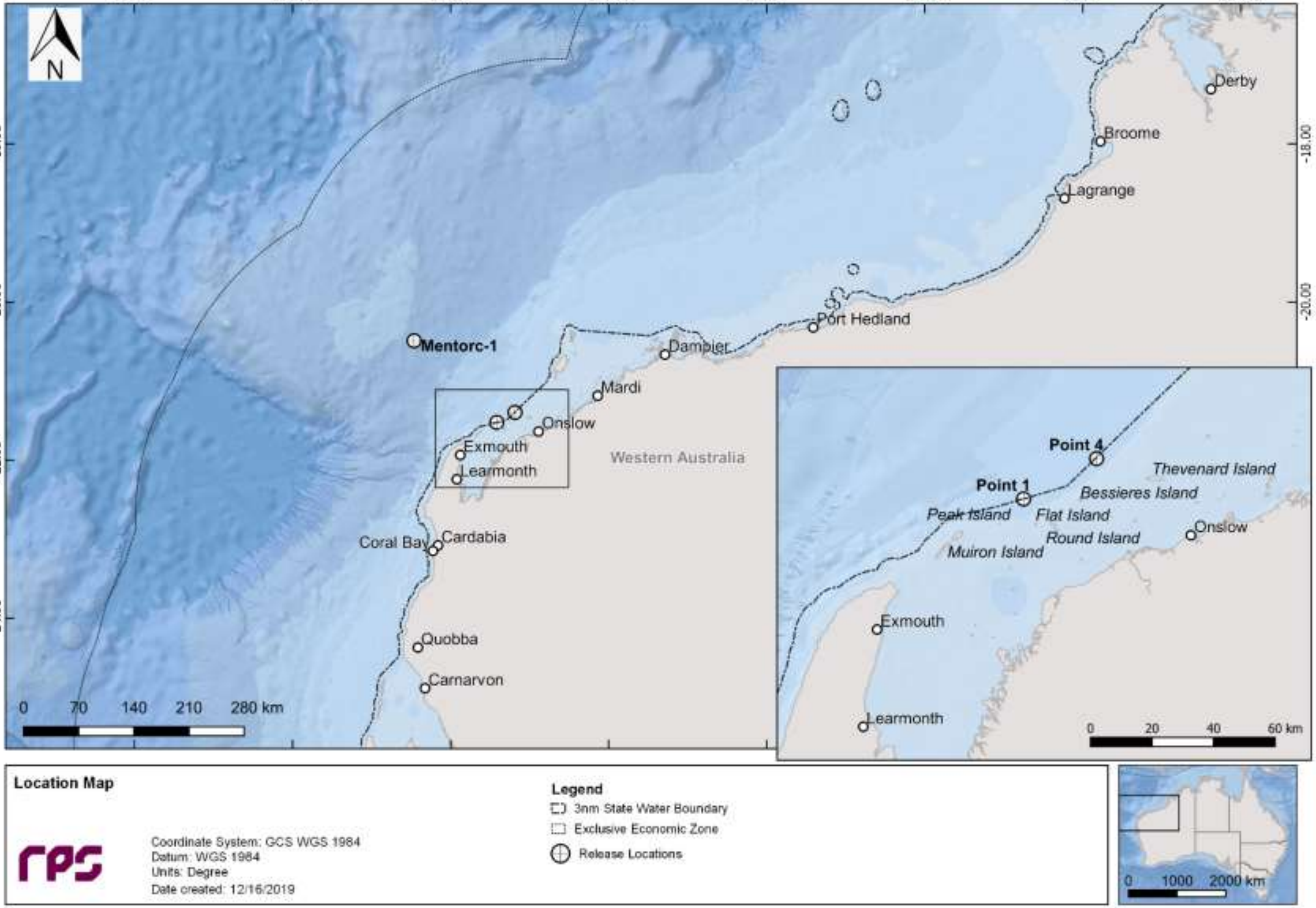


**Figure 1.1 Map of the release locations used as part of the Equus Gas Project oil spill modelling study.**

# 2 SCOPE OF WORK

The scope of work included the following components:

1. Generate ten years (2009 to 2018 (inclusive)) wind and current data. The three-dimensional current data includes the combined influence of ocean and tidal currents;
2. Use 10 years of high-resolution wind, aggregated current data and hydrocarbon characteristics as input into the 3-dimensional oil spill model to represent the movement, spreading, entrainment and weathering of the oil over time;
3. Use SIMAP's stochastic model to calculate exposure to surrounding waters (sea surface and water column) and contact to shorelines. This involved running 100 randomly selected single trajectory simulations for each season (i.e. 300 simulations per scenario), with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This will ensure that each spill trajectory is subjected to unique wind and current conditions.
4. Combine the 100 spill trajectories per season to determine the probability of exposure to the sea surface and water column, in addition to contact to shorelines (for a defined low, moderate and high threshold); and
5. Identify the "worst case" deterministic run for each scenario based on the largest volume of oil ashore (if shoreline contact is predicted) or the largest area of oil on the sea surface above 10 g/m$^2$ (actionable sea surface oil).

# 3 REGIONAL CURRENTS

The proposed release locations are located within the Carnarvon Basin, on the North West Shelf, a waterbody bordered by the Indian Ocean and Timor Sea. The North West Shelf is characterised by complex geomorphological features such as shoals, valleys and terraces and is dominated by high-amplitude tides and seasonally-dependant wind driven currents (DEWHA, 2007).

The Western Australian coastline is also influenced by the Indonesian Throughflow current. This system is a warm, low salinity current which travels predominantly from the northern Pacific Ocean, through the Indonesian Archipelago and into the eastern Indian Ocean (Schott and McCreary, 20016 ). Along the Western Australian coastline, the Throughflow eventually feeds into the Leeuwin Current, a warm south flowing current which separates the Western Australian coast from the Western Australian Current. The Operational Area lies in an area influenced by the Leeuwin Current.

A comprehensive description of the circulation patterns of the Northwest Shelf is provided in a review by Condie and Andrewartha (2008) and a schematic of the ocean currents along the Northwest Australian continental shelf is shown in Figure 3.1.

While, tidal currents are generally weaker in the deeper waters, its influence is greatest along the near shore and around islands. Therefore, to accurately account for the movement of an oil spill, which can move between the offshore and near shore region, ocean and tidal currents were combined as part of the study.

Figure 3.2 and Figure 3.3 present summer and winter current trends within the Carnarvon Basin and the North West Shelf.

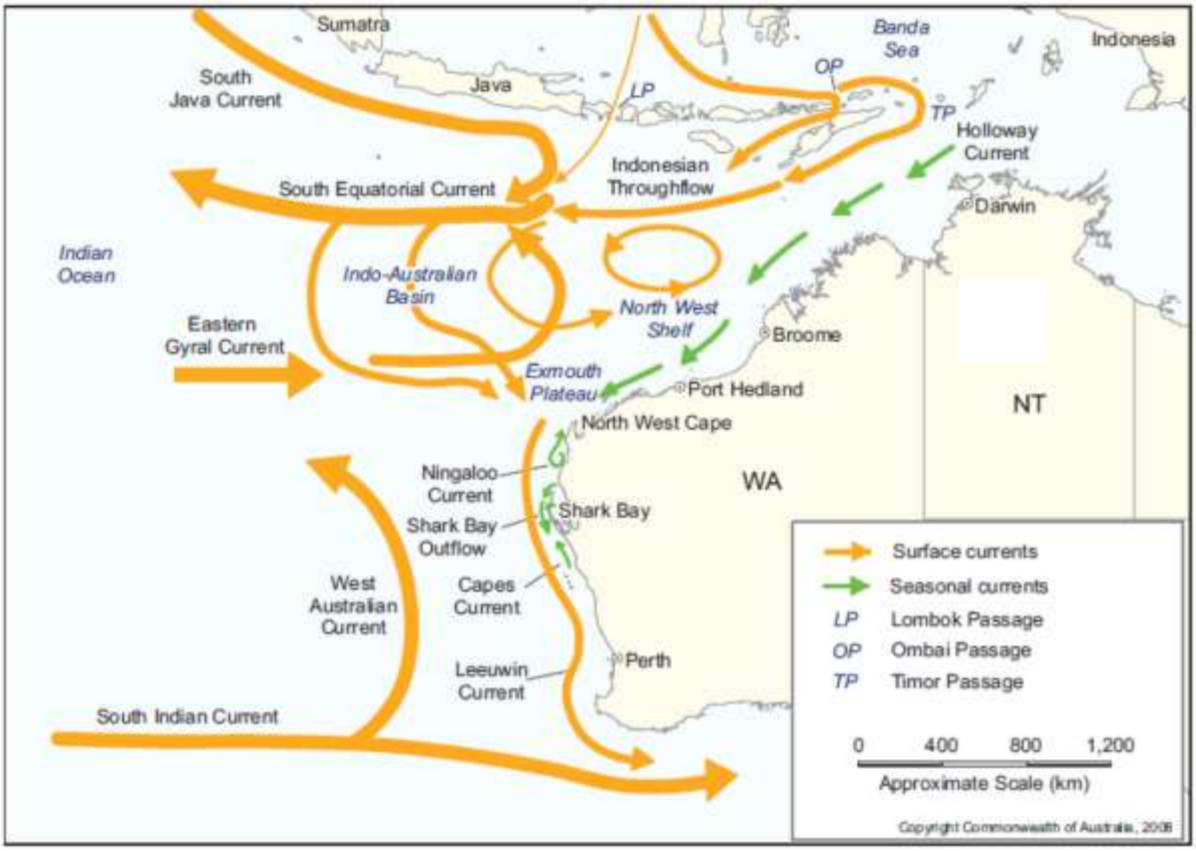


**Figure 3.1 Schematic of ocean currents along the northwest Australian continental shelf. Image adapted from DEWHA (2008).**

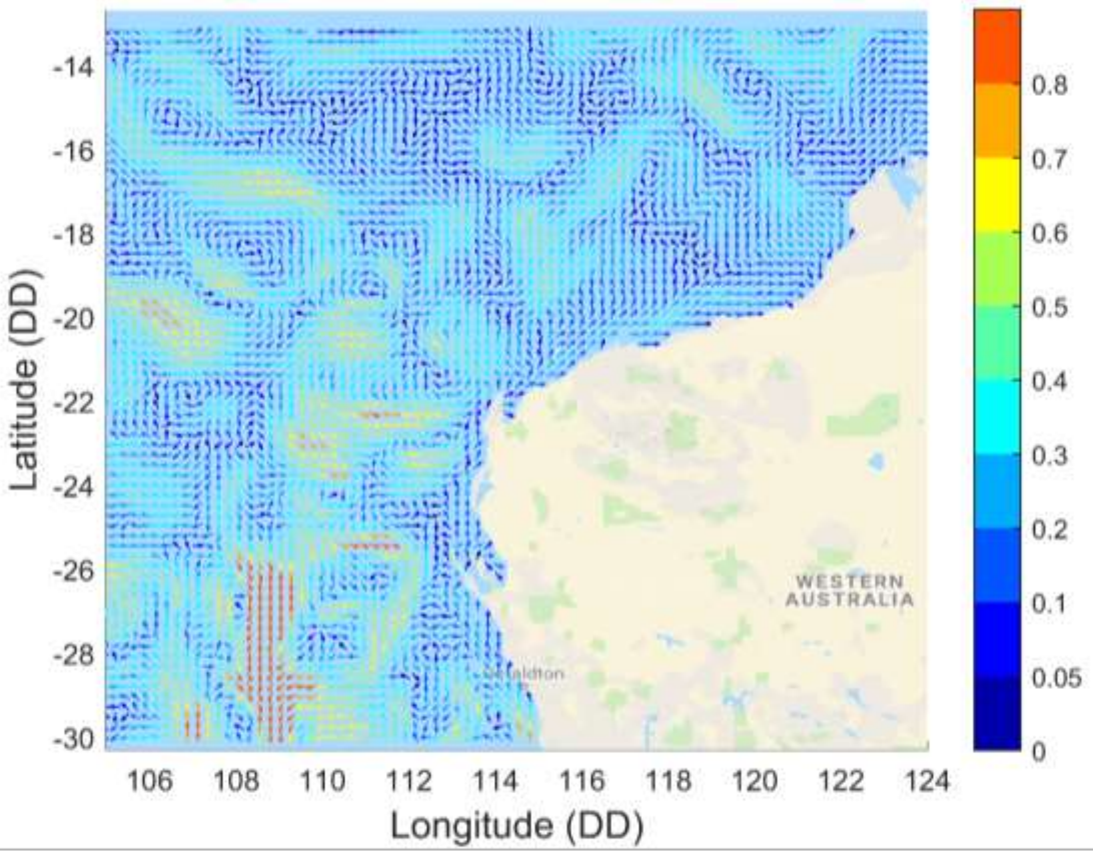


**Figure 3.2 Typical ocean current circulation pattern during the summer months.**

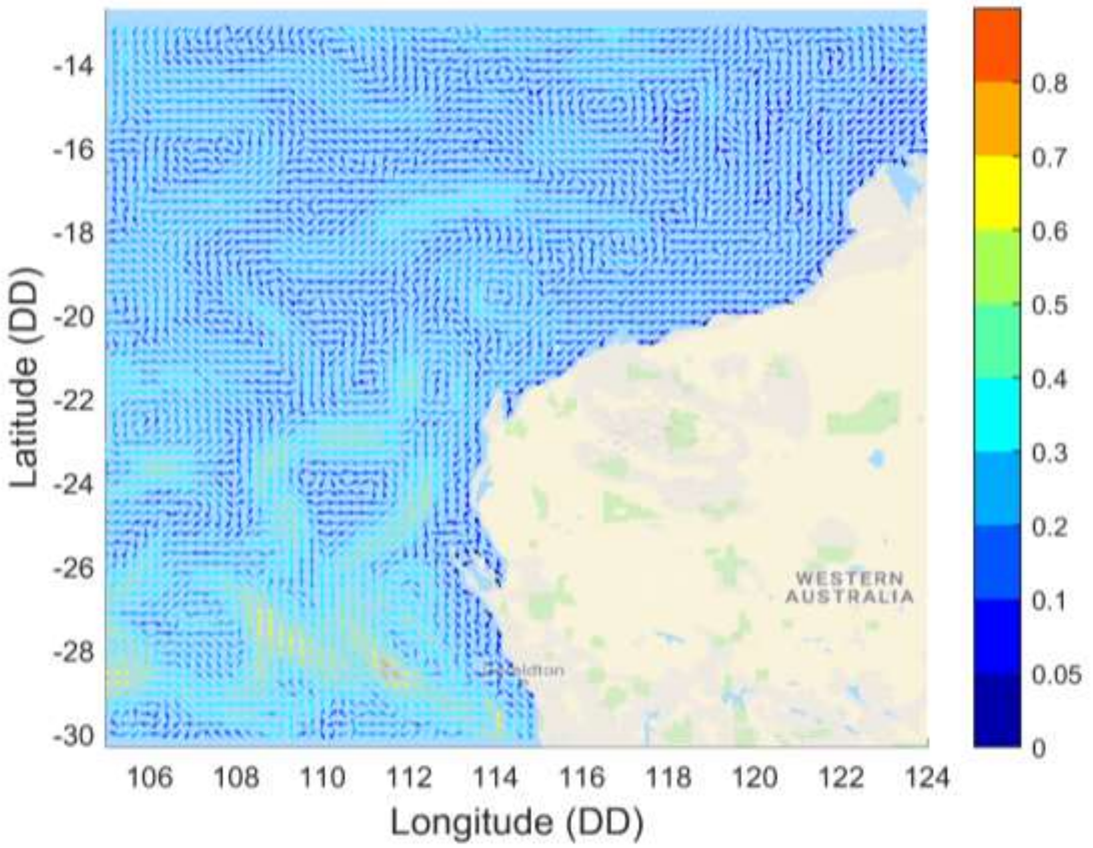


**Figure 3.3 Typical ocean current circulation pattern during the winter months.**

## 3.1 Tidal Currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for more than 30 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

### 3.1.1 Grid Setup

The tidal model domain has been sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids were allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3.4 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3.5). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

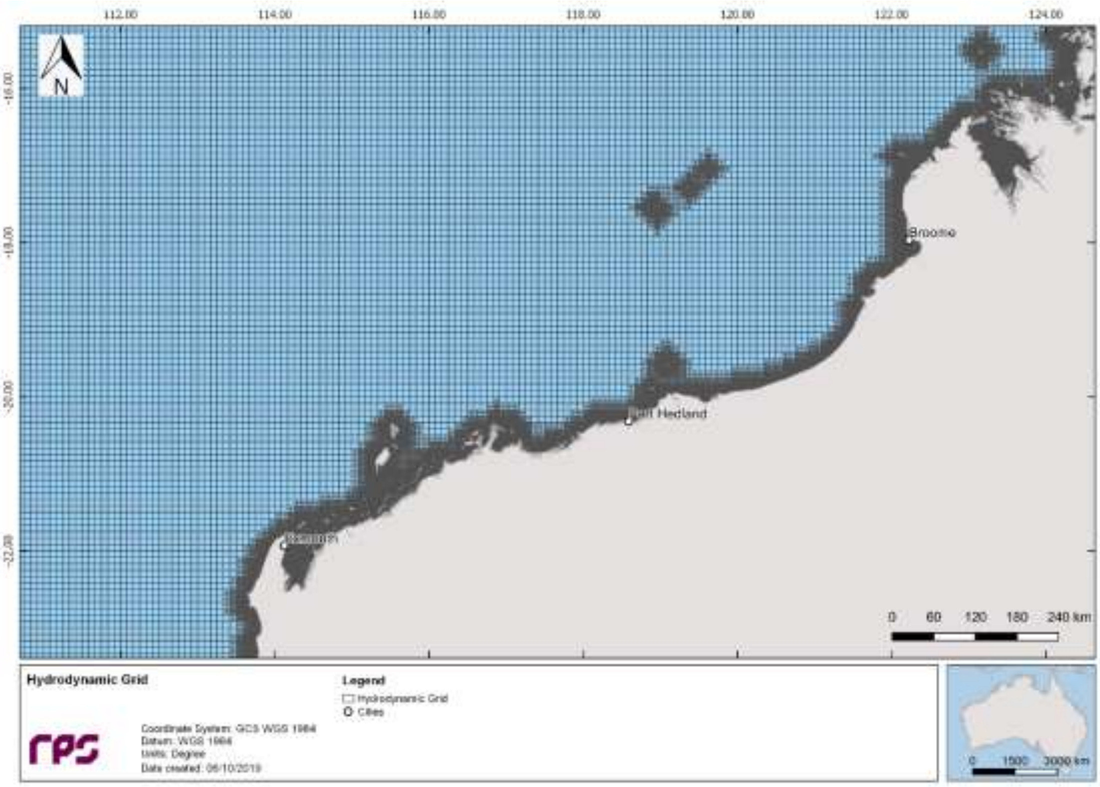


**Figure 3.4 Hydrodynamic grid for the tidal model.**

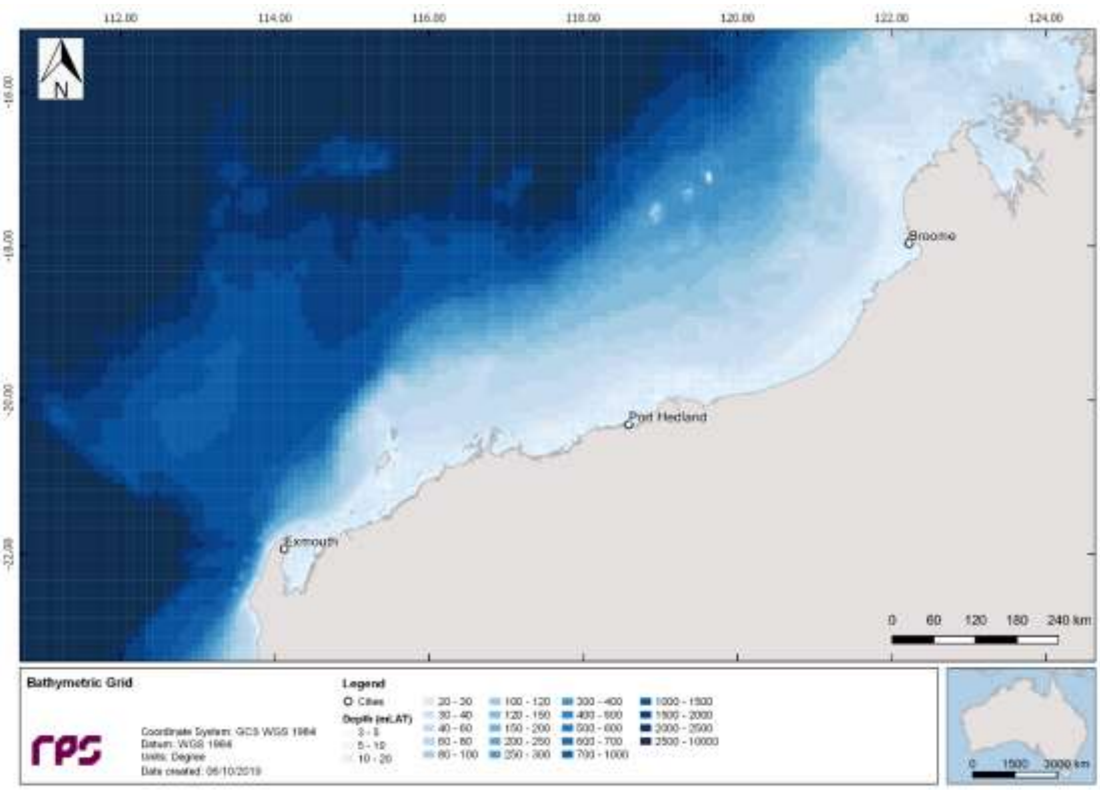


**Figure 3.5 Bathymetry defined throughout the tidal model domain.**

### 3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 7.2) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were $K_2$, $S_2$, $M_2$, $N_2$, $K_1$, $P_1$, $O_1$ and $Q_1$. Using the tidal data, surface heights were firstly calculated along the open boundaries, at each time step in the model.

The TOPEX/Poseidon satellite data has a global resolution of 0.25 degrees and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The satellites equipped with two highly accurate altimeters and capable of taking sea level measurements with an accuracy of ± 5 cm measured oceanic surface elevations (and the resultant tides) for over 13 years (1992–2005). In total, these satellites carried out 62,000 orbits of the planet.

The TOPEX/Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk and Tangdong, 2004; Qiu and Chen 2010). As such the TOPEX/Poseidon tidal data is considered suitably accurate for this study.

### 3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at several locations (see Table 3.2).

To provide a statistical measure of the model performance, the Index of Agreement (IOA - Willmott (1981)) and the Mean Absolute Error (MAE - Willmott (1982) and Willmott and Matsuura (2005)) were used.

The MAE (Eq.1) is simply the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error (Willmott and Matsuura, 2005) and more readily understood. The MAE is determined by:

$$MAE = N^{-1} \sum_{i=1}^{N} |P_i - O_i| \qquad \text{Eq.1}$$

Where: N = Number of observations
$P_i$ = Model predicted surface elevation
$O_i$ = Observed surface elevation

The Index of Agreement (IOA; Eq 2) in contrast, gives a non-dimensional measure of model accuracy or performance. A perfect agreement between the model predicted and observed surface elevations exists if the index gives an agreement value of 1, and complete disagreement between model and observed surface elevations will produce an index measure of 0 (Willmott, 1981). Willmott et al (1985) also suggests that values larger than 0.5 may represent good model performance. The IOA is determined by:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: $X_{model}$ = Model predicted surface elevation
$X_{obs}$ = Obsrved surface elevation

Clearly, a greater IOA and lower MAE represent a better model performance.

Figure 3.7 to Figure 3.9 illustrate a comparison of the predicted and observed surface elevations for each location for January 2014. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

**Table 3.1 Statistical comparison between the observed and predicted surface elevations.**

| Tide Station | IOA | MAE (m) |
|---|---|---|
| Learmonth | 0.96 | 0.14 |
| Onslow | 0.96 | 0.17 |
| Barrow Island - Tkr Mrg | 0.98 | 0.21 |
| Cape Legendre | 0.98 | 0.27 |
| Port Walcott | 0.98 | 0.30 |
| Port Hedland | 0.98 | 0.34 |
| Red Bluff | 0.99 | 0.30 |

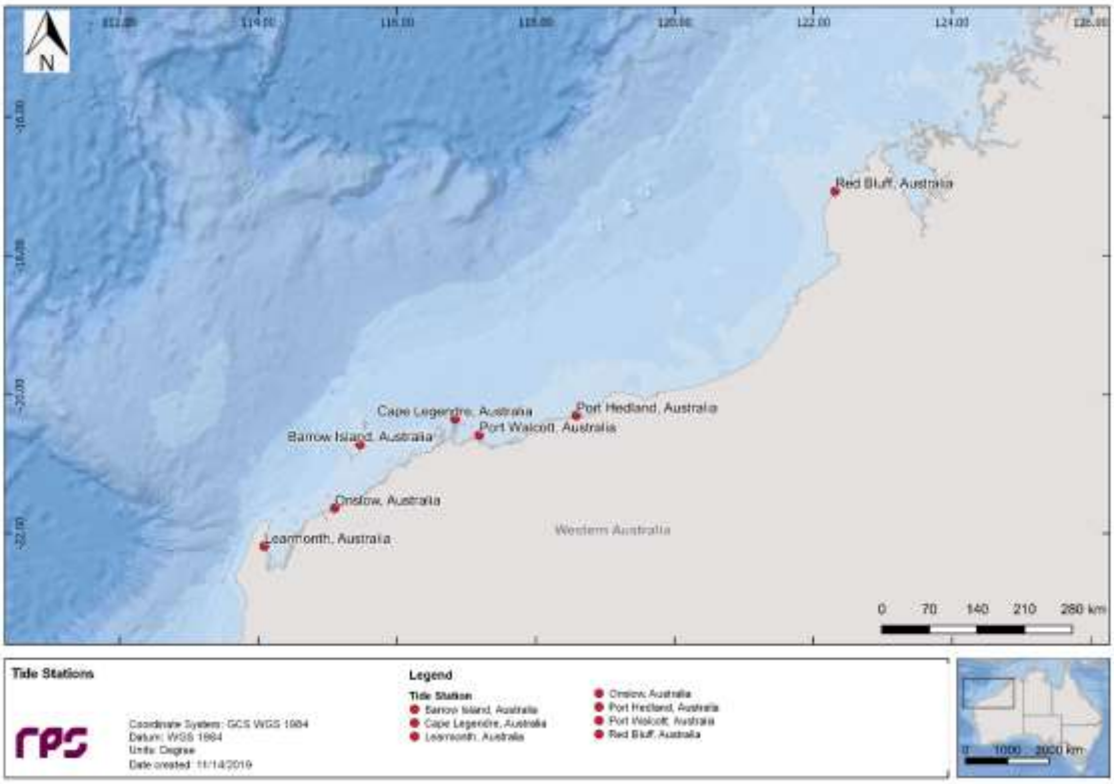


Figure 3.6 Tide stations used to calibrate surface elevation within the model.

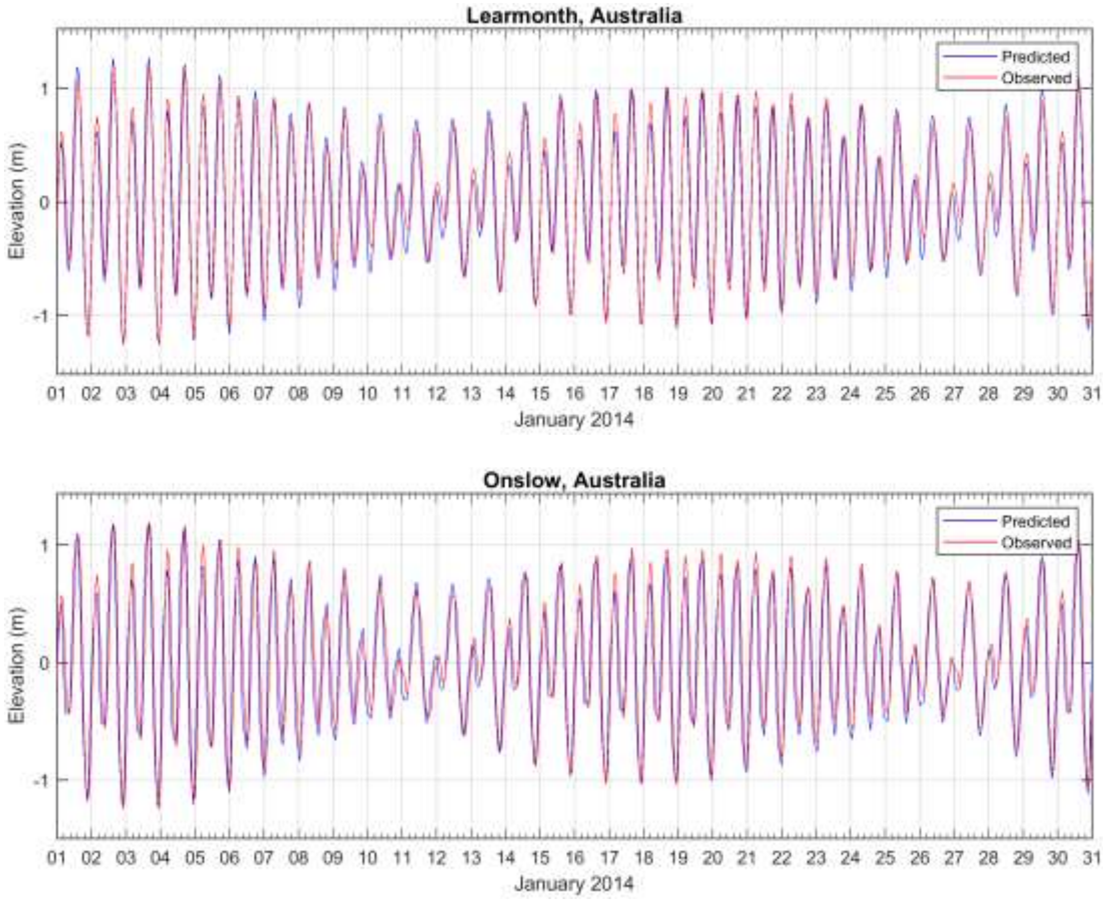


Figure 3.7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.

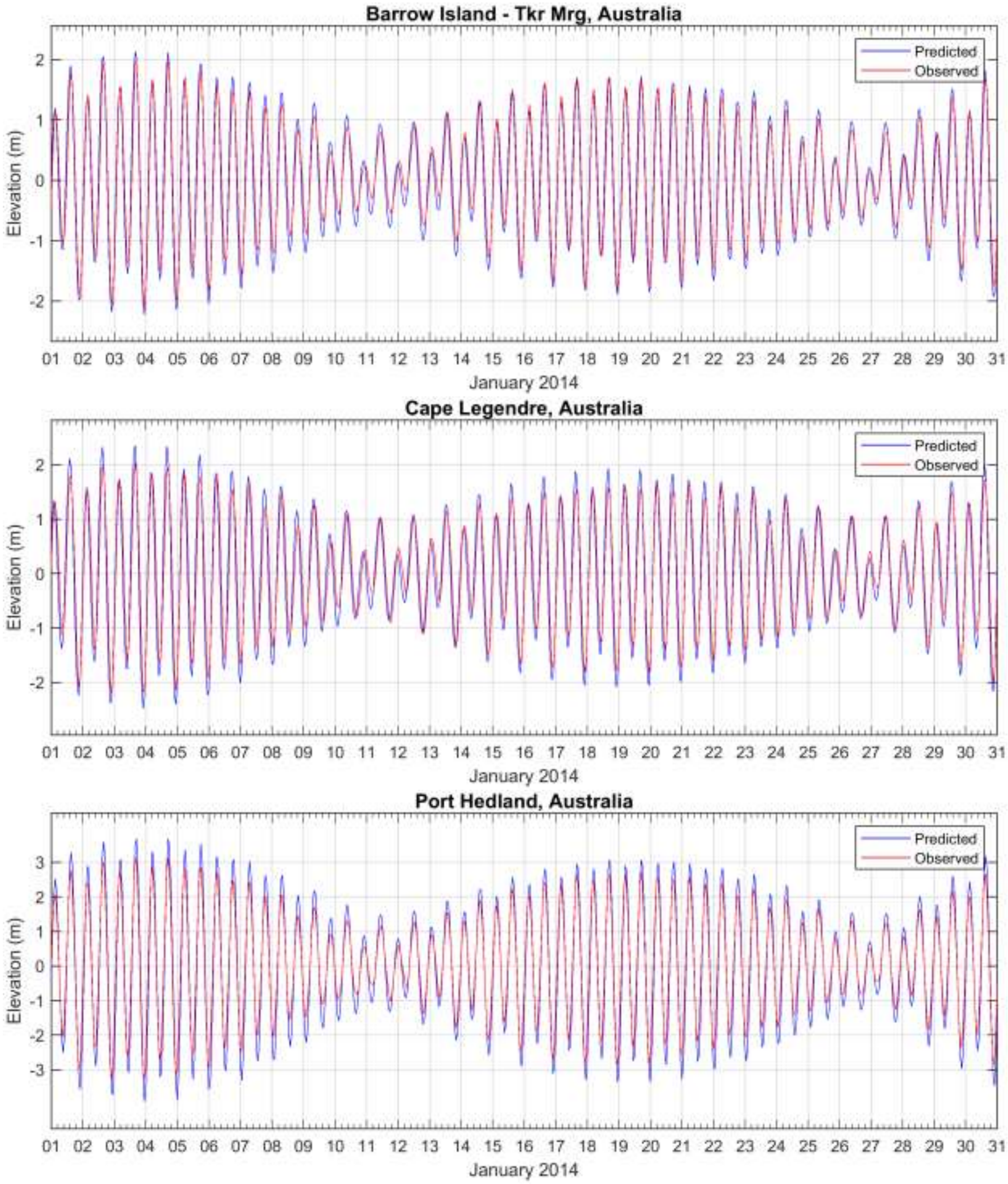


**Figure 3.8 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.**

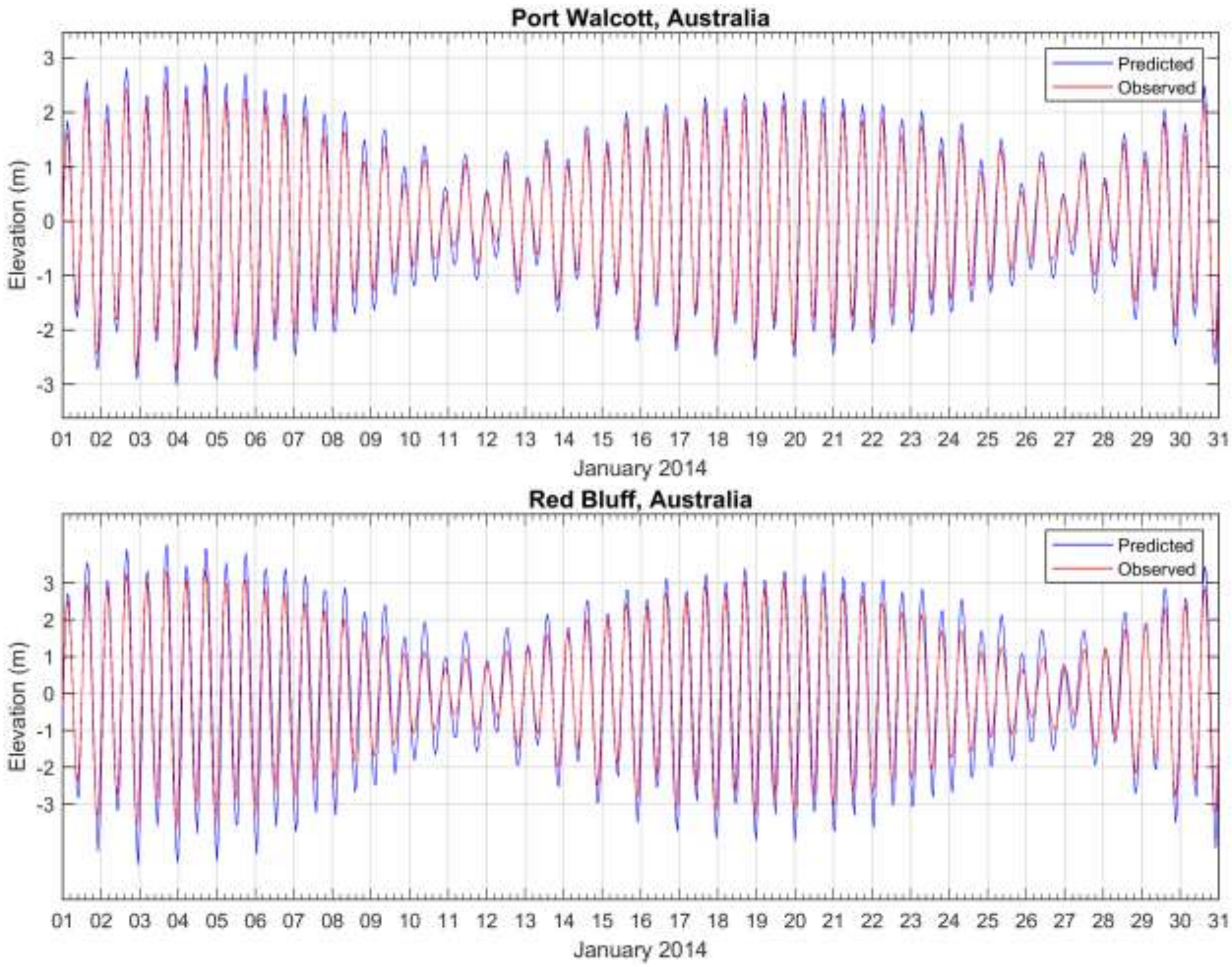


**Figure 3.9 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.**

## 3.2 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), operated by the HYCOM Consortium and sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12$^{th}$ of a degree) over the region, at a frequency of once per day. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM hindcast currents were obtained for the years 2009 to 2018 (inclusive).

### 3.2.1 Surface Currents

Table 3.2, Table 3.3 and Table 3.4 display the predicted average and maximum surface current speed near the Mentorc-1, Point 1 and Point 4 release locations, respectively. Figure 3.10, Figure 3.12 and Figure 3.14 illustrate the monthly current rose distributions (2009-2018 inclusive) while Figure 3.11, Figure 3.13 and Figure 3.15 illustrate the seasoal current rose distributions, derived from combining HYCOM ocean current data and HYDROMAP tidal data near the Mentorc-1, Point 1 and Point 4 release locations, respectively.

Note the convention for defining current direction throughout this report is the direction the current flows towards. Each branch of the current rose distribution represents the currents flowing to that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are predominantly used in these current roses. The length of each coloured segment within a branch is proportional to the frequency of currents flowing within the corresponding speed and direction.

The analysis of the combined surface current data (oceans plus tides) demonstrated slightly stronger currents at the offshore location (Mentorc-1), with waters generally flowing at 0.2-0.3 m/s on average throughout the year versus 0.1-0.2 m/s for the locations closer to the pipeline route at Point 1 and Point 4. The general current direction near the Mentorc-1 release location was predominately north during summer, west during winter and north and southwest during the transitional period with maximum current speeds ranging between 0.6 m/s (June) to 1.3 m/s (April and May).

**Table 3.2 Predicted monthly average and maximum surface current speeds close to the Mentorc-1 release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2009-2018 (inclusive).**

| Season | Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction (towards) |
|---|---|---|---|---|
| Summer | January | 0.3 | 0.9 | North |
| | February | 0.2 | 0.9 | North |
| | March | 0.2 | 0.6 | Variable |
| Transitional | April | 0.2 | 1.3 | Variable |
| Winter | May | 0.2 | 1.3 | Variable |
| | June | 0.2 | 0.6 | Variable |
| | July | 0.2 | 0.7 | Variable |
| Transitional | August | 0.2 | 0.8 | North |
| Summer | September | 0.3 | 0.9 | North |
| | October | 0.3 | 0.8 | North and West |
| | November | 0.3 | 1.1 | North |
| | December | 0.3 | 0.8 | Northeast |
| | **Minimum** | **0.2** | **0.6** | |
| | **Maximum** | **0.3** | **1.3** | |

**Table 3.3 Predicted monthly average and maximum surface current speeds close to the Point 1 location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2009-2018 (inclusive).**

| Season | Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction (towards) |
|---|---|---|---|---|
| Summer | January | 0.2 | 1.0 | Variable |
| | February | 0.2 | 0.7 | Variable |
| | March | 0.2 | 0.8 | Variable |
| Transitional | April | 0.2 | 0.7 | West |
| Winter | May | 0.2 | 0.7 | West |
| | June | 0.2 | 0.6 | West-southwest |
| | July | 0.2 | 0.6 | West-southwest |
| Transitional | August | 0.1 | 0.6 | West |
| Summer | September | 0.1 | 0.6 | Variable |
| | October | 0.2 | 0.5 | Variable |
| | November | 0.2 | 0.4 | Variable |
| | December | 0.2 | 0.5 | Variable |
| | **Minimum** | **0.1** | **0.4** | |
| | **Maximum** | **0.2** | **1.0** | |

**Table 3.4 Predicted monthly average and maximum surface current speeds close to the Point 4 release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2009-2018 (inclusive).**

| Season | Month | Average current speed (m/s) | Maximum current speed (m/s) | General direction (towards) |
|---|---|---|---|---|
| Summer | January | 0.2 | 0.9 | West and East-northeast |
| | February | 0.2 | 0.6 | West and East |
| | March | 0.2 | 0.7 | West and East-northeast |
| Transitional | April | 0.2 | 0.8 | West and East-northeast |
| Winter | May | 0.2 | 0.8 | West |
| | June | 0.2 | 0.8 | West-southwest |
| | July | 0.2 | 0.7 | West-southwest |
| Transitional | August | 0.2 | 0.7 | West |
| Summer | September | 0.2 | 0.6 | West and East |
| | October | 0.1 | 0.5 | West-northwest and East-northeast |
| | November | 0.1 | 0.5 | West and East-northeast |
| | December | 0.1 | 0.6 | West and East-northeast |
| | **Minimum** | **0.1** | **0.5** | |
| | **Maximum** | **0.2** | **0.9** | |

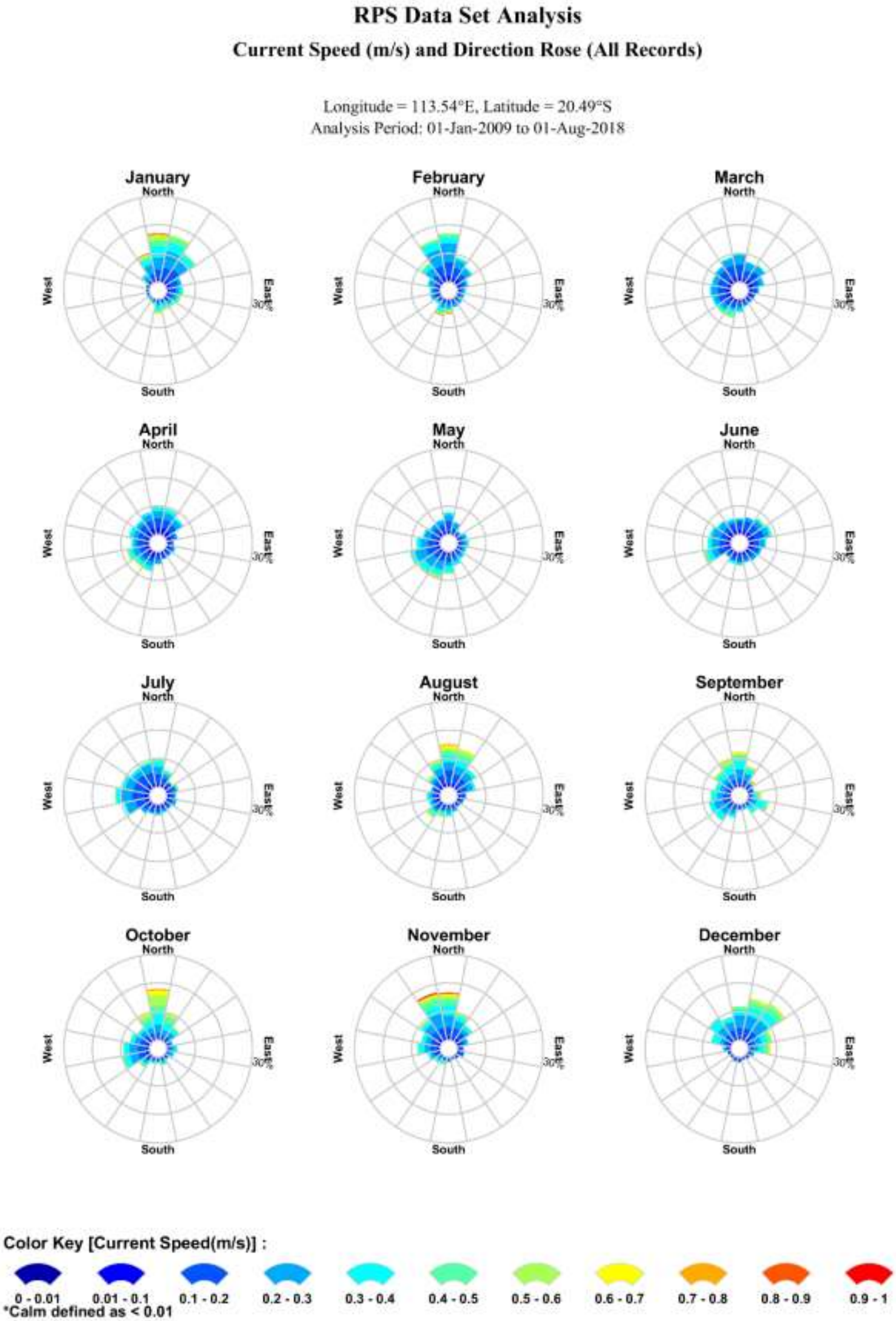


**Figure 3.10 Monthly surface current rose plots near the Mentorc-1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).**

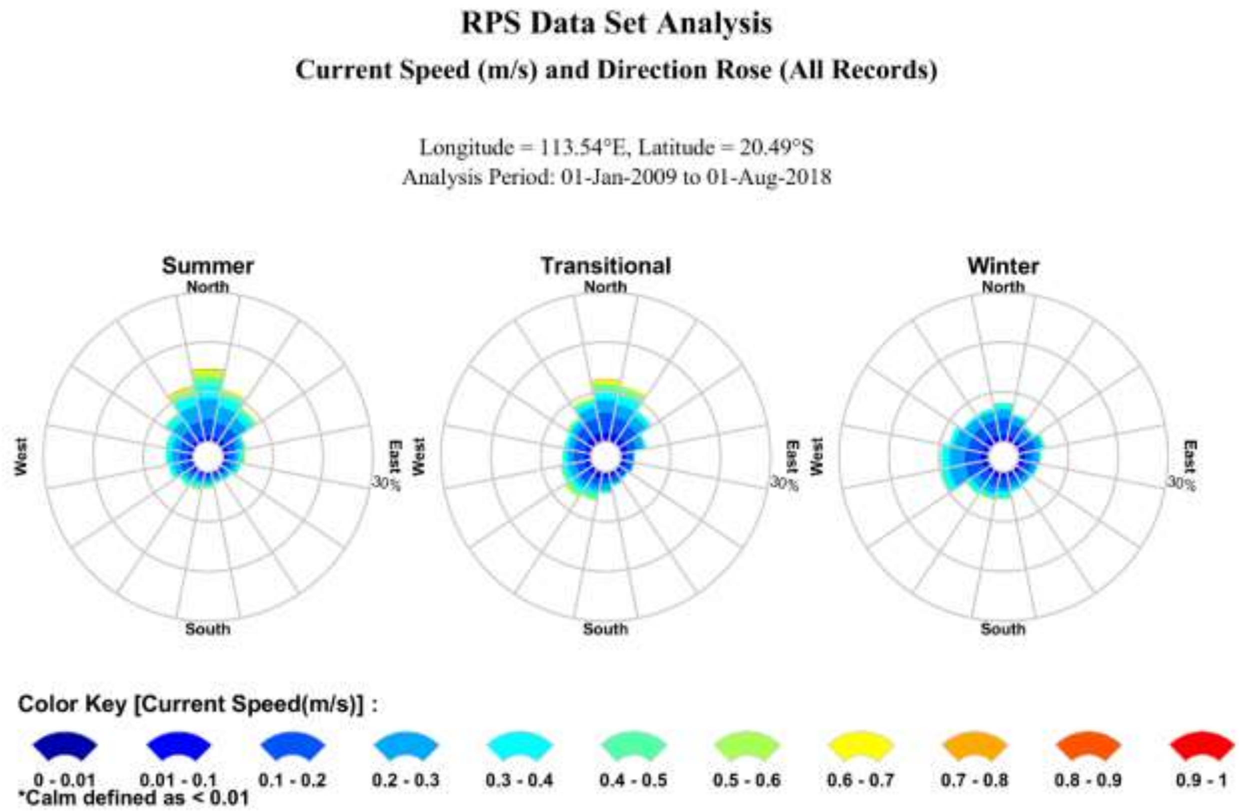


**Figure 3.11 Seasonal surface current rose plot near the Mentorc-1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).**

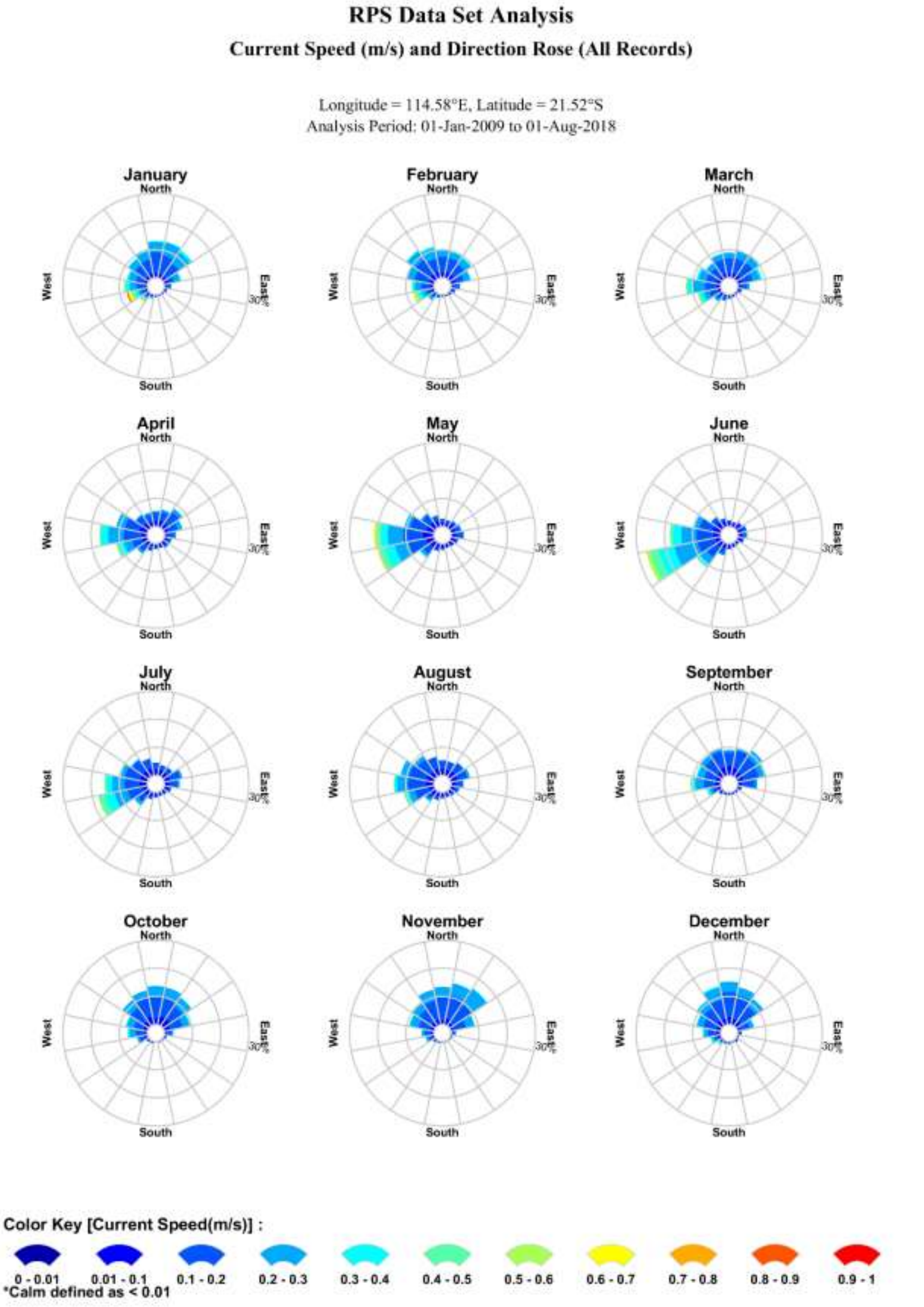


**Figure 3.12 Monthly surface current rose plots near the Point 1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).**

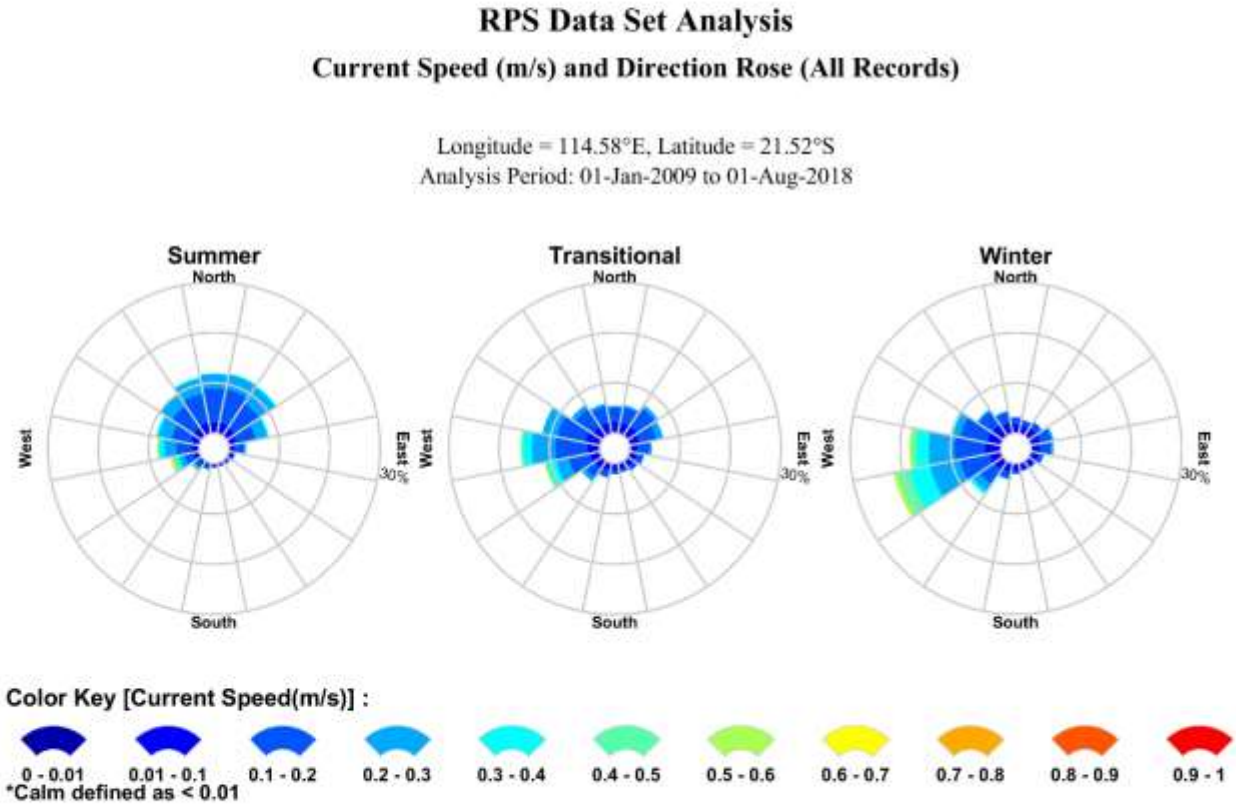


**Figure 3.13 Seasonal surface current rose plot near the Point 1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).**

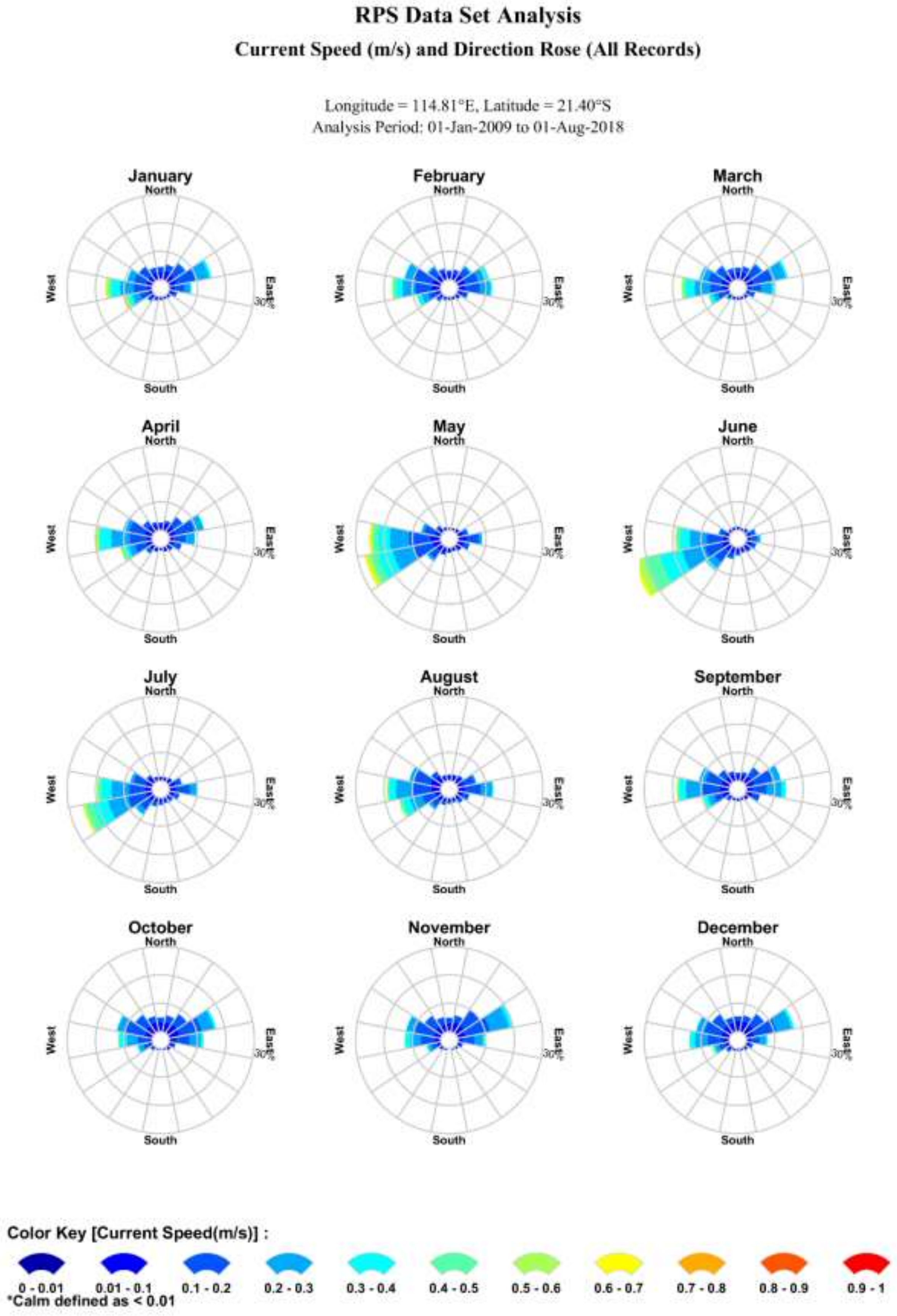


**Figure 3.14 Monthly surface current rose plots near the Point 4 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).**

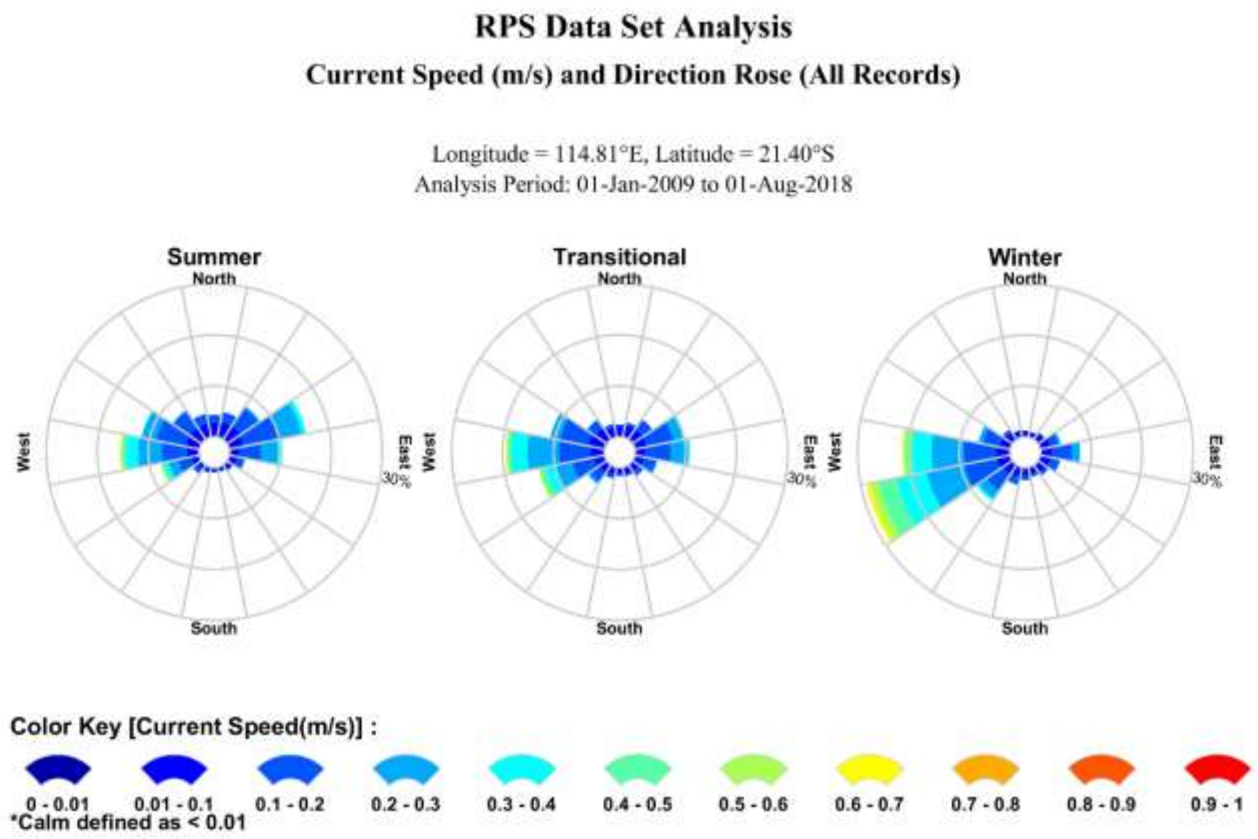


**Figure 3.15 Seasonal surface current rose plot near the Point 4 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).**

# 4 WIND DATA

High resolution wind data from 2009 to 2018 (inclusive) was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR; see Saha et al., 2010). The CFSR wind model includes observations from many data sources; surface observations, upper-atmosphere air balloon observations, aircraft observations and satellite observations. The model is capable of accurately representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals. Figure 4.1 shows the spatial resolution of the wind field used as input into the oil spill model and the wind point used to create the wind roses.

Table 4.1, Table 4.2 and Table 4.3 show the monthly average and maximum winds derived from the CFSR points located near the Mentorc-1, Point 1 and Point 4 release locations, respectively. Figure 4.2, Figure 4.4 and Figure 4.6 illustrate the monthly wind rose distributions while Figure 4.3, Figure 4.5 and Figure 4.7 illustrate the seasonal wind rose distributions at the Mentorc-1, Point 1 and Point 4 release locations, respectively.

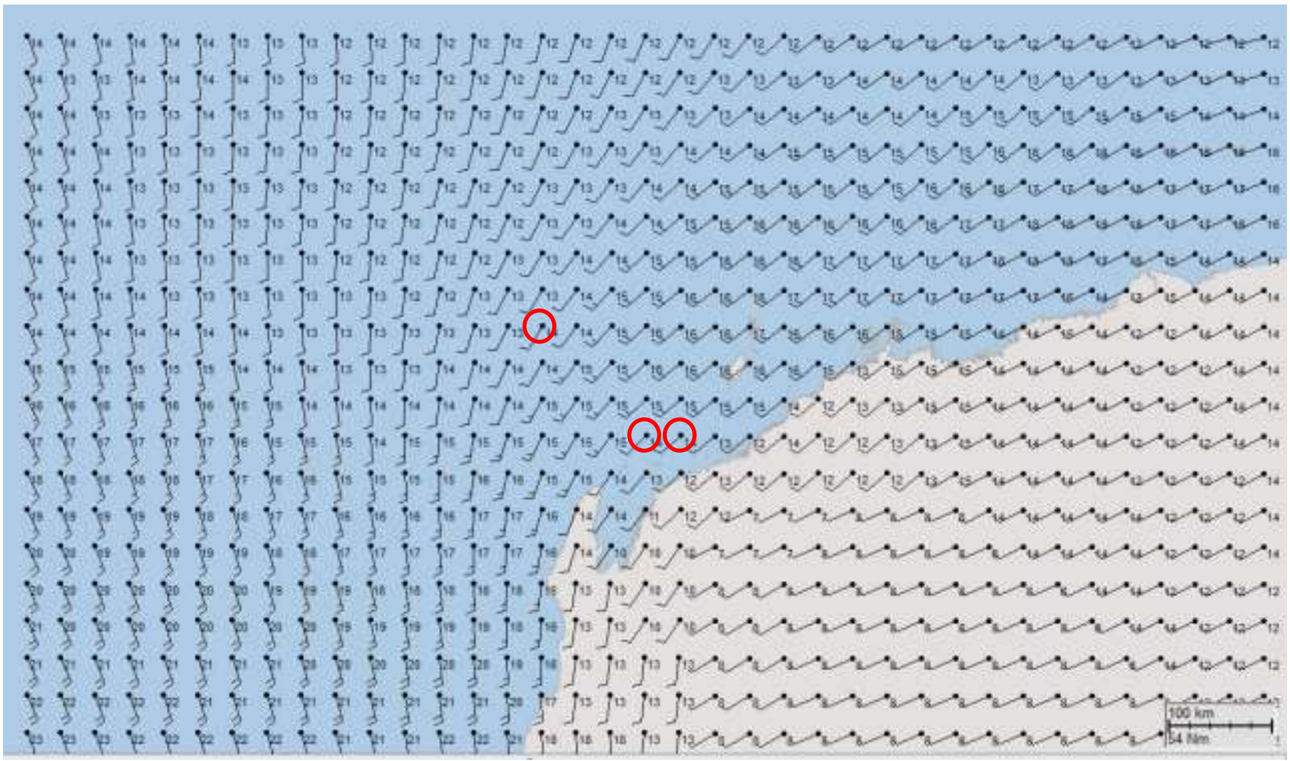


**Figure 4.1 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model. The red circles indicate the wind points used to generate the wind roses, for each release location.**

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 2 knot intervals, are used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

The model wind data demonstrated that this region typically experiences moderate winds all year round and although the monthly average wind speeds remain under 7 knots, winds can at times blow over 31 knots at the offshore location (Mentorc-1). Winds in the region typically blow from the southwest during summer, east-southeast during winter and south during the transitional period.

**Table 4.1 Predicted average and maximum winds for the wind station closest to the Mentorc-1 release location. Data derived from CFSR hindcast model 2009 to 2018 (inclusive).**

| Season | Month | Average wind (knots) | Maximum wind (knots) | General direction (from) |
|---|---|---|---|---|
| Summer | January | 7 | 28 | Southwest |
| | February | 6 | 27 | Southwest |
| | March | 6 | 18 | South-southwest |
| Transitional | April | 6 | 31 | South-southeast |
| Winter | May | 6 | 28 | East-southeast |
| | June | 7 | 18 | East-southeast |
| | July | 7 | 16 | Southeast |
| Transitional | August | 6 | 15 | South |
| Summer | September | 7 | 14 | South |
| | October | 7 | 14 | South-Southwest |
| | November | 7 | 14 | Southwest |
| | December | 7 | 17 | Southwest |
| | **Minimum** | **6** | **14** | |
| | **Maximum** | **7** | **31** | |

**Table 4.2 Predicted average and maximum winds for the wind station closest to the Point 1 release location. Data derived from CFSR hindcast model 2009 to 2018 (inclusive).**

| Season | Month | Average wind (knots) | Maximum wind (knots) | General direction (from) |
|---|---|---|---|---|
| Summer | January | 7 | 26 | Southwest |
| | February | 6 | 30 | Southwest |
| | March | 6 | 18 | Southwest |
| Transitional | April | 6 | 22 | Variable |
| Winter | May | 6 | 25 | East-southeast |
| | June | 6 | 18 | Southeast |
| | July | 7 | 18 | South-southwest |
| Transitional | August | 6 | 15 | South-southeast |
| Summer | September | 7 | 15 | Southwest |
| | October | 7 | 15 | Southwest |
| | November | 7 | 14 | Southwest |
| | December | 7 | 16 | Southwest |
| | **Minimum** | **6** | **14** | |
| | **Maximum** | **7** | **30** | |

**Table 4.3 Predicted average and maximum winds for the wind station closest to the Point 4 release location. Data derived from CFSR hindcast model 2009 to 2018 (inclusive).**

| Season | Month | Average wind (knots) | Maximum wind (knots) | General direction (from) |
|---|---|---|---|---|
| Summer | January | 7 | 25 | Southwest |
| | February | 6 | 28 | Southwest |
| | March | 6 | 17 | Southwest |
| Transitional | April | 6 | 21 | Variable |
| Winter | May | 6 | 25 | East-southeast |
| | June | 6 | 17 | East-southeast |
| | July | 6 | 17 | Southeast |
| Transitional | August | 6 | 14 | South-southeast |
| Summer | September | 7 | 14 | Southwest |
| | October | 7 | 14 | Southwest |
| | November | 7 | 14 | Southwest |
| | December | 7 | 15 | Southwest |
| | **Minimum** | **6** | **14** | |
| | **Maximum** | **7** | **28** | |

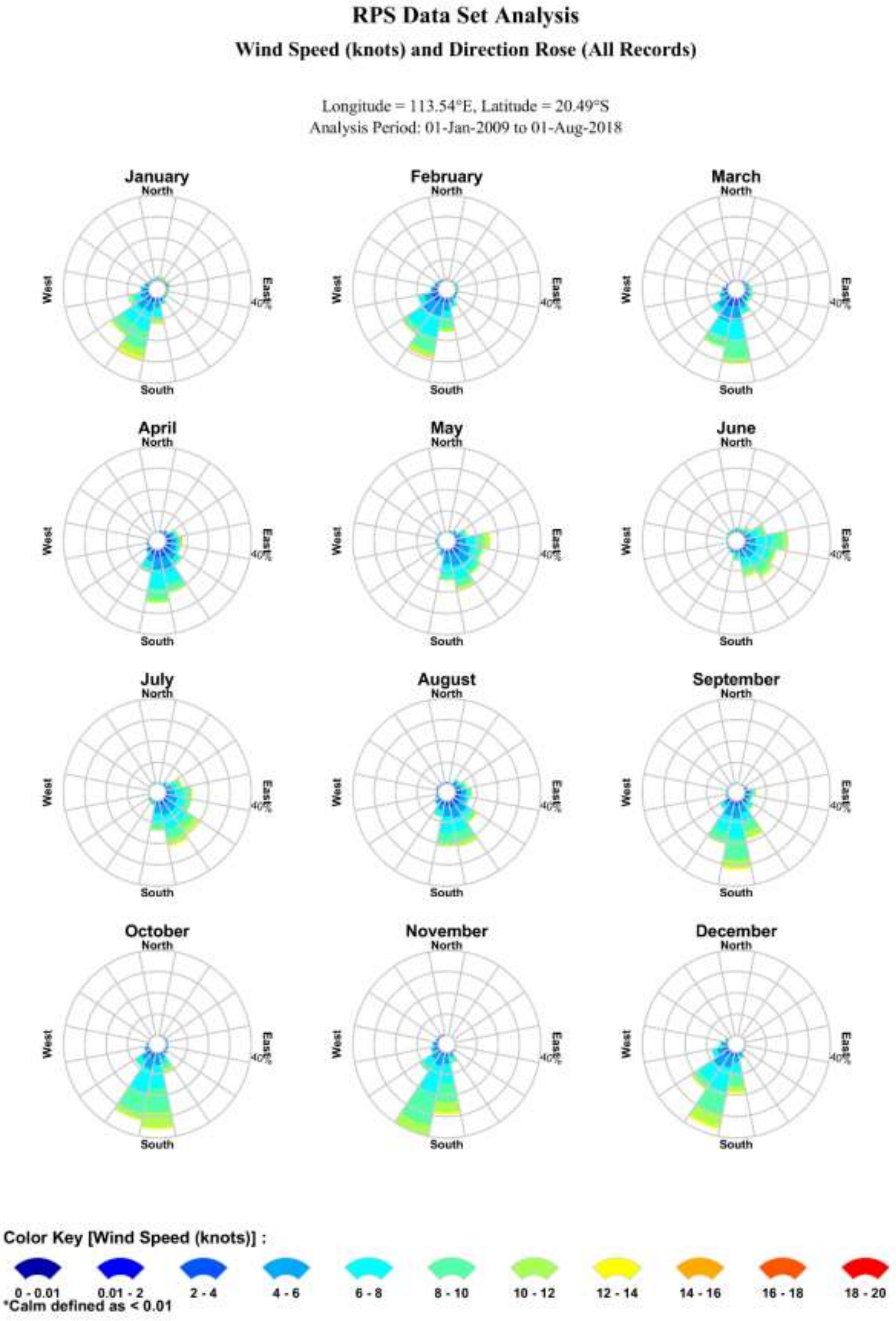


**Figure 4.2 Monthly wind rose distributions derived from CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Mentorc-1 release location.**

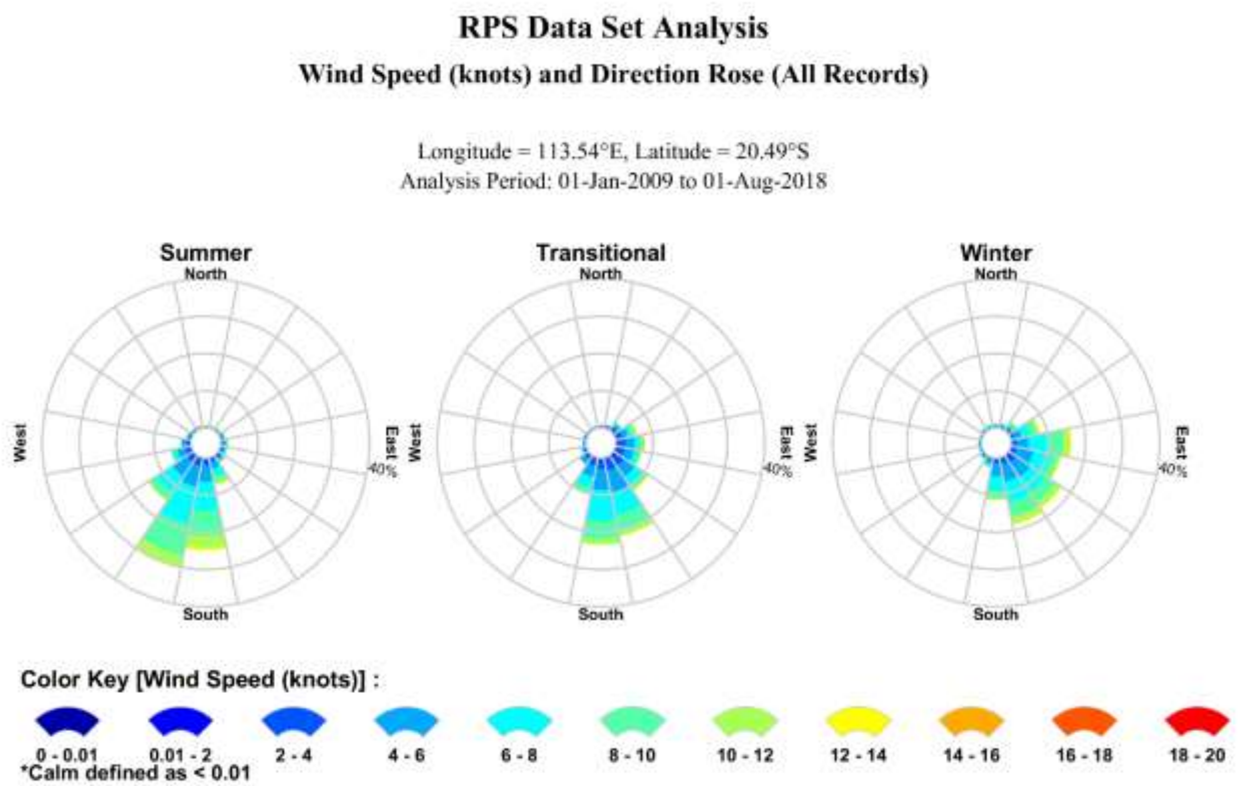


**Figure 4.3 Seasonal wind rose distribution derived from the CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Mentorc-1 release location.**

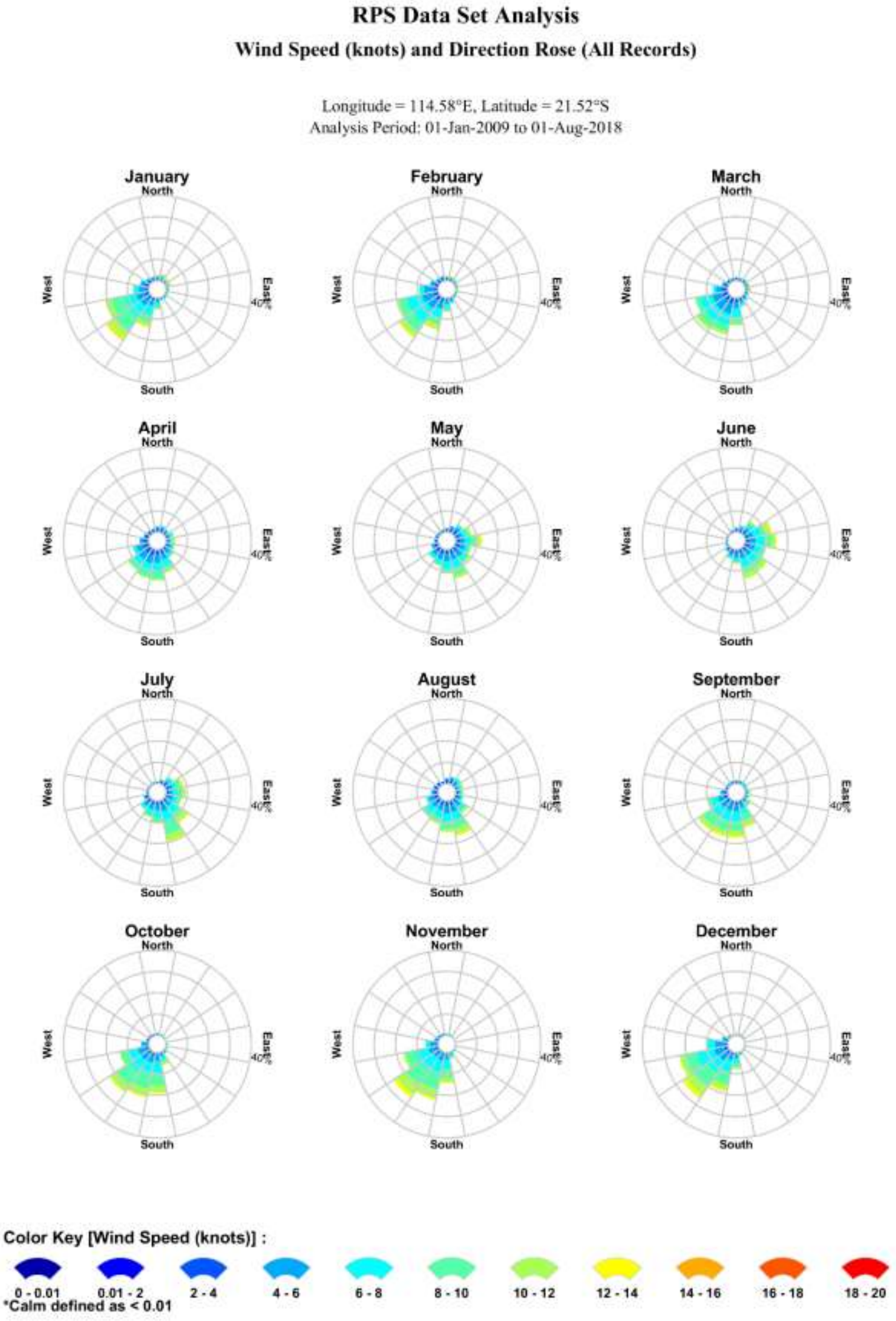


**Figure 4.4 Monthly wind rose distributions derived from CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 1 release location.**

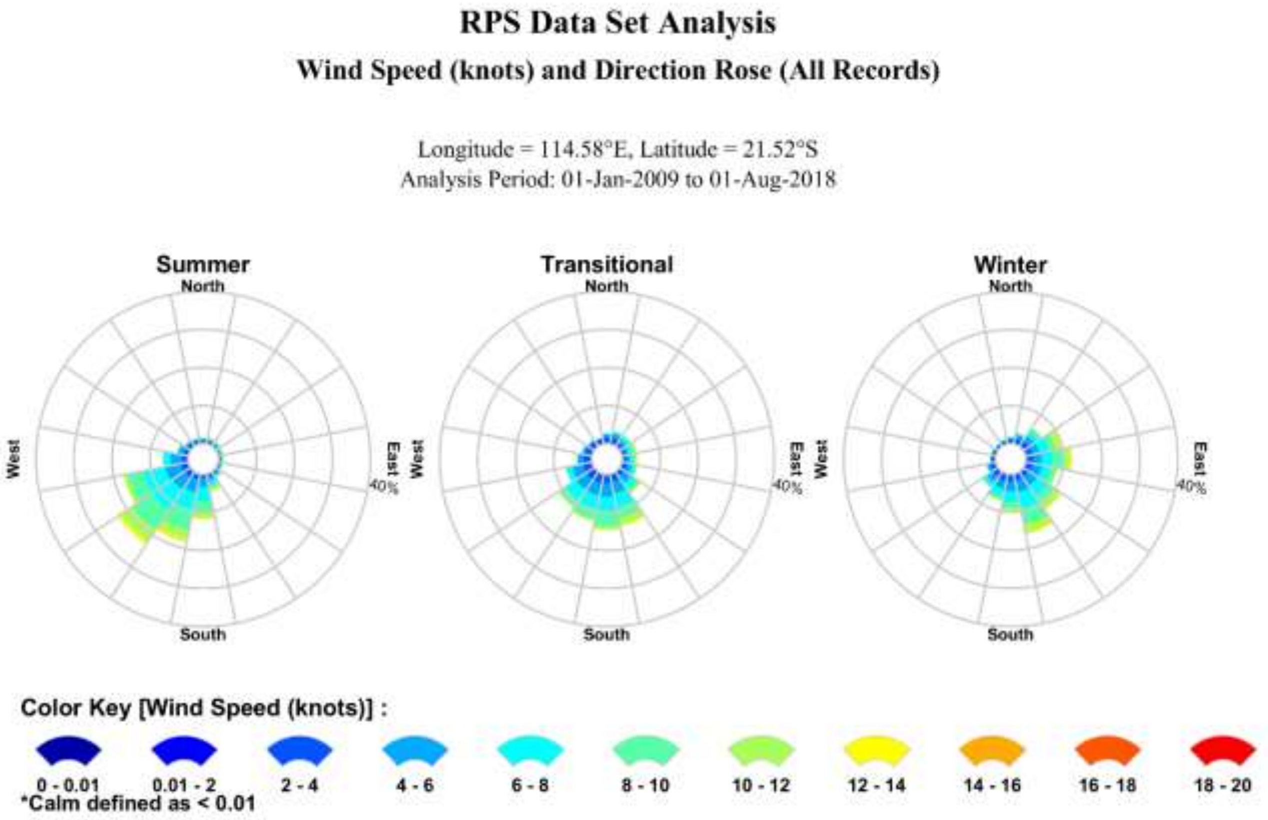


**Figure 4.5 Seasonal wind rose distribution derived from the CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 1 release location.**

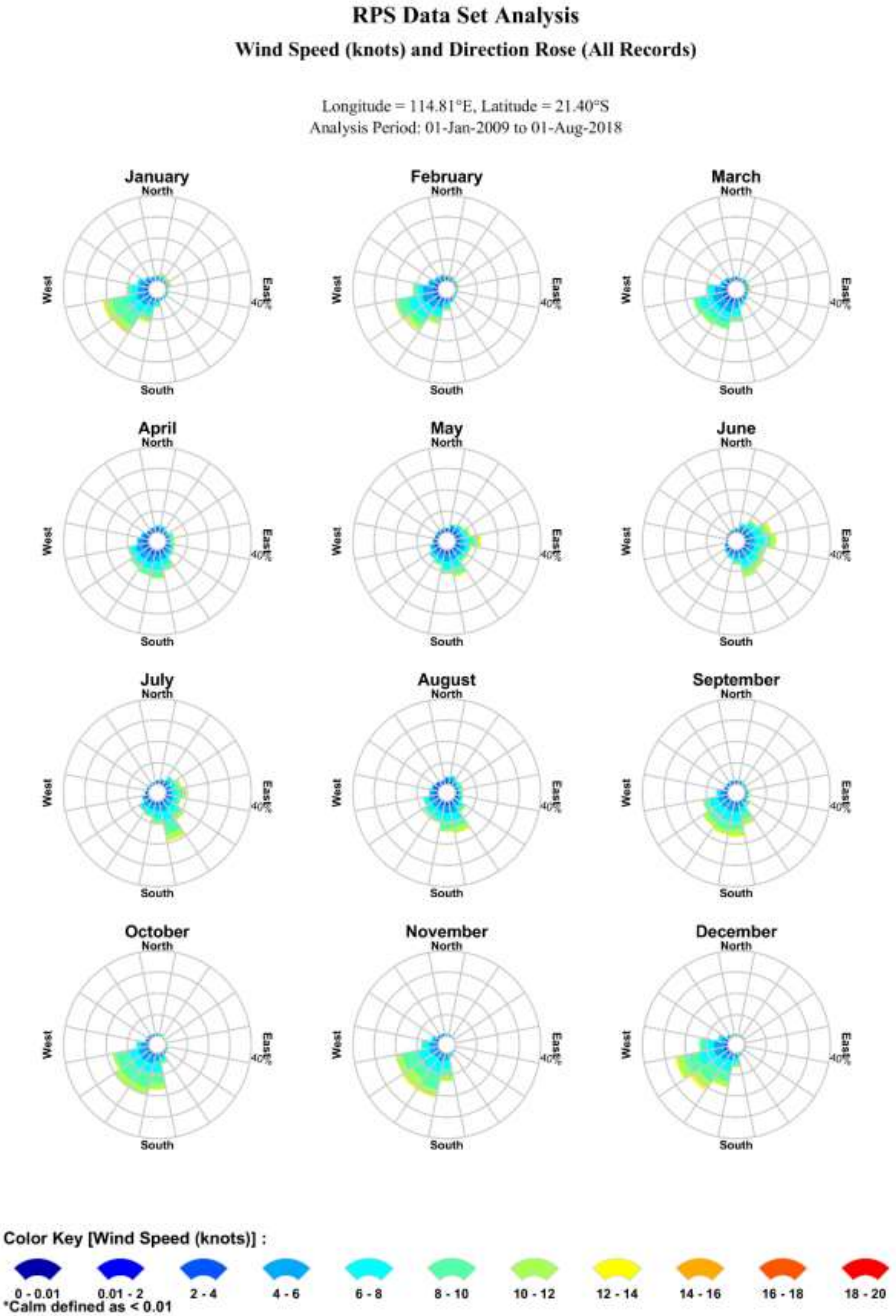


**Figure 4.6 Monthly wind rose distributions derived from CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 4 release location.**

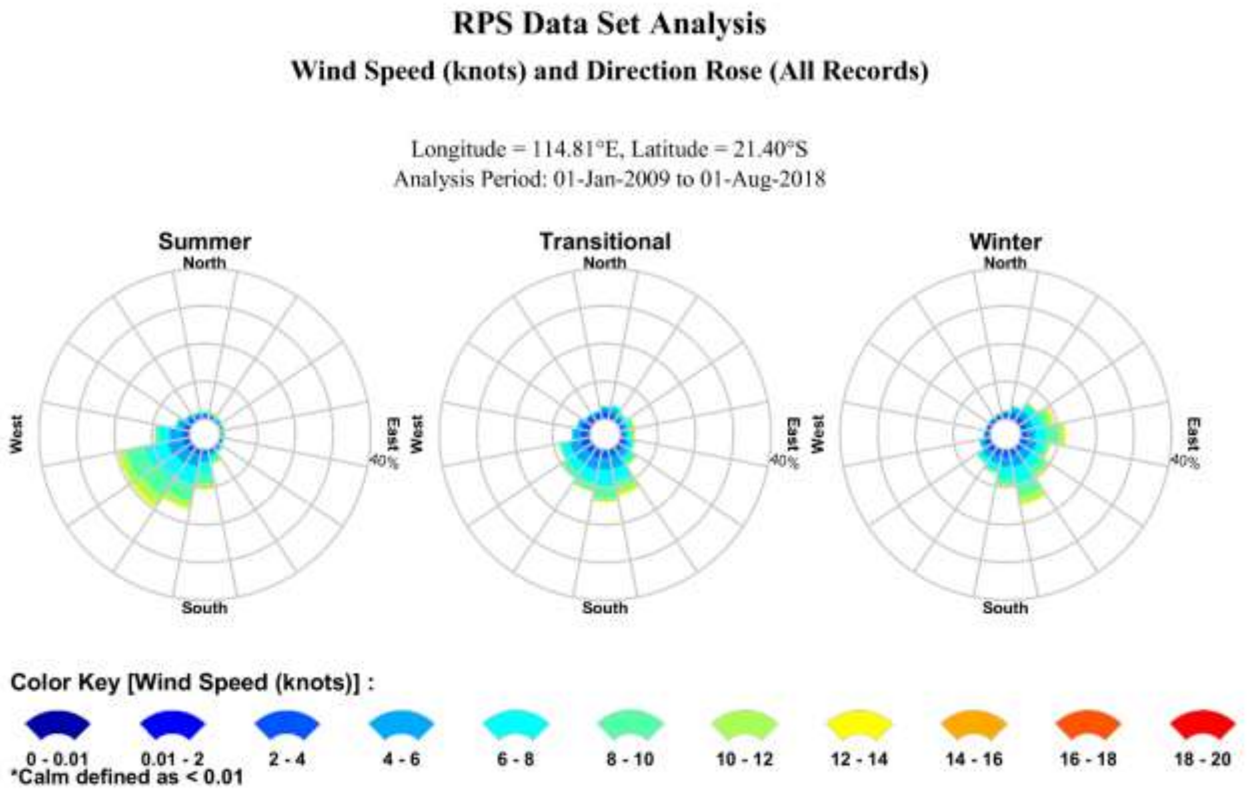


**Figure 4.7 Seasonal wind rose distribution derived from the CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 4 release location.**

# 5 WATER TEMPERATURE AND SALINITY

To accurately represent the water column temperature and salinity, monthly data was obtained from the World Ocean Atlas 2013 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (Levitus et al. 2013). The data is used to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and subsurface layers.

The World Ocean Atlas 2013 is a set of objectively analysed (1° grid) fields of in situ parameters (e.g. temperature, salinity and dissolved oxygen) at standard depth levels for annual, seasonal, and monthly periods for the global oceans. The dataset represents the largest collection of restriction-free ocean profile data available internationally. Locarnini et al. (2013) and Zweng et al. (2013) provide discussion regarding the temperature and salinity data as part of the World Ocean Atlas 2013 database.

Table 5.1 details the monthly average sea surface temperatures and salinity (from the 0-5 m depth layer) nearest to the Mentorc-1 release location. Monthly temperature and salinity profiles throughout the water column are presented in Figure 5.1. Monthly average sea surface temperatures were shown to range from 23.7°C (September) to 29.1°C (March). Salinity remained consistent throughout the year at 34-35 psu.

**Table 5.1 Monthly average sea surface temperature and salinity near the Mentorc-1 release location in the 0-5 m depth layer.**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (°C) | 27.9 | 28.6 | 29.1 | 28.6 | 27.3 | 26.1 | 24.9 | 23.8 | 23.7 | 24.8 | 26.2 | 26.7 |
| Salinity (psu) | 34.9 | 34.8 | 34.8 | 34.5 | 34.5 | 34.6 | 34.6 | 34.8 | 34.9 | 34.8 | 34.8 | 34.8 |

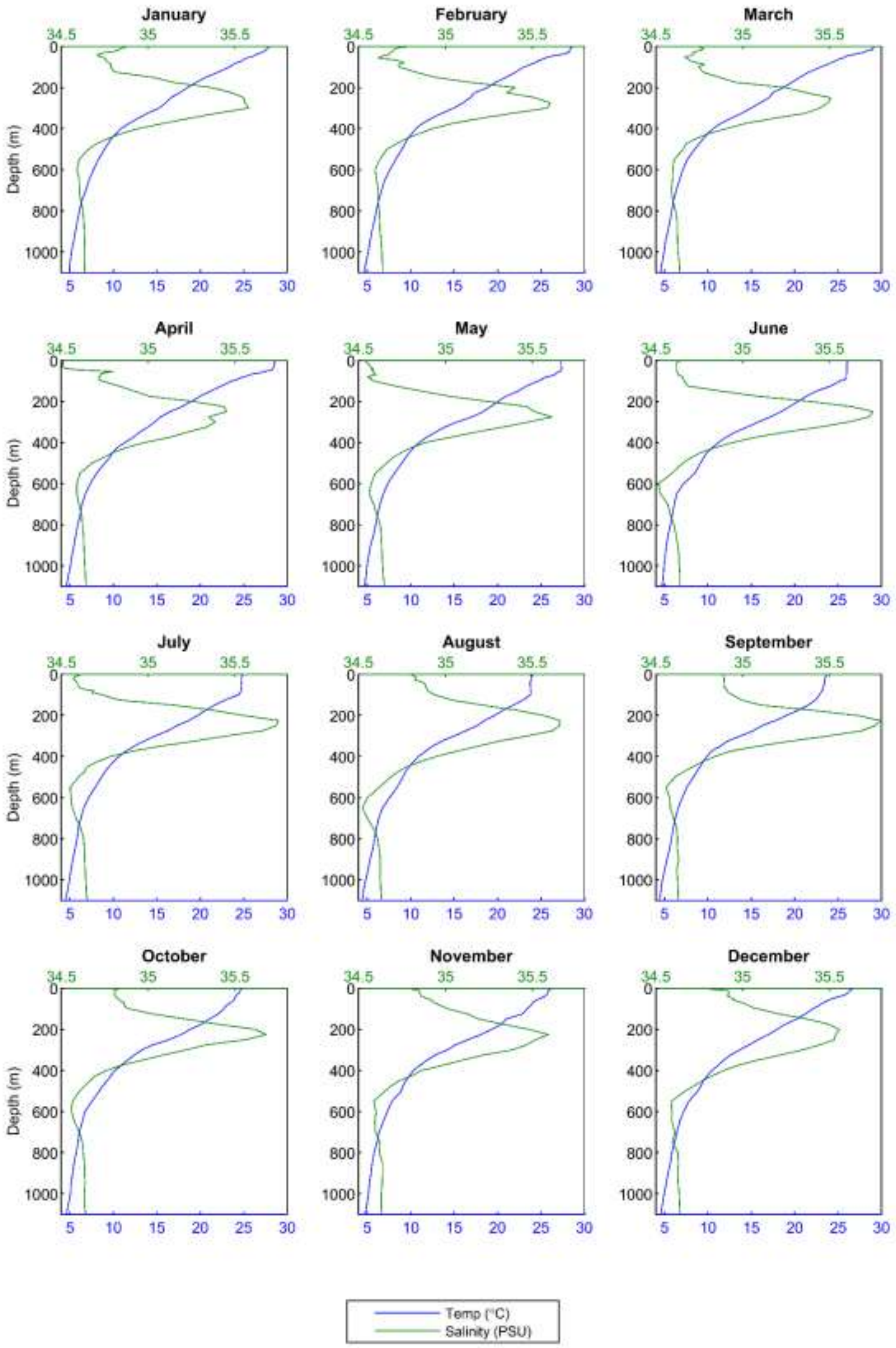


**Figure 5.1 Monthly temperature and salinity profiles throughout the water column near the Mentorc-1 release location.**

# 6 NEAR-FIELD MODEL – OILMAP DEEP

The plume dynamics due to the amalgamation of the condensate, gas and fluids during the loss of well control at the seabed was modelled using the advanced OILMAP-DEEP blowout model. The model simulates the plume rise dynamics in two phases, the initial jet phase and the buoyant plume phase. The initial jet phase governs the plume dynamics directly above the subsea release location and is predominantly driven by the exit velocity. During this phase, the condensate droplet size and distribution are calculated. Next, the rise dynamics are dominated by the buoyant nature of the plume until the termination of the plume phase (known as the trapping depth). At this point, the results from OILMAP-DEEP (including plume trapping depth, plume diameter and droplet size distribution) are integrated into the far-field model SIMAP to simulate the rise and dispersion of the condensate droplets. Figure 6.1 illustrates the various stages of an example blowout plume.

More details on the OILMAP-DEEP model, can be found in Spaulding et al. (2015). The model has been validated against observations from Deepwater Horizon as well as small and large-scale laboratory studies on subsurface oil releases (Brandvik et al 2013, 2014; Belore 2014; Spaulding et al. 2015; Li et al. 2017).

Table 6.1 presents the near-field model input parameters and key results used in the SIMAP far-field model. The modelling showed that in the event of a blowout from the Mentorc-1 well, the gas/liquid will propel the condensate upward from the seabed (i.e. 1,000 m depth) to approximately 600 m below the sea surface corresponding to the plume trapping depth. From this point onward, the condensate droplets will be subject to their own buoyancy and the varying oceanographic conditions. The model predicted condensate droplet sizes to range from 134 µm to 578 µm. The larger droplets in this study (above 200 µm) would rise to the surface, spread and evaporate over time. The smaller droplets (less than 200 µm) were predicted to rise toward the surface though re-entrain more readily due to the prevailing conditions back in the water column and decay overtime.

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**Table 6.1 Input characteristics and key results from the subsea modelling.**

| Input Variable | Value |
|---|---|
| Scenario | Scenario 1 |
| Location name | Mentorc-1 |
| Water depth (m) | 1,000 |
| Tubing diameter (inch) [m] | 12.25 [0.31] |
| Condensate rate (stb/day) | 22,542 |
| Water rate (stb/day) | 233 |
| Gas rate (MMscf/day) | 670 |
| Condensate to gas ratio (bbl/MMscf) | 34.5 |
| Gas to total liquids ration (scf/bbl) | 29,418 |
| Reservoir temperature (°C) | 70 |
| Release pressure (psia) | 3,553 |
| **Key Results** | |
| Plume execution depth (m BMSL) | 600 |
| Droplet sizes (µm) | 134-578 |

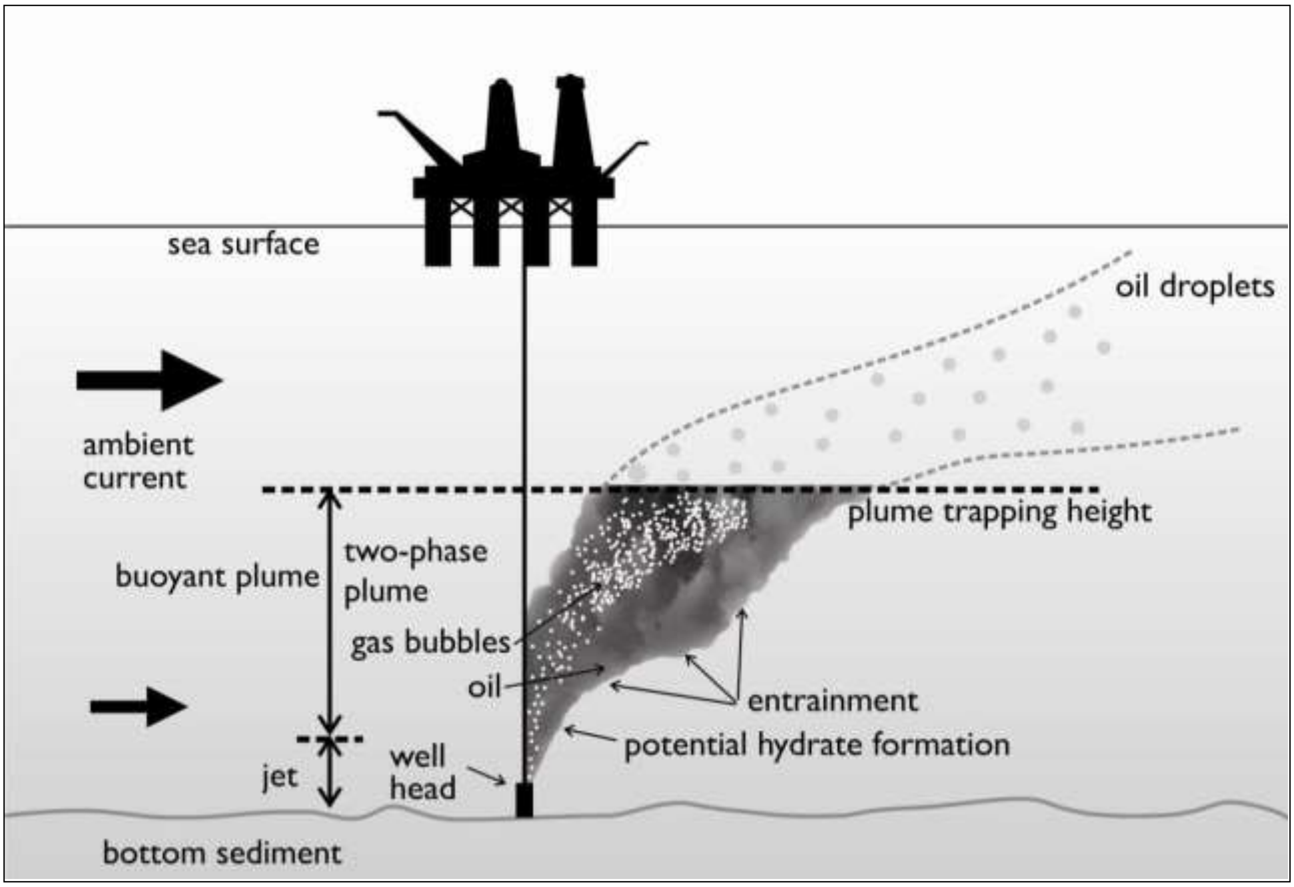


**Figure 6.1 Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).**

# 7 OIL SPILL MODEL – SIMAP

Modelling of the fate of oil was performed using the Spill Impact Mapping Analysis Program (SIMAP). SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases (Spaulding et al. 1994; French et al. 1999; French-McCay, 2003, 2004; French-McCay et al. 2004).

SIMAP has been used to predict the weathering and fate of oil spills during and after major incidents including: Montara (Australia) well blowout August 2009 in the Timor Sea (Asia-Pacific ASA, 2010); Macondo (USA) well blowout April 2010 in the Gulf of Mexico; Bohai Bay (China) oil spill August 2011; and the pipeline oil spill July 2013 in the Gulf of Thailand

The SIMAP model calculates the transport, spreading, entrainment, evaporation and decay of surface hydrocarbon slicks as well as the entrained and dissolved oil components in the water column, either from surface slicks or from oil discharged subsea. The movement and weathering of the spilled oil is calculated for specific oil types. Input specifications for oil mixtures include the density, viscosity, pour point, distillation curve (volume lost versus temperature) and the aromatic/aliphatic component ratios within given boiling point ranges.

SIMAP is a three-dimensional  model that allows for various response actions to be modelled including oil removal from skimming, burning, or collection booms, and surface and subsurface dispersant application.

The SIMAP model includes advanced weathering algorithms, specifically focussed on unique oils that tend to form emulsions and/or tar balls. The weathering algorithms are based on 5 years of extensive research conducted in response to the Deepwater Horizon oil spill in the Gulf of Mexico (French et al., 2015).

Biodegradation is included in the oil spill model. In the model, SIMAP, degradation is calculated for the surface slick, deposited oil on the shore, the entrained oil and dissolved constituents in the water column, and oil in the sediments. For surface oil, water column oil, and sedimented oil a first order degradation rate is specified. Biodegradation rates are relatively high for hydrocarbons in dissolved state or in dispersed small droplets.

## 7.1 Stochastic Modelling

Stochastic modelling involves running numerous individual oil spill simulations using a range of prevailing wind and current conditions that are historically representative of the season and location of where the spill event may occur. Stochastic oil spill modelling is created by overlaying a great number (often 100 hundred) simulated hypothetical oil spills. As part of this study, 300 oil spills were simulated for each season using the same spill information (release location, spill volume, duration and oil type) but with varied start dates and times corresponding to the period represented by the available wind and current data. Once the simulations were complete, the results were overlaid (NOPSEMA, 2018, Figure 7.1) to determine the following on seasonal basis:

- Exposure load (concentrations and volumes);
- Minimum time before exposure;
- Probability of contact above defined concentrations;
- Volume of oil that may strand on shorelines from any single simulation;
- Concentration that might occur on sections of individual shorelines;
- Instantaneous exposure to dissolved hydrocarbons in the water column; and
- Instantaneous exposure to entrained hydrocarbons in the water column.


**Figure 7.1 Predicted movement of four single oil spill simulations by SIMAP for the same scenario (left image). All model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability (Source: NOPSEMA, 2018).**

## 7.2 Sea-Surface, Shoreline and In-Water Thresholds

The thresholds and their relationship to exposure for the sea surface, shoreline and water column (entrained and dissolved hydrocarbons) are presented in Sections 7.2.1 to 7.2.3. Supporting justifications of the adopted thresholds applied during the study and additional context relating to the area of influence are also provided. It is important to note that the thresholds herein are based on NOPSEMA (2019).

### 7.2.1 Sea-surface Exposure Thresholds

The modelling results can be presented to any levels; therefore, thresholds have been specified (based on scientific literature) to record oil exposure to the sea-surface at meaningful levels only, described in the following paragraphs.

The lowest threshold to better assess the potential for sea surface exposure, was 1 g/m$^2$, 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 7.1). Figure 7.2 shows photographs highlighting the difference in appearance between a silvery sheen, rainbow sheen and metallic sheen. 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 7.1 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/m$^2$ (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/m$^2$ 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 at oil concentrations on the sea surface of 25 g/m$^2$ (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). For this study the high exposure threshold was set to 50 g/m$^2$ and above based on NOPSEMA (2019). This threshold can also be used to inform response planning.

Table 7.1 defines the thresholds used to classify the zones of sea surface exposure reported herein.

**Table 7.1 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 |

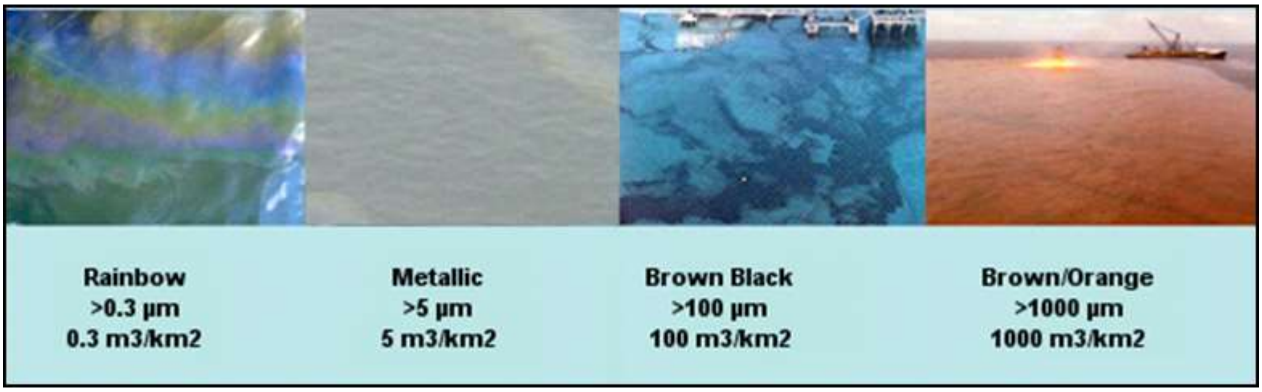


**Figure 7.2 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from OilSpillSolutions.org, 2015).**

**Table 7.2 Oil exposure thresholds on the sea surface as per NOPSEMA (2019).**

| Threshold level | Floating oil (g/m$^2$) | Appearance | Oil presence |
|---|---|---|---|
| Low | 1 | Rainbow to metallic sheen | ¼ teaspoon to 2 teaspoons of oil every 1 m$^2$ |
| Moderate | 10 | Metallic sheen | 2 teaspoons to under 4 tablespoons of oil every 1 m$^2$ |
| High | 50 | Metallic sheen to continuous true oil colour | > 4 tablespoon of oil every 1 m$^2$ |

### 7.2.2 Shoreline Contact Thresholds

There are many different types of shorelines, ranging from cliffs, rocky beaches, sandy beaches, mud flats and mangroves, and each of these influence the volume of oil that can remain stranded ashore and its thickness before the shoreline saturation point occurs. For instance, a sandy beach may allow oil to percolate through the sand, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence oil can increase in thickness onshore over time. A sandy beach shoreline was assumed as the default shoreline type for the modelling herein, as it allows for the highest carrying capacity of oil (of the available open/exposed shoreline types). Hence the results contained herein would be indicative of a worst-case scenario, where the highest volume of oil may be stranded on the shoreline (when compared to other shoreline types, such as exposed rocky shores).

In previous risk assessment studies, French-McCay et al. (2005a; 2005b) used a threshold of 10 g/m$^2$ to assess the potential for shoreline contact. This is a conservative threshold used to define regions of socio-economic impact, such as triggering temporary closures of adjoining fisheries or the need for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). It would equate to approximately two teaspoons of hydrocarbon per square meter of shoreline contacted. The appearance is described as a stain/film. On that basis, the 10 g/m$^2$ shoreline contact threshold has been selected to define the zone of potential "low shoreline contact".

French et al. (1996) and French-McCay (2009) have defined a hydrocarbon exposure threshold for shorebirds and wildlife (furbearing aquatic mammals and marine reptiles) on or along the shore at 100 g/m$^2$, which is 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). The 100 g/m$^2$ shoreline contact threshold is also recommended in the Australian Maritime Safety Authority's (AMSA) foreshore assessment guide[1] as the acceptable minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone (AMSA 2007). It equates to approximately ½ a cup of hydrocarbon per square meter of shoreline contacted. The appearance is described as a hydrocarbon coat. Therefore, 100 g/m$^2$ has been selected to define the zone of potential "moderate shoreline contact".

Observations by Lin & Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m$^2$ of hydrocarbon during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing hydrocarbon impacts on mangroves (Grant, Clarke & Allaway 1993; Suprayogi & Murray 1999). Hence, 1,000 g/m$^2$ has been selected to define the zone of potential "high shoreline contact". It equates to approximately 1 litre of hydrocarbon per square meter of shoreline contacted. The appearance is described as a hydrocarbon cover.

It is worth noting that the shoreline contact thresholds derived from extensive literature review (outlined in Table 7.2) agree with the commonly used threshold values for oil spill modelling specified in NOPSEMA (2019).

**Table 7.3 Thresholds used to assess shoreline contact.**

| Threshold level | Shoreline concentration (g/m$^2$) | Appearance | Oil presence |
|---|---|---|---|
| Low (socioeconomic/sublethal) | 10 – 100 | Stain/Film | 2 tsp to ½ cup of oil every 1 m$^2$ |
| Moderate | 100* 1,000 | Coat | ~ ½ cup to >4 ¼ cups of oil every 1 m$^2$ |
| High | > 1,000 | Cover | >4 ¼ cups of oil every 1 m$^2$ |

* 100 g/m$^2$ also used to define the threshold for actionable shoreline oil.

### 7.2.3 In-water Exposure 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

[1] Recommended for shoreline typles including sandy beach, boulder shorelines, pebble shorelines, rock platforms and industry facility structures.

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.

#### 7.2.3.1 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 ($LC_{50}$) 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 7.4) was applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high), based on NOPSEMA (2019).

#### 7.2.3.2 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 7.4), 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 7.4 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 |

# 8 OIL PROPERTIES

Table 8.1 and Table 8.2 present the physical properties and boiling point ranges of Mentorc condensate used for the loss of well control scenario (Scenario 1) and Marine Gas Oil (MGO) used for the vessel collision scenario.

**Table 8.1 Physical properties of oil types used in this study.**

| Characteristic | Mentorc Condensate | Marine Gas Oil (MGO) |
|---|---|---|
| Density (kg/m$^3$) | 728 (at 15 °C) | 830 (at 15 °C) |
| API | 62.8 | 36.4 |
| Dynamic viscosity (cP) | 0.5 | 4 |
| Pour point (°C) | -100 | -36 |
| Hydrocarbon property category | Group I | Group II |
| Hydrocarbon property classification | Non - Persistent | Light – Persistent |

**Table 8.2 Boiling point ranges of the oil types used in this study.**

| Characteristics | Non-Persistent | | | Persistent |
|---|---|---|---|---|
| | *Volatile (%)* | *Semi-volatile (%)* | *Low-volatility (%)* | *Residual (%)* |
| Boiling point (°C) | *<180* | *180-265* | *265-380* | *>380* |
| Mentorc Condensate | 51.7 | 32.1 | 12.1 | 4.1 |
| MGO | 16.4 | 49 | 31.9 | 2.7 |

## 8.1 Mentorc Condensate

Mentorc condensate has a density of 728 kg/m$^3$ (API of 62.8), dynamic viscosity of 0.5 cP at 15°C and a low pour point (-100°C). Up to 69% of the hydrocarbon would evaporate over the first few hours or day, with up to 83% evaporated after a few days when on the sea surface. Only 4% of the condensate is considered persistent, which would eventually breakdown due to the decay. These properties classify the condensate as a group I oil (or non-persistent oil), according to the International Tanker Owners Pollution Federation (ITOPF, 2014), and it is expected to readily evaporate once on the sea surface. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

Figure 8.1 shows weathering for Mentorc-1 condensate. At the conclusion of the simulation (day-141), approximately 1,976,743 bbl (72%) spilled oil was lost to the atmosphere through evaporation. Approximately 645,504 bbl (24%) of the condensate was predicted to have decayed, while approximately 104,561 bbl (4%) was predicted to remain within the water column and no condensate was predicted to accumulate on the shorelines.

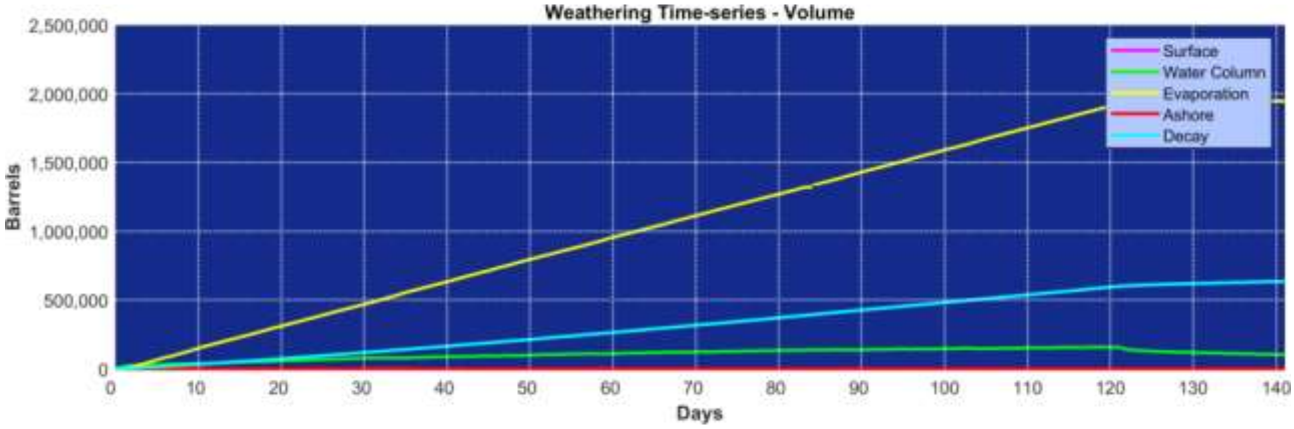


**Figure 8.1 Weathering of Mentorc condensate for the trajectory resulting in the largest swept area above 10 g/m$^2$ on the sea surface. The results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days.**

## 8.2 Marine Gas Oil

Marine gas oil (MGO) has a density of 830 kg/m$^3$ (API gravity of 36.4), a pour point of -36°C and a dynamic viscosity of 4 cP at 25°C. This oil is likely to spread quickly when spilt at sea and thin out to low thickness levels; which increases the rate of evaporation. Due to its chemical composition, up to 65% will generally evaporate over the first two days depending upon the prevailing conditions and spill volume. Approximately 2.7% of the oil is considered “persistent hydrocarbons”, which are unlikely to evaporate. These properties classify it as a group II oil (light persistence) according to ITOPF (2014).

Figure 8.2 shows weathering graphs for a 1,000 m$^3$ release of MGO over 6 hours (tracked for 40 days) during three static wind conditions. The prevailing weather conditions will influence the weathering and fate of the MGO. Under low (5 knots) wind-speeds, the MGO will remain on the surface longer, forming a moderately thick film on the sea surface while sustained stronger winds (>10 knots) will generate breaking waves at the surface, causing a higher volume to be entrained into the water column, hence increasing the amount available to degradation and reducing the amount available to evaporation.

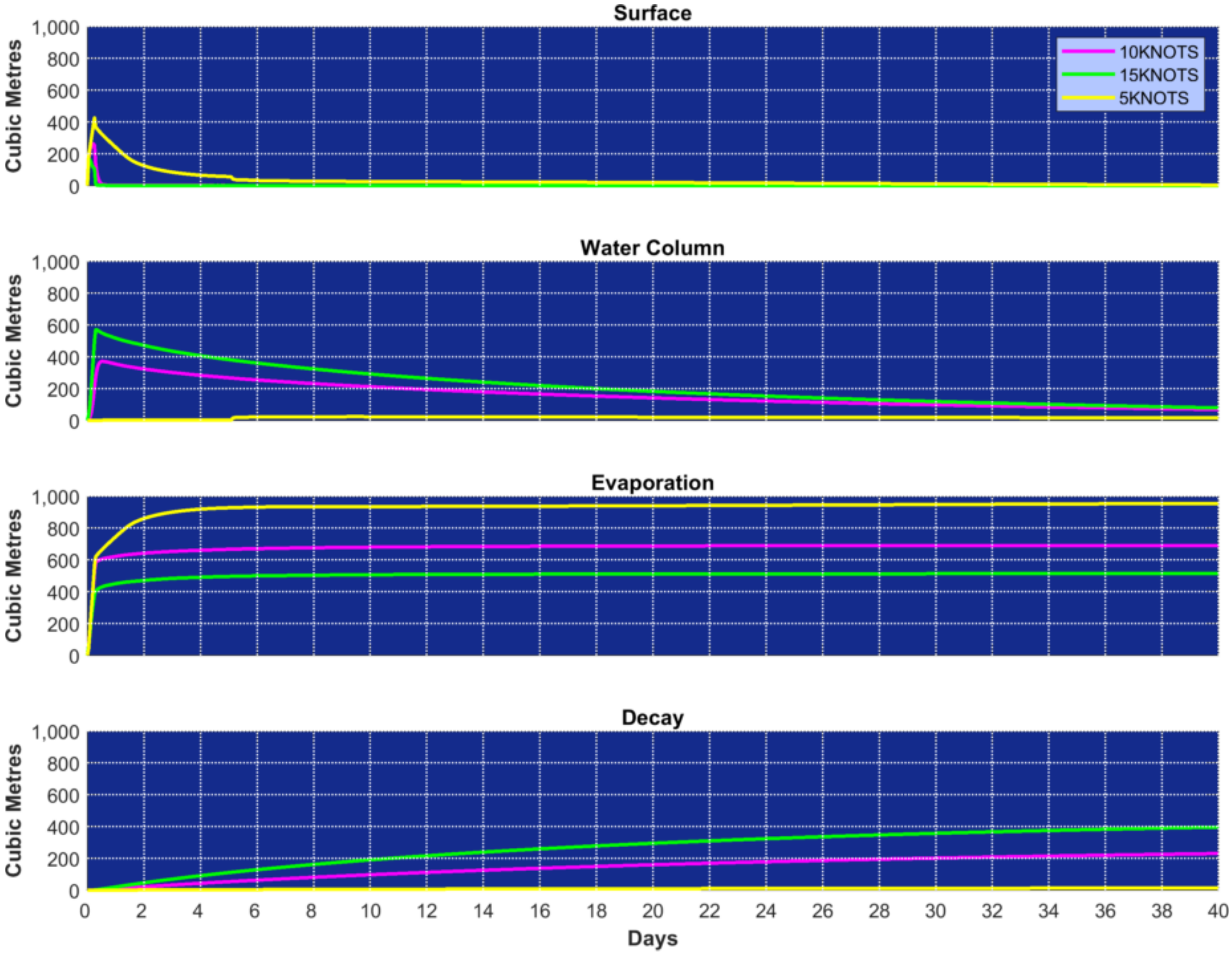


**Figure 8.2 Weathering of MGO under three static wind conditions (5, 10 and 15 knots). The results are based on a 1,000 $m^3$ surface release of MGO over 6 hours and tracked for 40 days.**

# 9 MODEL SETTINGS

Table 9.1 provides a summary of the oil spill model settings.

**Table 9.1 Summary of the oil spill model settings used in this assessment.**

| Input Parameters | Scenario 1 | Scenario 2 | |
|---|---|---|---|
| Scenario Description | Blowout at Mentorc-1 Well | Vessel collision along the pipeline route straddling the State/Commonwealth boundary | Vessel collision along the pipeline route straddling the State/Commonwealth boundary |
| Location Name | Mentorc-1 | Point 1 | Point 4 |
| Geographic location (WGS 84) | 20º 29' 21.9" S, 113º 32' 13.2" E | 21º 31' 22.59" S, 114º 35' 4.69" E | 21º 23' 44.29' S, 114º 48' 53.70" E |
| Number of randomly selected spill start times per season | 100 (300 total) | 100 (300 total) | 100 (300 total) |
| Oil type | Mentorc condensate | Marine Gas Oil | |
| Daily flow rate | ~22,542 bbl/day | - | |
| Total volume released | 2,727,570 bbl | 1,000 $m^3$ | |
| Release duration | 121 days | 6 hours | |
| Release depth | 1,000 m | surface | |
| Simulation length | 141 days | 40 days | |
| Seasons assessed | Summer (September to the following March)<br>Transitional period (April and August)<br>Winter (May to July) | | |
| Surface thresholds ($g/m^2$) | 1 (low exposure)<br>10 (moderate exposure)<br>50 (high exposure) | | |
| Shoreline accumulation thresholds ($g/m^2$) | 10 (low potential exposure)<br>100 (moderate potential exposure)<br>1,000 (high potential exposure) | | |
| Dissolved hydrocarbon exposure thresholds (ppb) | 10 (10 ppb x 1 hr, potential low exposure)<br>50 (50 ppb x 1 hrs, potential moderate exposure)<br>400 (400 ppb x 1 hrs, potential high exposure) | | |
| Entrained hydrocarbon exposure thresholds (ppb) | 10 (10 ppb x 1 hr, potential low exposure)<br>100 (100 ppb x 1 hr, potential high exposure) | | |

# 10 PRESENTATION AND INTERPRETATION OF MODEL RESULTS

The results from the modelling study are presented in a number of tables and figures, which aim to provide an understanding of the predicted sea-surface and water column (subsurface) exposure and shoreline contact (if predicted).

## 10.1 Annual Analysis

### 10.1.1 Figures

The figures are based on the following principles:

- The ***potential zones of exposure (surface oil, entrained and dissolved hydrocarbons)*** – is determined by identifying the maximum loading (surface) or exposure (in-water) within a grid cell and is then classified according to identified surface or subsea thresholds.

- The ***probability of exposure/contact (surface oil, shoreline oil, entrained and dissolved hydrocarbons)*** – is calculated by dividing the number of spill trajectories passing over that given cell (surface, shoreline or subsea) by the total number of spill trajectories, above the specified threshold value.

- The ***maximum potential shoreline loading*** – is determined by identifying the maximum loading within a shoreline cell and is then classified according to the identified thresholds (i.e. 10 g/m$^2$, 100 g/m$^2$ and 1,000 g/m$^2$).

- The ***dissolved and entrained hydrocarbon concentration*** – is determined by recording the maximum instantaneous concentrations (i.e. exposure over the model 1-hour timestep) at each grid cell.

### 10.1.2 Statistics

The statistics are based on the following principles:

- The ***greatest distance travelled by a spill trajectory*** – is determined by a) recording the maximum and b) second greatest distance travelled (or 99th percentile) by a single trajectory, within a scenario, from the release location to the identified exposure thresholds.

- The ***probability of oil exposure to a receptor*** – is determined by recording the number of spill trajectories to reach a specified sea surface or subsea threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.

- The ***minimum time before oil exposure to a receptor*** – is determined by ranking the elapsed time before sea surface exposure, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.

- The ***probability of oil contact to a receptor*** – is determined by recording the number of spill trajectories to reach a specified shoreline contact threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.

- The ***maximum potential oil loading within a receptor*** – is determined by identifying the maximum loading to any grid cell within a receptor polygon, for a scenario.

## 10.2 Deterministic Trajectories

The modelling results were assessed for each scenario (and release point) and the "worst case" deterministic runs were identified based on the largest volume of oil ashore (if shoreline contact was predicted for the given scenario) or the area of oil exposure on the sea surface above 10 g/m$^2$ (actionable sea surface oil).

## 10.3 Sensitive Receptors Assessed

A range of environmental receptors and shorelines were assessed for sea surface exposure, shoreline contact and water column exposure as part of the study (see Table 10.1). The receptors are geographically represented in Figure 10.1 to Figure 10.9.

The Pilbarra (Offshore) Integrated Marine and Coastal Regionalisation of Australia (IMCRA) is not presented in tabulated results as the release locations for Scenario 2 reside within the receptors boundary and therefore will always record a 100% probability of exposure.

Additionally, the Exmouth Plateau Key Ecological Feature (KEF) was excluded from tabulated results for Scenario 1.

**Table 10.1 Summary of receptors used to assess surface, shoreline and in-water exposure to hydrocarbons.**

| Receptor category | Acronym | Hydrocarbon exposure assessment | | |
|---|---|---|---|---|
| | | Water column | Sea surface | Shoreline |
| Australian Marine Park | AMP | ✓ | ✓ | ✗ |
| National/Marine Park also includes: Indigenous Protected Area & Marine Management Area | NP & MP IPA & MMA | ✓ | ✓ | ✗ |
| Nature Reserves | NR | ✓ | ✓ | ✗ |
| RAMSAR | RAMSAR | ✓ | ✓ | ✗ |
| Integrated Marine and Coastal Regionalisation of Australia | IMCRA | ✓ | ✓ | ✗ |
| Interim Biogeographic Regionalisation of Australia | IBRA | ✓ | ✓ | ✓ |
| Key Ecological Feature | KEF | ✓ | ✓ | ✗ |
| Reefs, Shoals and Banks | RSB | ✓ | ✓ | ✗ |
| Shoreline | Shore | ✗ | ✓ (reported as nearshore waters) | ✓ |

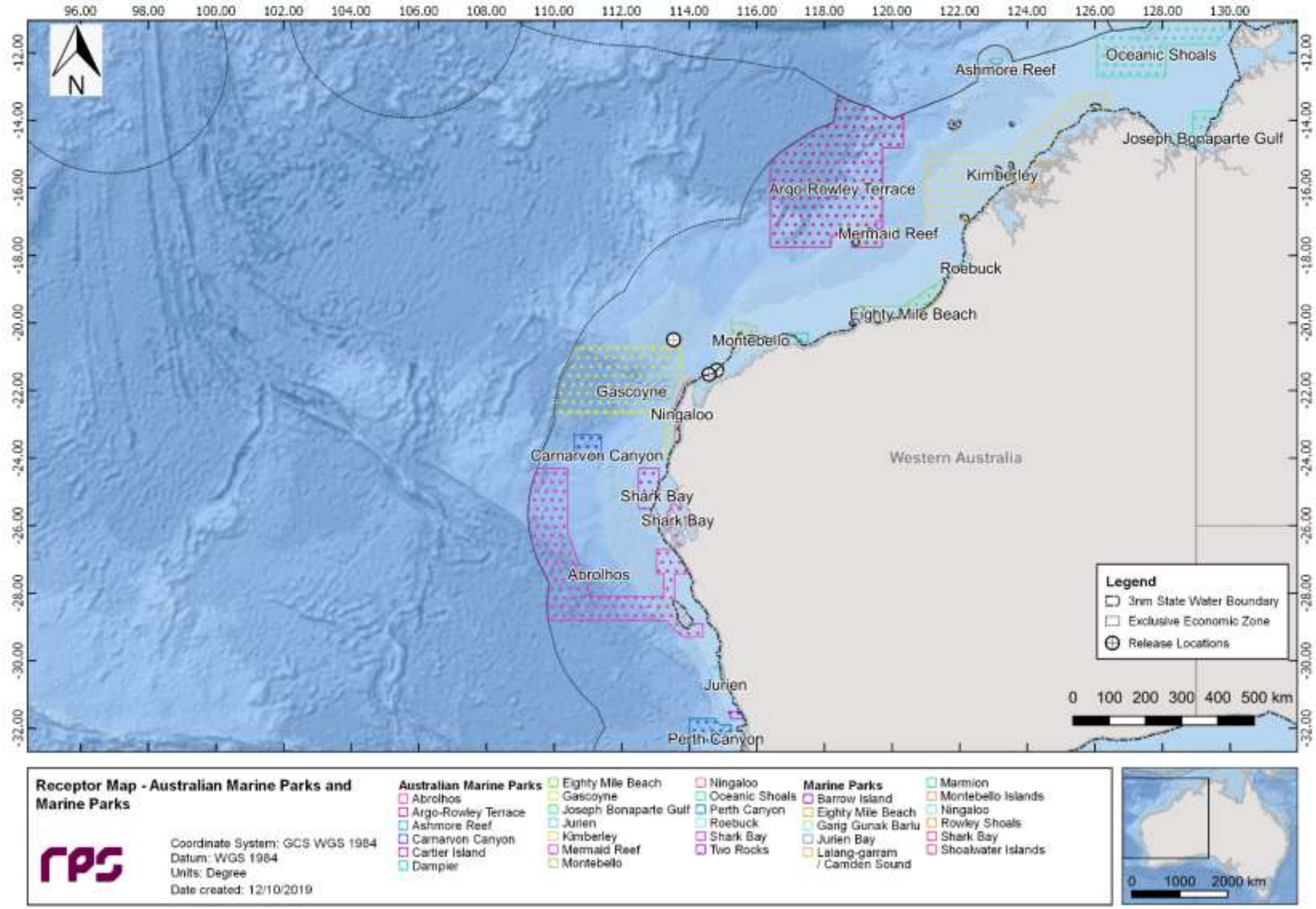


**Figure 10.1 Receptor map for Australian Marine Parks (AMP) and Marine Parks (MP).**

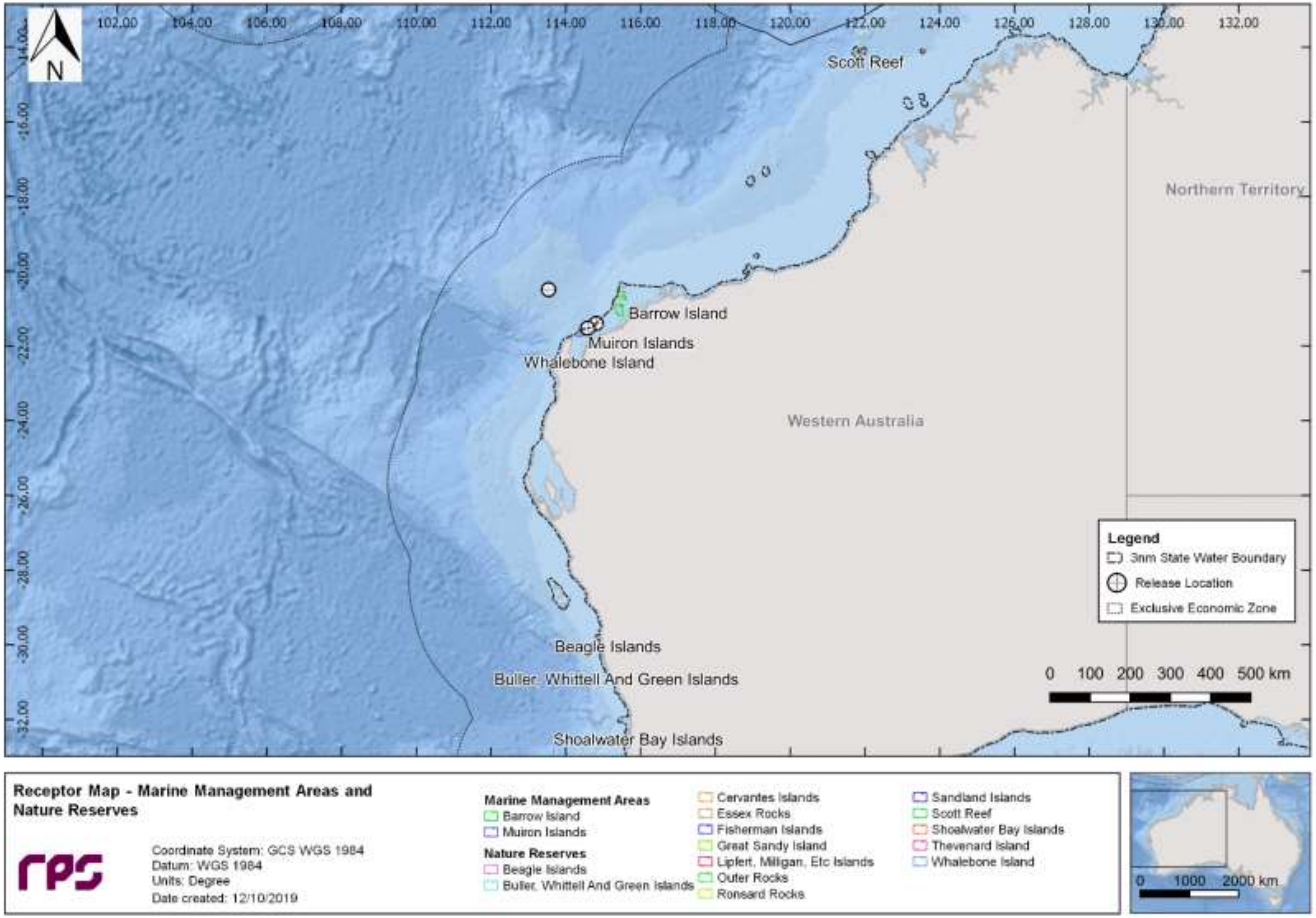


**Figure 10.2 Receptor map for Marine Management Areas (MMA) and Nature Reserves (NR).**

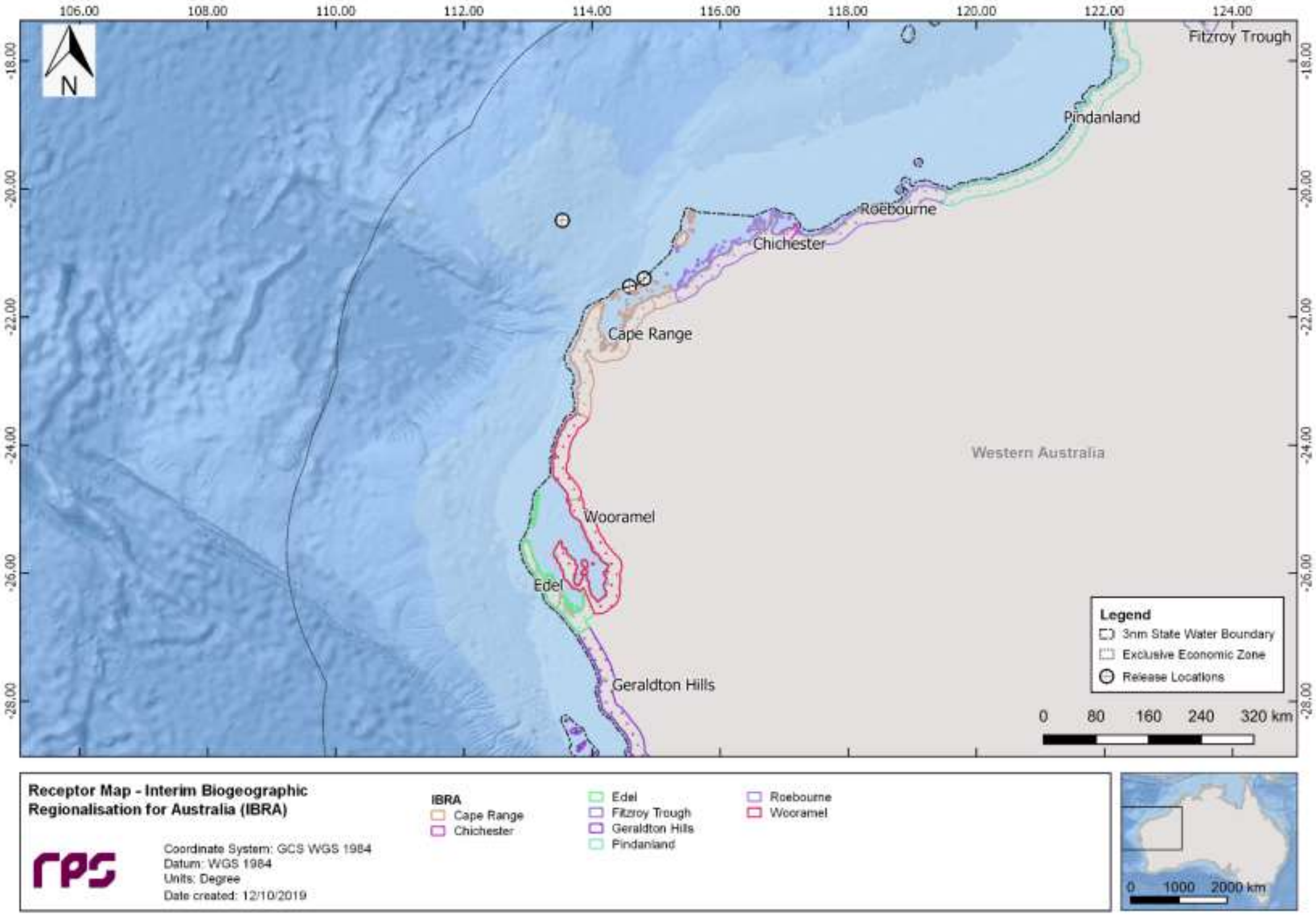


**Figure 10.3 Receptor map for Interim Biogeographic Regionalisation for Australia (IBRA).**

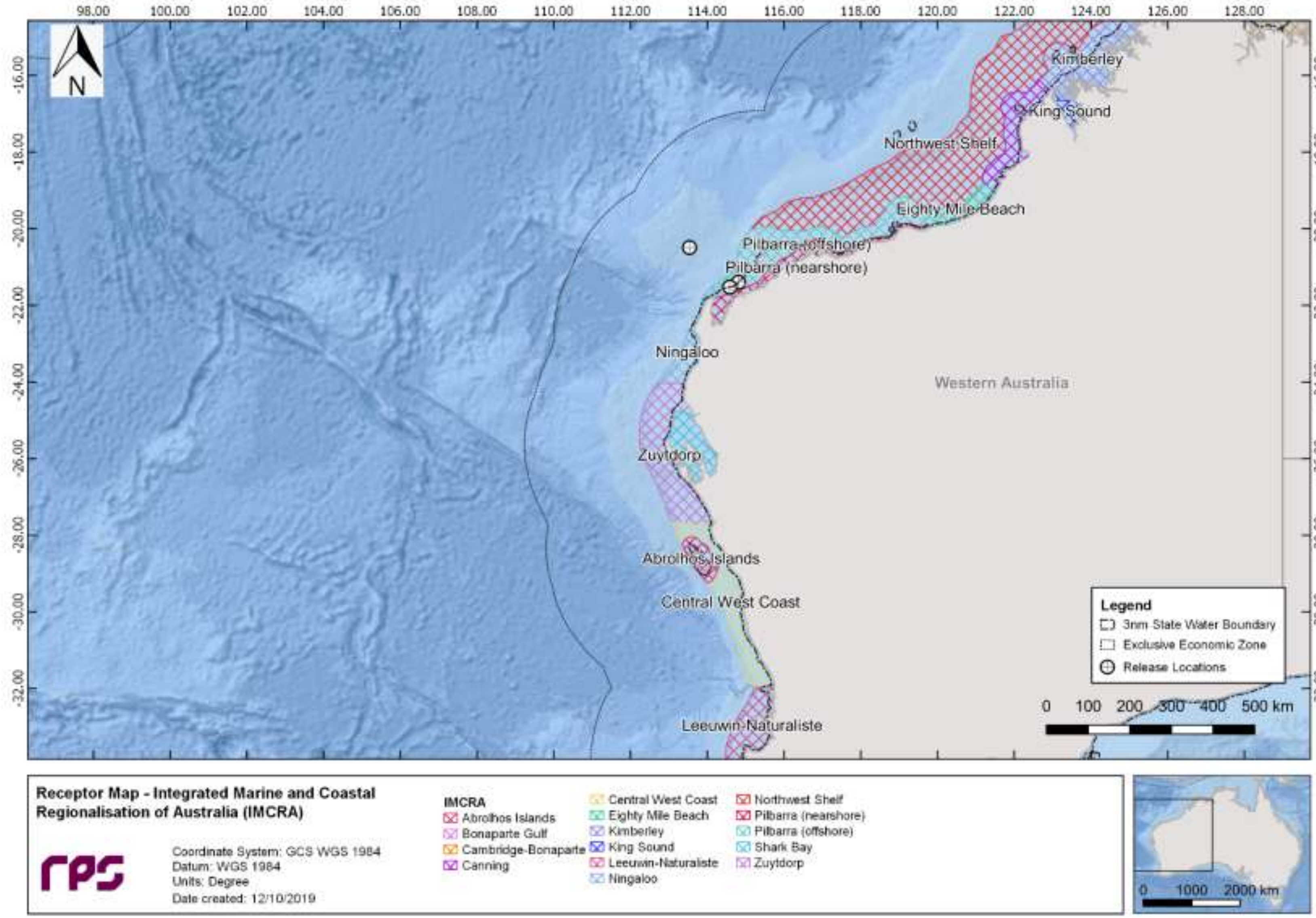


**Figure 10.4 Receptor map for Integrated Marine and Coastal Regionalisation of Australia (IMCRA).**

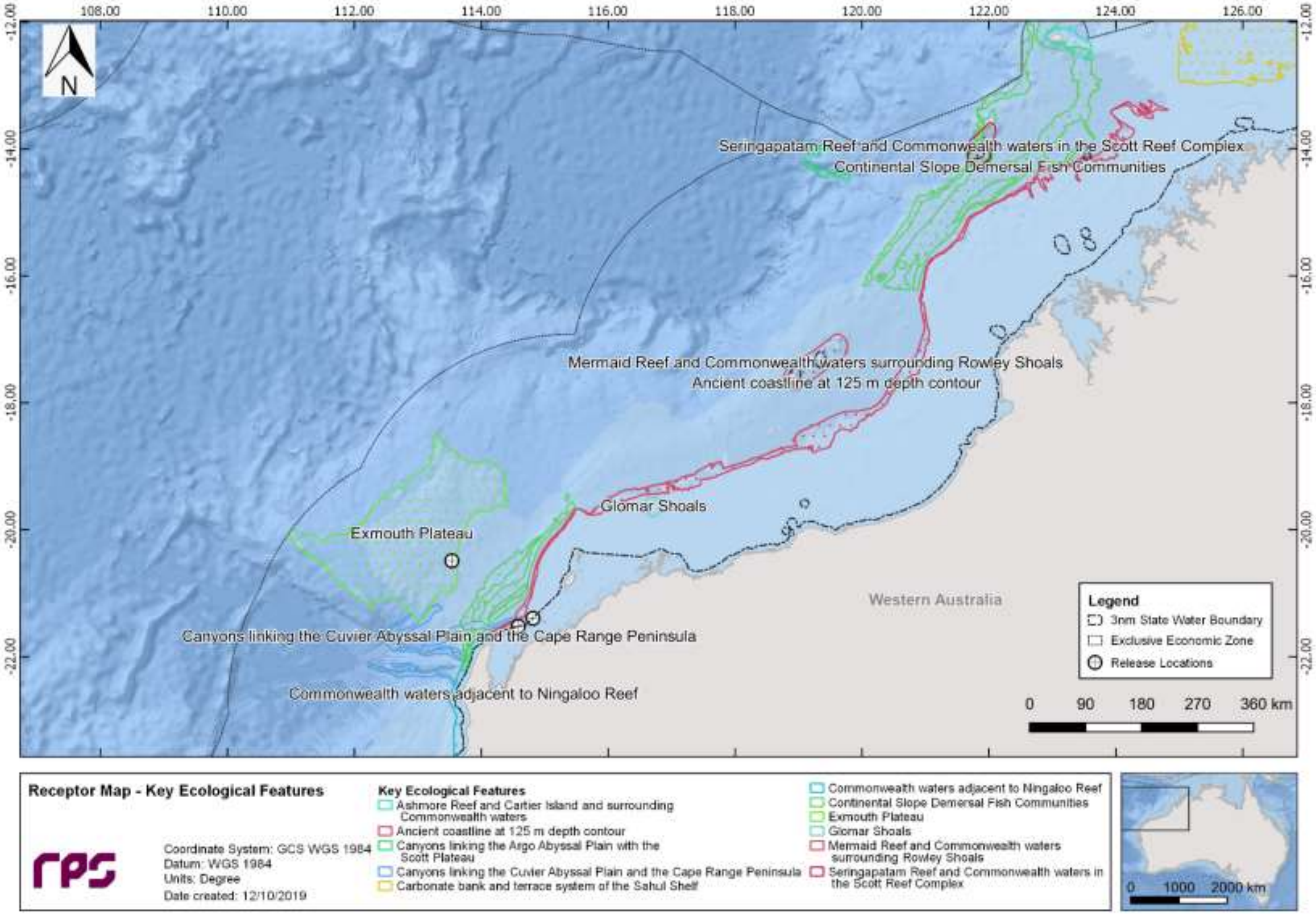


**Figure 10.5 Receptor map for Key Ecological Features (KEF) (1 of 2).**

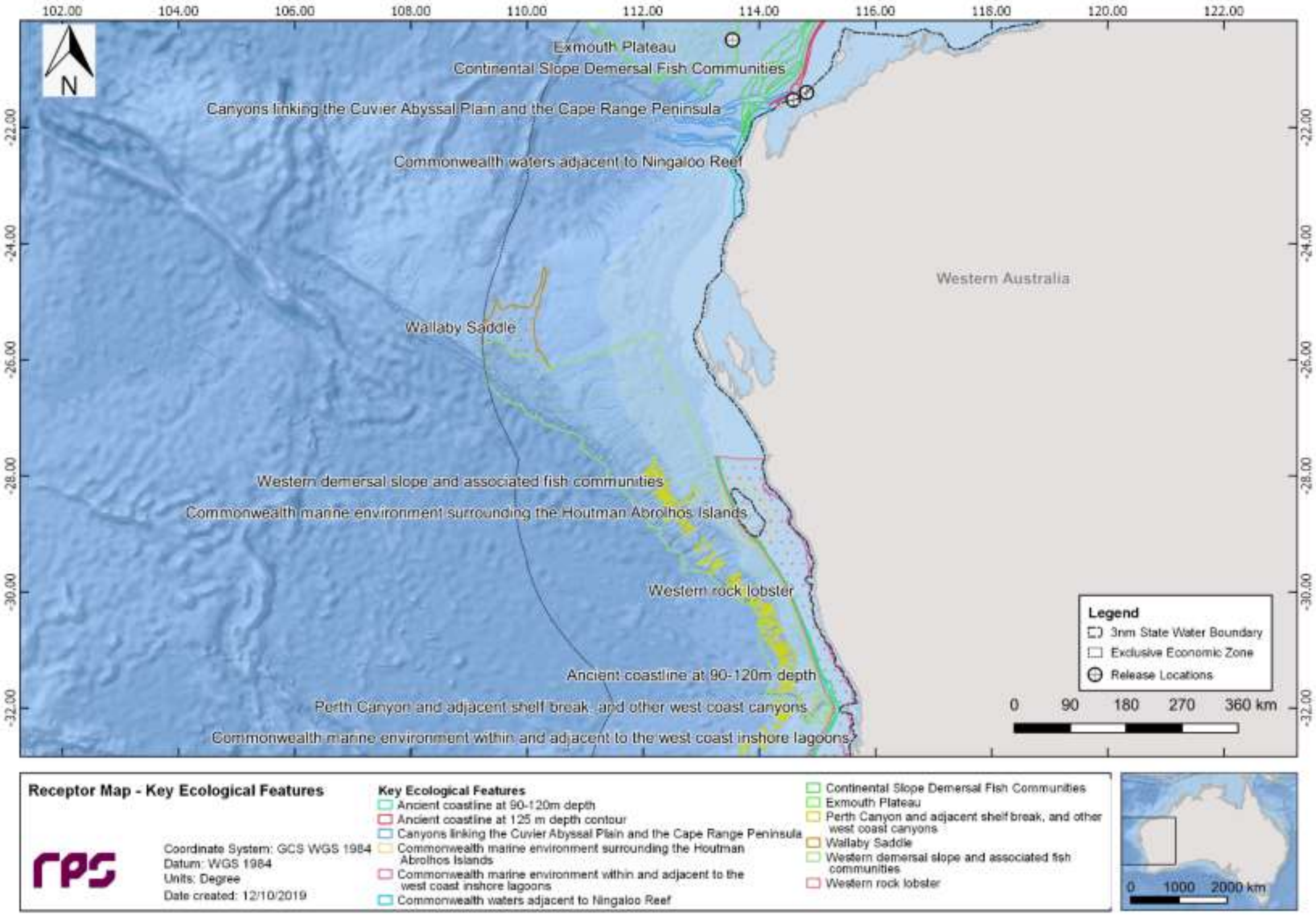


**Figure 10.6 Receptor map for Key Ecological Features (KEF) (2 of 2).**

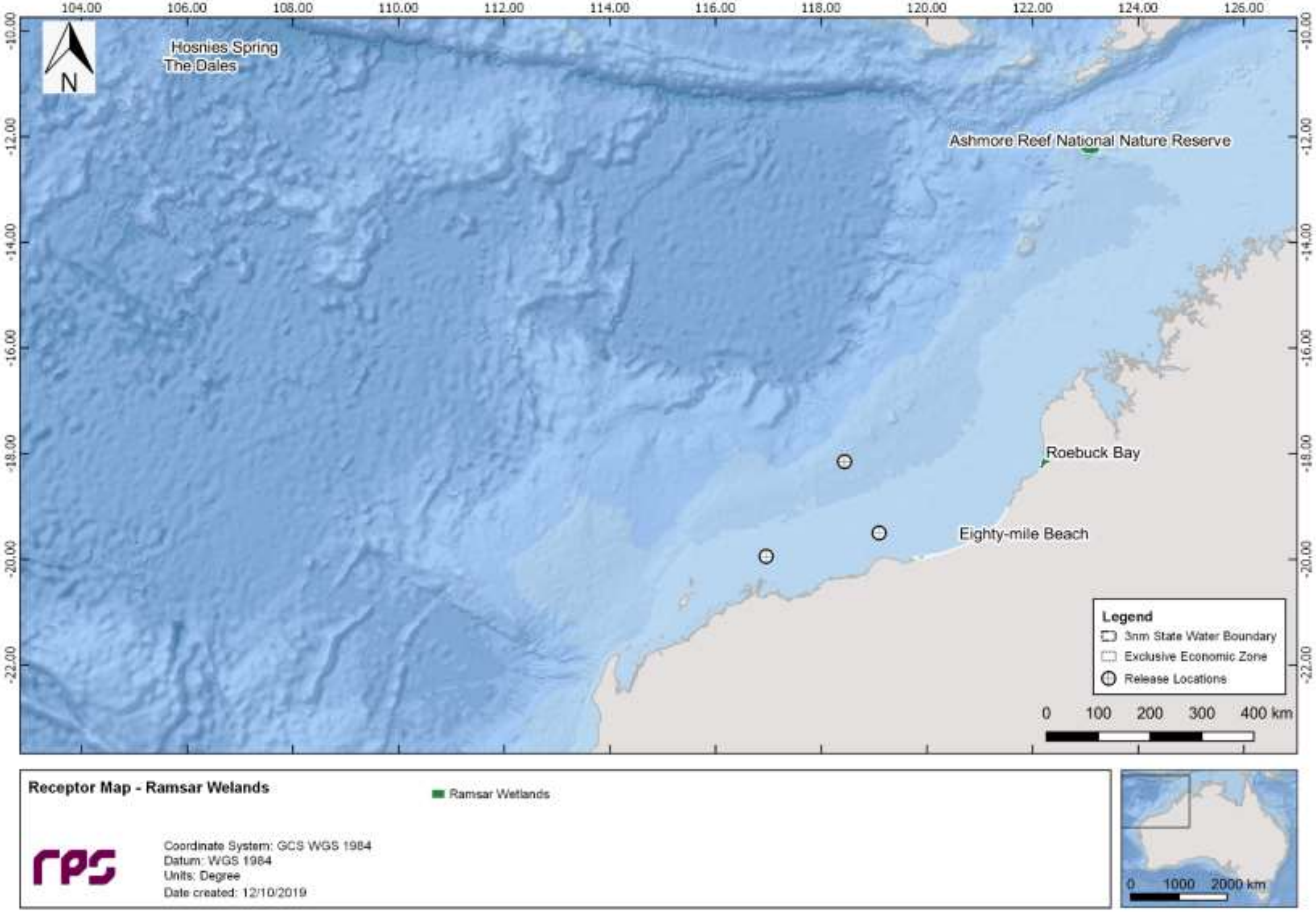


**Figure 10.7 Receptor map for RAMSAR sites.**

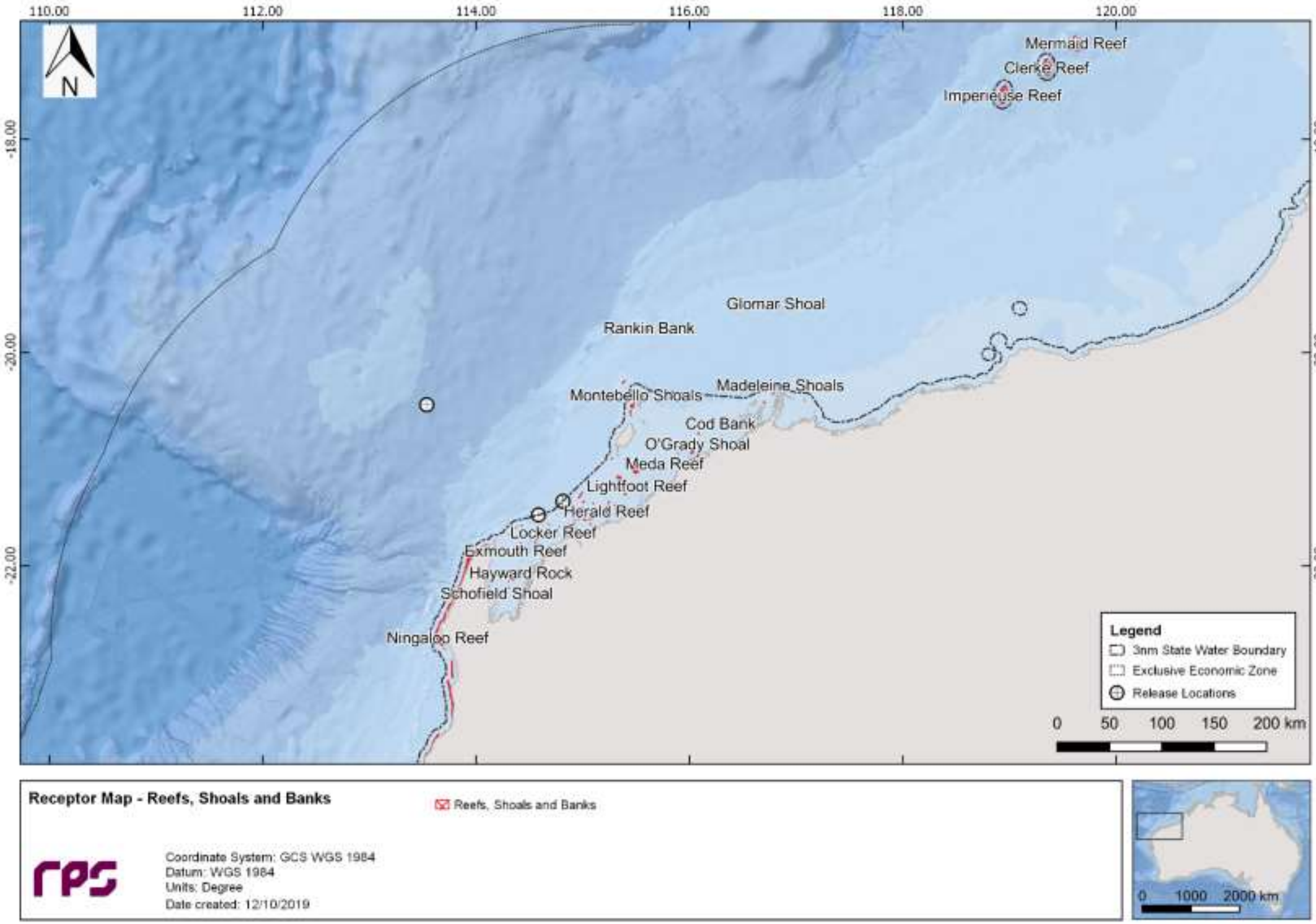


**Figure 10.8 Receptor map for Reefs, Shoals and Banks (RSB).**

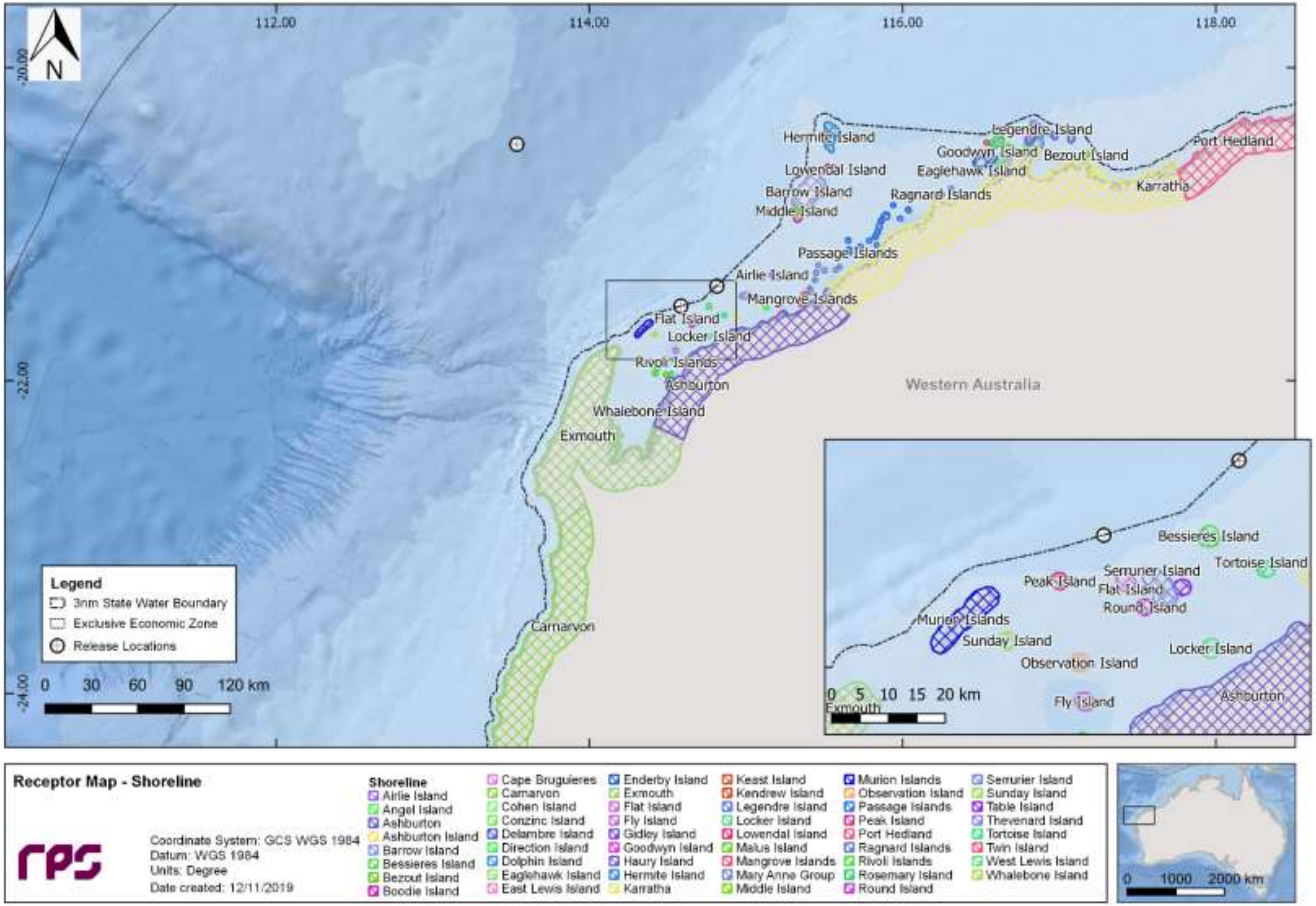


**Figure 10.9 Receptor map for Shorelines.**

# 11 RESULTS: SCENARIO 1: 2,727,570 BBL SUBSEA RELEASE OF CONDENSATE AT MENTORC-1

This scenario examined a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. A total of 300 spill trajectories were simulated across three seasons; summer, transitional and winter (i.e. 100 spills per season).

Section 11.1 presents the seasonal stochastic analysis and Section 11.2 presents the deterministic results.

## 11.1 Seasonal analysis

### 11.1.1 Sea Surface Exposure

Table 11.1 summarises the maximum distances from the release location to oil exposure zones on the sea surface for each season.

The maximum distance from the release location to the low (≥ 1 $g/m^2$), moderate (≥ 10 $g/m^2$) and high (≥ 50 $g/m^2$) exposure thresholds was 134.7 km north-northwest (transitional), 62.9 km south-southwest (summer) and 5.2 km south-southwest (transitional), respectively.

Table 11.2 presents the potential sea surface exposure to the two receptors during summer, transitional and winter conditions. Low sea surface exposure was predicted at the Gascoyne Australian Marine Park (AMP) and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula Key Ecological Feature (Canyons KEF) during summer, transitional and winter conditions. At the Gascoyne AMP, predicted probabilities of low sea surface exposure ranged from 84% in summer to 93% in winter while the Canyons KEF recorded probabilities of low sea surface exposure ranging from 2% during transitional and winter conditions to 11% in summer.

Additionally, the Gascoyne AMP recorded probabilities of sea surface exposure at or above the moderate threshold with probabilities of 25% in summer, 33% during transitional conditions and 32% during winter.

Figure 11.1 to Figure 11.3 present the zones of sea surface exposure at the low, moderate and high thresholds in summer, transitional and winter conditions.

Note, the release location resides within the Exmouth Plateau KEF, hence it is not presented in the tabulated results.

**Table 11.1 Maximum distance and direction from Mentorc-1 to oil exposure thresholds on the sea surface. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Distance and direction | Zones of potential sea surface exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Max. distance from release site (km) | 129.2 | 62.9 | 4.8 |
| | Max distance from release site (km) (99$^{th}$ percentile) | 79.5 | 40.1 | 4.8 |
| | Direction | SSW | SSW | NE |
| Transitional | Max. distance from release site (km) | 134.7 | 47.9 | 5.2 |
| | Max distance from release site (km) (99$^{th}$ percentile) | 75.6 | 39.7 | 5.2 |
| | Direction | NNW | SE | SSW |
| Winter | Max. distance from release site (km) | 125.1 | 52.6 | 5.0 |
| | Max distance from release site (km) (99$^{th}$ percentile) | 73.1 | 40.5 | 5.0 |
| | Direction | NNW | S | SW |

**Table 11.2 Summary of the potential sea surface exposure to individual receptors. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Probability of oil exposure on the sea surface (%) | | | Minimum time before oil exposure on the sea surface (days) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Low | Moderate | High | Low | Moderate | High |
| Summer | AMP | Gascoyne | 84 | 25 | - | 1.25 | 3.96 | - |
| | KEF | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 11 | - | - | 21.71 | - | - |
| Transitional | AMP | Gascoyne | 91 | 33 | - | 1.08 | 2.58 | - |
| | KEF | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 2 | - | - | 4.25 | - | - |
| Winter | AMP | Gascoyne | 93 | 32 | - | 2.83 | 8.67 | - |
| | KEF | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 2 | - | - | 48.83 | - | - |

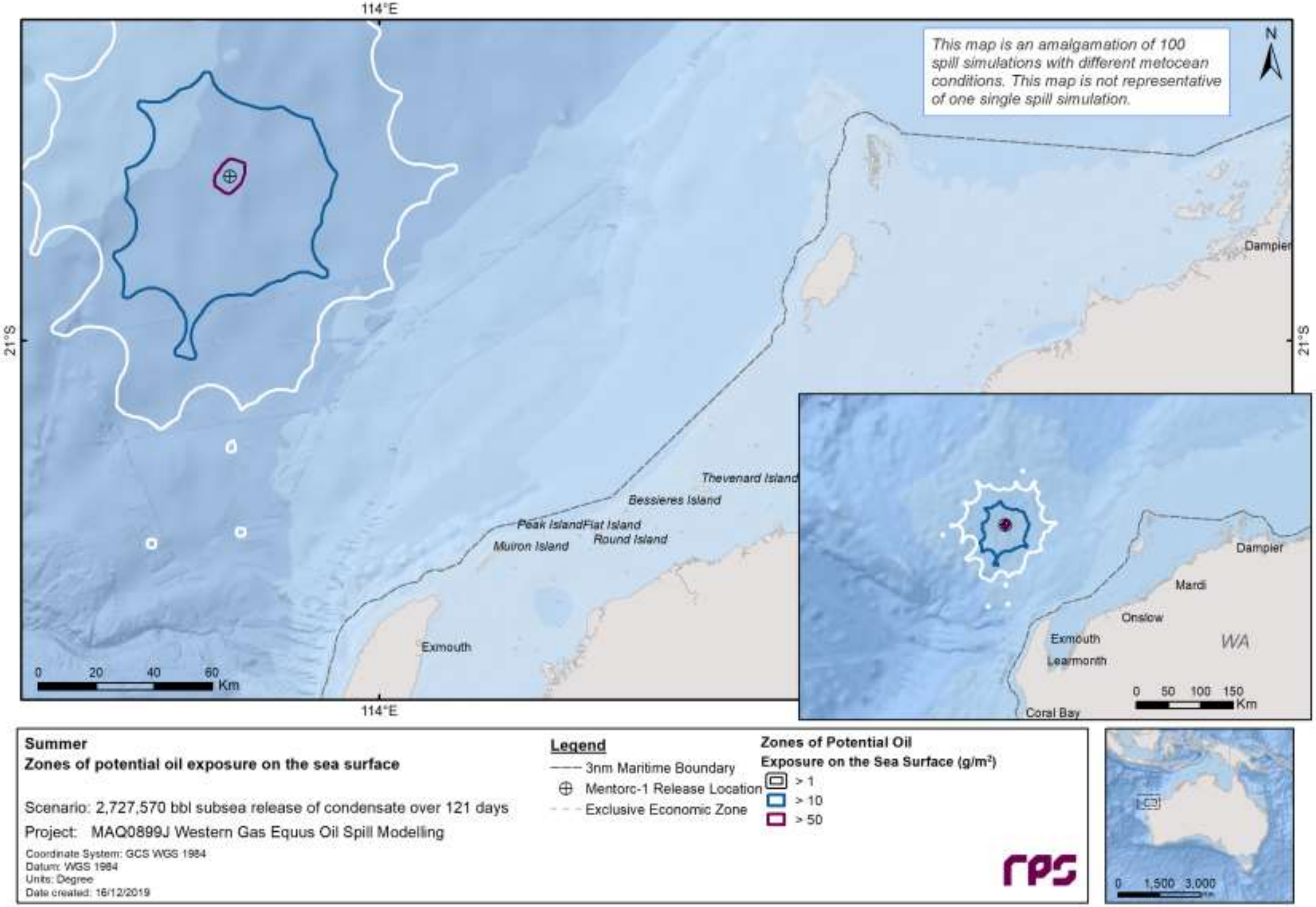


**Figure 11.1 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

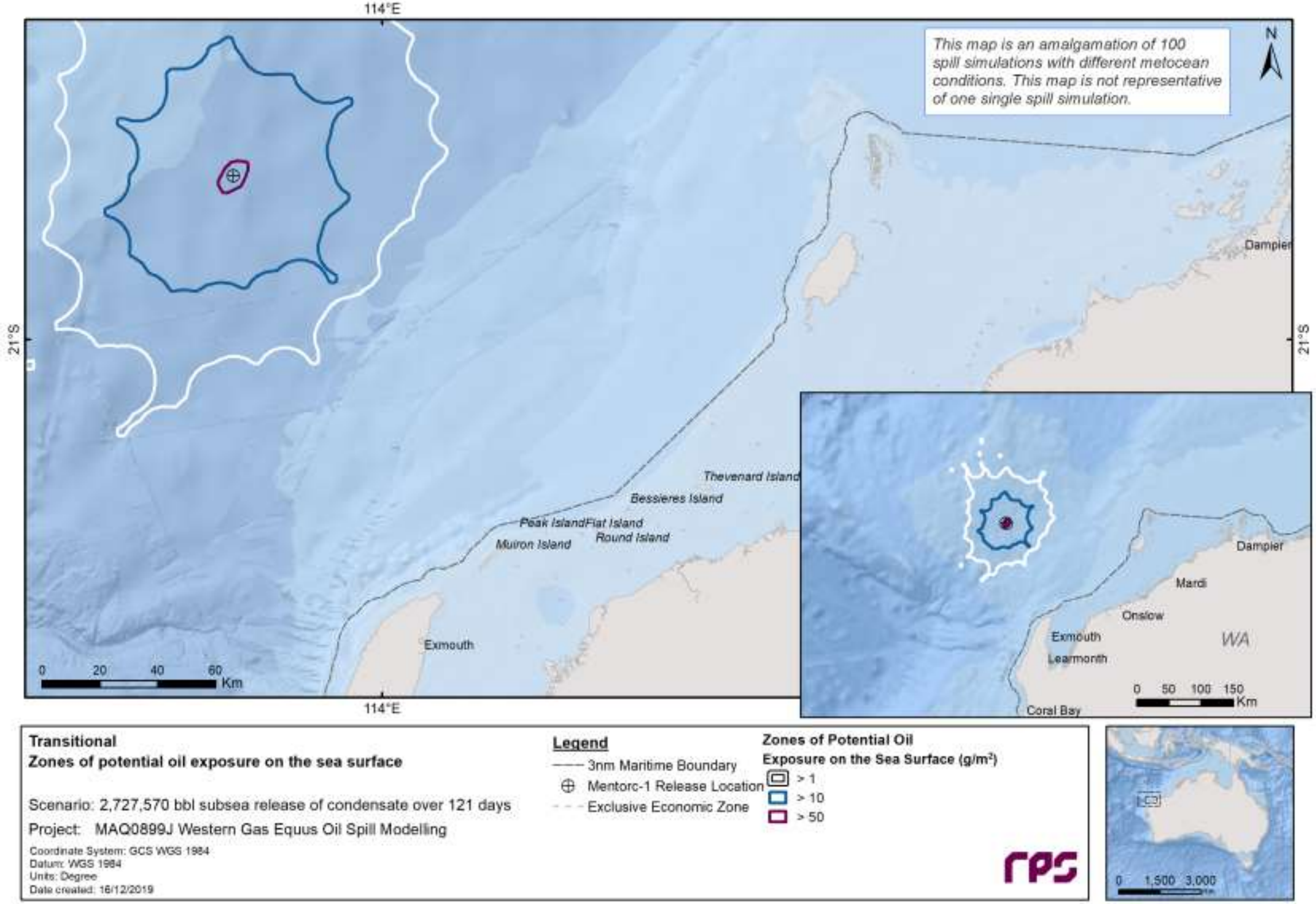


**Figure 11.2 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

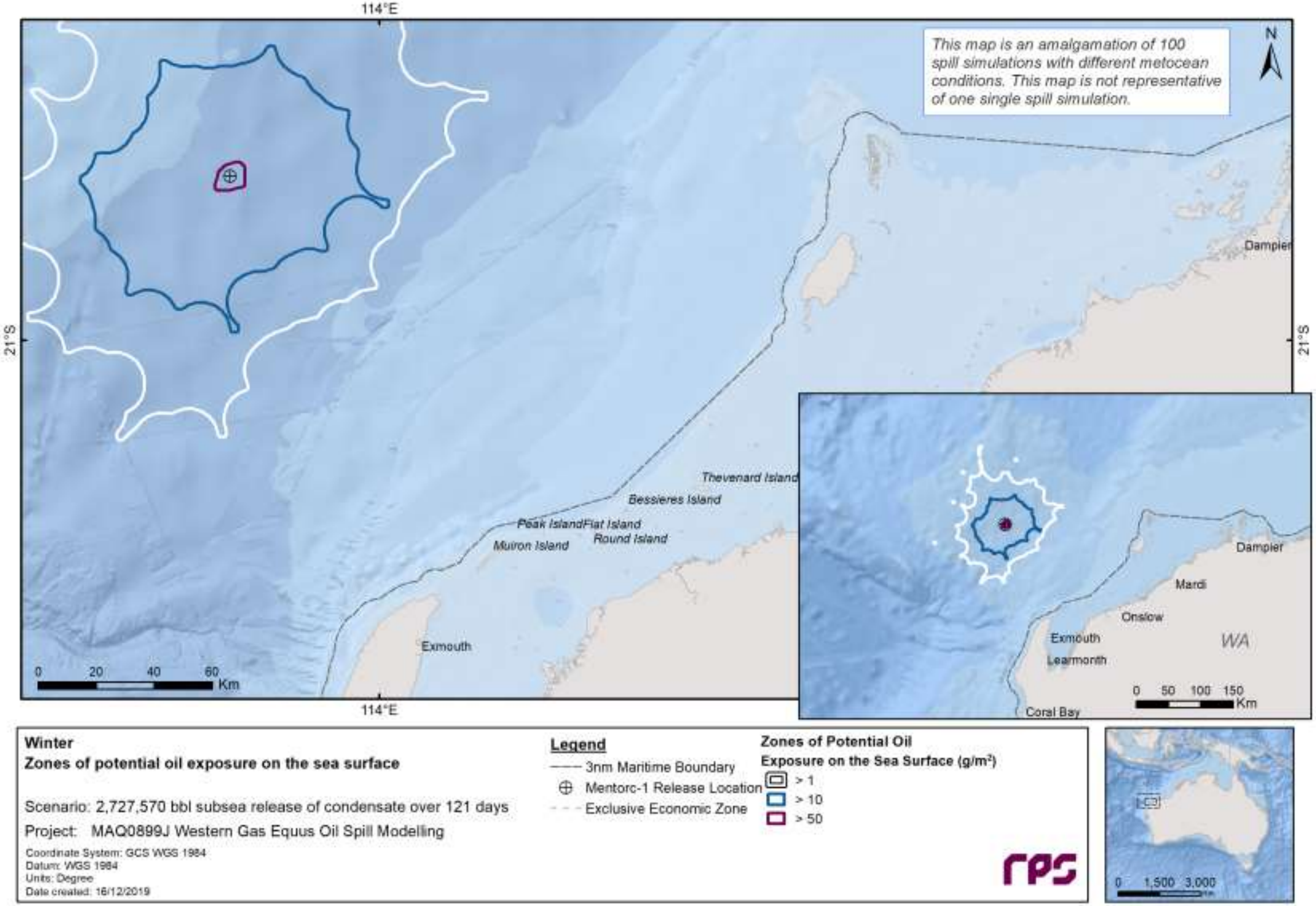


**Figure 11.3 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

### 11.1.2 Shoreline Contact

No shoreline contact was predicted above the low threshold for this scenario, consequently no shoreline contact results are presented.

### 11.1.3 Water Column Exposure

#### 11.1.3.1 Dissolved Hydrocarbons

No dissolved hydrocarbon exposure was predicted above the low threshold in the top 30 m of the water column for this scenario, consequently no dissolved hydrocarbon results are presented.

### 11.1.3.2 Entrained Hydrocarbons

Table 11.3 summarises the maximum distance and direction from the release location to entrained hydrocarbon exposure zones at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and high entrained hydrocarbon exposure was 1881.6 km (northeast) and 704.8 km (southwest), recorded during summer and transitional conditions, respectively.

Table 11.4 to Table 11.6 summarise the probability of exposure to receptors from entrained hydrocarbons in the 0-10 m depth layer for each of the three seasons, at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds (NOPSEMA, 2019).

The Gascoyne AMP was predicted to record 100% probability of entrained hydrocarbon exposure at the low threshold during every season. Additionally, the Argo-Rowley Terrace, the Carnarvon Canyon and the Ningaloo AMPs, the Ningaloo, Northwest Shelf, and the Pilbarra (offshore) IMCRAs and the Canyons and the Commonwealth waters adjacent to Ningaloo Reef KEFs all recorded probabilities of low entrained hydrocarbon exposure at or above 30% for each season. At the high entrained hydrocarbon exposure threshold, the Gascoyne AMP recorded the greatest probabilities of exposure ranging from 91% in summer to 100% during transitional and winter conditions. The Canyons KEF was also predicted to be exposed at the high entrained hydrocarbon threshold with predicted probabilities of 60% in summer, 72% during transitional conditions and 61% during winter.

Table 11.7 summarises the probability of exposure to receptors from entrained hydrocarbons in the 10-20 m depth layer, during all seasonal conditions and at the low and high entrained hydrocarbon exposure thresholds.

In the 10-20 m layer, the Gascoyne AMP recorded the highest predicted low entrained hydrocarbon exposure, with probabilities of 77% during summer, 86% during transitional conditions and 98% during winter. Additionally, the Canyons KEF recorded probabilities of low entrained hydrocarbon exposure of 9% during summer, 11% during transitional conditions and 14% in winter. Only the Gascoyne AMP was predicted to be exposed at or above the high entrained hydrocarbon ci with predicted probabilities of 6% during summer and 4% during transitional and winter conditions.

Table 11.8 summarises the probability of exposure to receptors from entrained hydrocarbons in the 20-30 m depth layer, during all seasonal conditions and at the low and high entrained hydrocarbon exposure thresholds.

In the 20-30 m layer, only the Gascoyne AMP was predicted to be exposed to entrained hydrocarbons at or above the low threshold during summer, transitional and winter conditions with predicted probabilities ranging from 60% during transitional conditions to 75% during winter. At the high entrained hydrocarbon threshold, the Gascoyne AMP recorded probabilities of exposure ranging from 4% during transitional and winter conditions and 5% during summer.

Figure 11.4 to Figure 11.12 illustrate the zones of potential entrained hydrocarbon exposure for the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds in the 0-10 m, 10-20 m and 20-30 m depth layers during summer, transitional and winter conditions.

**Table 11.3 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days for all seasons. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential entrained hydrocarbon exposure | |
|---|---|---|---|
| | | Low<br>10 ppb | High<br>100 ppb |
| Summer | Maximum distance (km) from the release location | 1881.6 | 640.5 |
| | Direction | NE | NW |
| Transitional | Maximum distance (km) from the release location | 1814.9 | 704.8 |
| | Direction | NE | SW |
| Winter | Maximum distance (km) from the release location | 1497.2 | 642.6 |
| | Direction | NW | SSW |

**Table 11.4 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during summer (September to March) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 81 | 28 | - |
| | Argo-Rowley Terrace | 95 | 36 | - |
| | Carnarvon Canyon | 154 | 68 | 4 |
| | Gascoyne | 1,825 | 100 | 91 |
| | Montebello | 235 | 49 | 10 |
| | Ningaloo | 179 | 42 | 8 |
| | Perth Canyon | 26 | 3 | - |
| | Shark Bay | 40 | 33 | - |
| EEZ | Christmas Island Exclusive Economic Zone | 31 | 8 | - |
| | Cocos Islands Exclusive Economic Zone | 13 | 2 | - |
| | East Timorian Exclusive Economic Zone | 15 | 5 | - |
| | Indonesian Exclusive Economic Zone | 37 | 5 | - |
| | Oecussi Ambeno Exclusive Economic Zone | 10 | 1 | - |
| IBRA | Cape Range | 89 | 25 | - |
| | Roebourne | 35 | 13 | - |
| IMCRA | Central West Coast | 16 | 5 | - |
| | Leeuwin-Naturaliste | 12 | 2 | - |
| | Ningaloo | 159 | 52 | 8 |
| | Northwest Shelf | 258 | 54 | 11 |
| | Pilbarra (nearshore) | 16 | 5 | - |
| | Pilbarra (offshore) | 275 | 68 | 12 |
| | Zuytdorp | 62 | 35 | - |
| KEF | Ancient coastline at 125 m depth contour | 236 | 52 | 11 |
| | Ancient coastline at 90-120m depth | 10 | 1 | - |
| | Canyons linking the Argo Abyssal Plain with the Scott Plateau | 19 | 3 | - |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 527 | 91 | 60 |
| | Commonwealth marine environment surrounding the Houtman Abrolhos Islands | 11 | 1 | - |
| | Commonwealth waters adjacent to Ningaloo Reef | 179 | 42 | 8 |
| | Glomar Shoals | 80 | 14 | - |
| | Perth Canyon and adjacent shelf break, and other west coast canyons | 32 | 8 | - |
| | Wallaby Saddle | 81 | 22 | - |
| | Western demersal slope and associated fish communities | 124 | 24 | 3 |
| | Western rock lobster | 13 | 2 | - |
| MMA | Barrow Island | 53 | 27 | - |
| | Muiron Islands | 30 | 15 | - |
| MP | Barrow Island | 50 | 20 | - |

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| NR | Montebello Islands | 49 | 29 | - |
| | Ningaloo | 141 | 26 | 8 |
| | Thevenard Island | 51 | 6 | - |
| RSB | Barrow Island Reefs and Shoals | 11 | 1 | - |
| | Brewis Reef | 28 | 6 | - |
| | Dailey Shoal | 10 | 1 | - |
| | Glomar Shoal | 40 | 14 | - |
| | Herald Reef | 12 | 1 | - |
| | Montebello Shoals | 45 | 24 | - |
| | Moresby Shoals | 10 | 1 | - |
| | Ningaloo Reef | 95 | 18 | - |
| | Penguin Bank | 24 | 19 | - |
| | Poivre Reef | 18 | 12 | - |
| | Rankin Bank | 45 | 28 | - |
| | Ripple Shoals | 17 | 6 | - |
| | Rosily Shoals | 57 | 17 | - |
| | Tryal Rocks | 49 | 37 | - |
| State Waters | Western Australia State Waters | 141 | 29 | 8 |

**Table 11.5 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during transitional (April and August) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 122 | 19 | 1 |
| | Argo-Rowley Terrace | 89 | 47 | - |
| | Carnarvon Canyon | 146 | 51 | 3 |
| | Gascoyne | 1,635 | 100 | 100 |
| | Montebello | 119 | 36 | 2 |
| | Ningaloo | 145 | 32 | 8 |
| | Perth Canyon | 25 | 4 | - |
| | Shark Bay | 30 | 29 | - |
| EEZ | Christmas Island Exclusive Economic Zone | 19 | 7 | - |
| | Cocos Islands Exclusive Economic Zone | 14 | 2 | - |
| | East Timorian Exclusive Economic Zone | 13 | 2 | - |
| | Indonesian Exclusive Economic Zone | 36 | 12 | - |
| | Oecussi Ambeno Exclusive Economic Zone | 12 | 1 | - |
| IBRA | Cape Range | 64 | 11 | - |
| | Roebourne | 32 | 10 | - |
| IMCRA | Central West Coast | 17 | 6 | - |
| | Leeuwin-Naturaliste | 12 | 2 | - |
| | Ningaloo | 191 | 40 | 6 |
| | Northwest Shelf | 150 | 55 | 5 |
| | Pilbarra (nearshore) | 14 | 6 | - |
| | Pilbarra (offshore) | 269 | 71 | 10 |
| | Zuytdorp | 62 | 28 | - |
| KEF | Ancient coastline at 125 m depth contour | 244 | 57 | 9 |
| | Canyons linking the Argo Abyssal Plain with the Scott Plateau | 23 | 6 | - |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 565 | 89 | 72 |
| | Commonwealth marine environment surrounding the Houtman Abrolhos Islands | 11 | 1 | - |
| | Commonwealth waters adjacent to Ningaloo Reef | 145 | 32 | 8 |
| | Glomar Shoals | 17 | 2 | - |
| | Perth Canyon and adjacent shelf break, and other west coast canyons | 33 | 9 | - |
| | Wallaby Saddle | 122 | 19 | 1 |
| | Western demersal slope and associated fish communities | 115 | 18 | 2 |
| | Western rock lobster | 12 | 1 | - |
| MMA | Barrow Island | 42 | 13 | - |
| | Muiron Islands | 28 | 5 | - |
| MP | Barrow Island | 35 | 12 | - |
| | Montebello Islands | 32 | 13 | - |

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| | Ningaloo | 120 | 17 | 1 |
| NR | Thevenard Island | 52 | 10 | - |
| RSB | Barrow Island Reefs and Shoals | 11 | 1 | - |
| | Brewis Reef | 30 | 10 | - |
| | Dailey Shoal | 11 | 2 | - |
| | Glomar Shoal | 11 | 1 | - |
| | Herald Reef | 11 | 1 | - |
| | Montebello Shoals | 24 | 12 | - |
| | Ningaloo Reef | 74 | 5 | - |
| | Penguin Bank | 27 | 10 | - |
| | Poivre Reef | 21 | 8 | - |
| | Rankin Bank | 34 | 16 | - |
| | Ripple Shoals | 19 | 8 | - |
| | Rosily Shoals | 52 | 10 | - |
| | Tryal Rocks | 50 | 12 | - |
| State Waters | Western Australia State Waters | 120 | 17 | 1 |

**Table 11.6 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during winter (May to July) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 94 | 34 | - |
| | Argo-Rowley Terrace | 68 | 36 | - |
| | Carnarvon Canyon | 150 | 54 | 6 |
| | Gascoyne | 1,878 | 100 | 100 |
| | Montebello | 99 | 28 | - |
| | Ningaloo | 137 | 31 | 5 |
| | Perth Canyon | 14 | 1 | - |
| | Shark Bay | 49 | 30 | - |
| EEZ | Christmas Island Exclusive Economic Zone | 15 | 2 | - |
| | Indonesian Exclusive Economic Zone | 34 | 13 | - |
| IBRA | Cape Range | 23 | 8 | - |
| IMCRA | Central West Coast | 16 | 1 | - |
| | Ningaloo | 187 | 30 | 6 |
| | Northwest Shelf | 142 | 55 | 9 |
| | Pilbarra (offshore) | 287 | 60 | 7 |
| | Zuytdorp | 57 | 31 | - |
| KEF | Ancient coastline at 125 m depth contour | 235 | 49 | 6 |
| | Canyons linking the Argo Abyssal Plain with the Scott Plateau | 21 | 5 | - |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 588 | 100 | 61 |
| | Commonwealth marine environment surrounding the Houtman Abrolhos Islands | 10 | 1 | - |
| | Commonwealth waters adjacent to Ningaloo Reef | 137 | 31 | 5 |
| | Perth Canyon and adjacent shelf break, and other west coast canyons | 19 | 2 | - |
| | Wallaby Saddle | 93 | 27 | - |
| | Western demersal slope and associated fish communities | 98 | 27 | - |
| MMA | Barrow Island | 25 | 3 | - |
| MP | Barrow Island | 21 | 3 | - |
| | Montebello Islands | 22 | 2 | - |
| | Ningaloo | 47 | 13 | - |
| RSB | Montebello Shoals | 14 | 1 | - |
| | Ningaloo Reef | 45 | 9 | - |
| | Penguin Bank | 21 | 3 | - |
| | Rankin Bank | 20 | 17 | - |
| | Rosily Shoals | 15 | 3 | - |
| | Tryal Rocks | 41 | 2 | - |
| State Waters | Western Australia State Waters | 47 | 13 | - |

**Table 11.7 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 10-20 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|---|
| | | | | Low | High |
| Summer | AMP | Gascoyne | 183 | 77 | 6 |
| | | Ningaloo | 12 | 1 | - |
| | IMCRA | Ningaloo | 12 | 1 | - |
| | | Pilbarra (offshore) | 14 | 1 | - |
| | KEF | Ancient coastline at 125 m depth contour | 12 | 1 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 21 | 9 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 12 | 1 | - |
| | MP | Ningaloo | 12 | 1 | - |
| | State Waters | Western Australia State Waters | 12 | 1 | - |
| Transitional | AMP | Gascoyne | 218 | 86 | 4 |
| | | Ningaloo | 11 | 1 | - |
| | IMCRA | Ningaloo | 11 | 1 | - |
| | | Pilbarra (offshore) | 15 | 1 | - |
| | KEF | Ancient coastline at 125 m depth contour | 11 | 1 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 25 | 11 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 11 | 1 | - |
| Winter | AMP | Gascoyne | 187 | 98 | 4 |
| | IMCRA | Ningaloo | 10 | 1 | - |
| | | Pilbarra (offshore) | 13 | 1 | - |
| | KEF | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 25 | 14 | - |

**Table 11.8 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 20-30 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|---|
| | | | | Low | High |
| Summer | AMP | Gascoyne | 176 | 63 | 5 |
| Transitional | AMP | Gascoyne | 161 | 60 | 4 |
| Winter | AMP | Gascoyne | 154 | 75 | 4 |

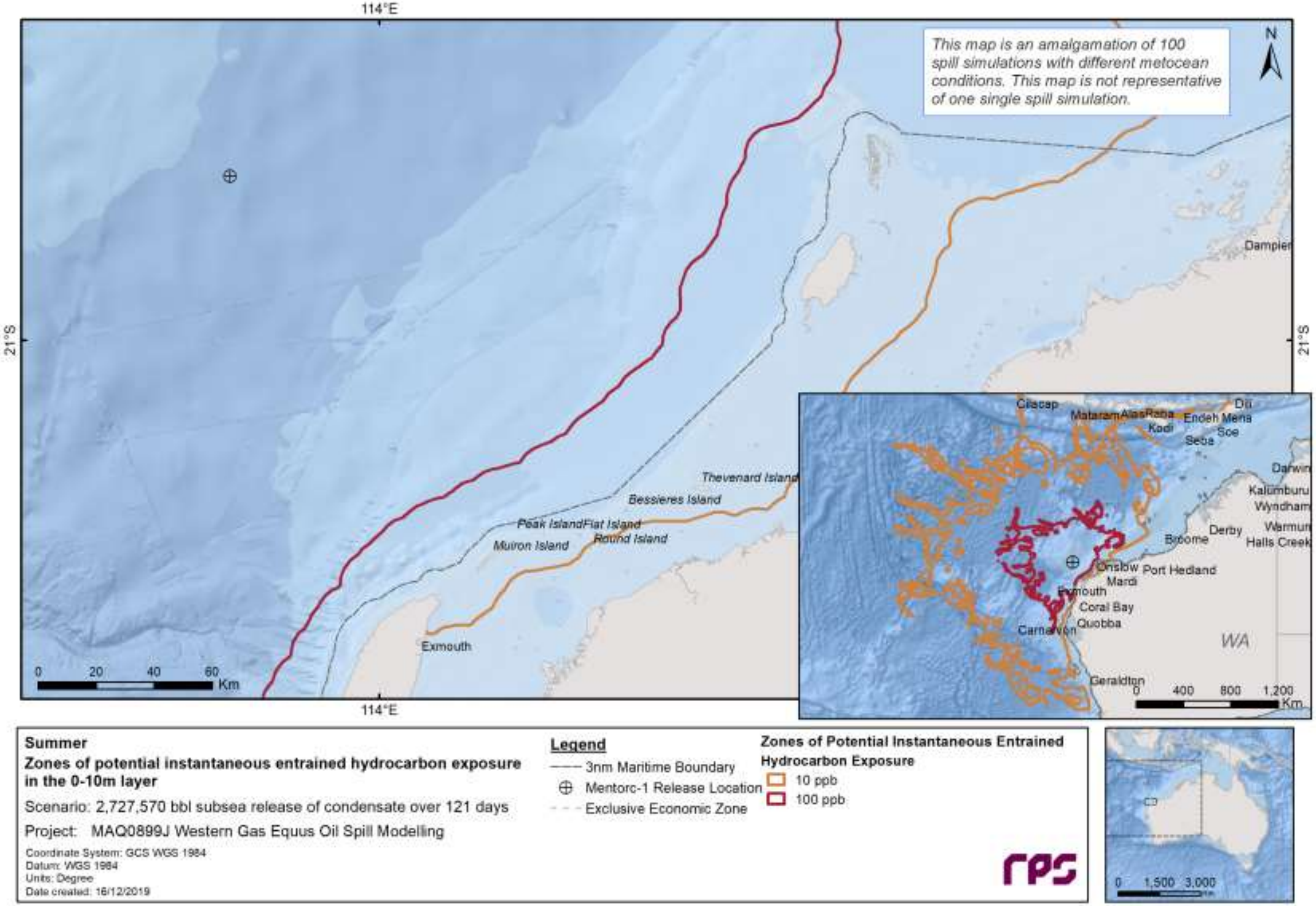


**Figure 11.4 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 0-10 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

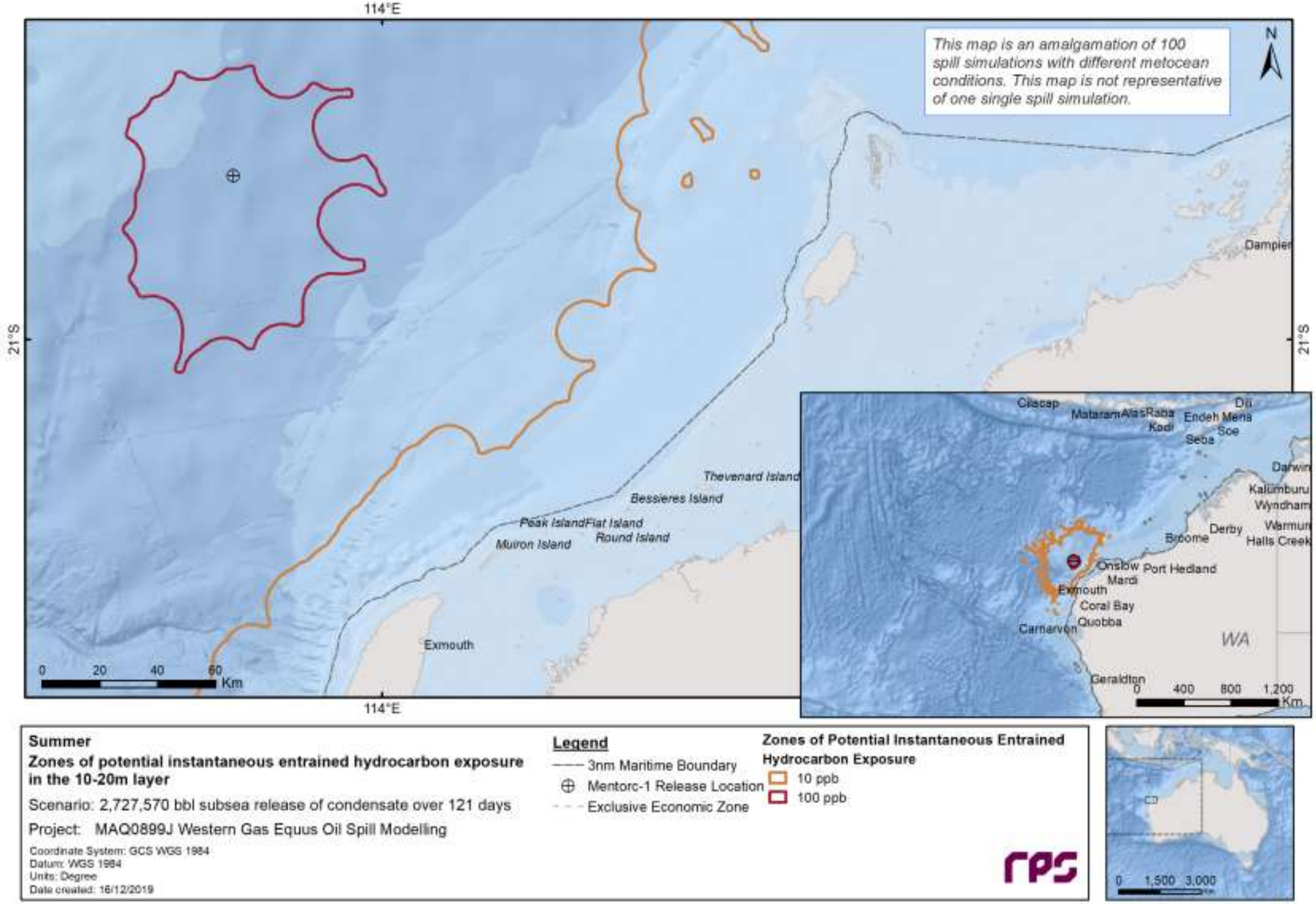


**Figure 11.5 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

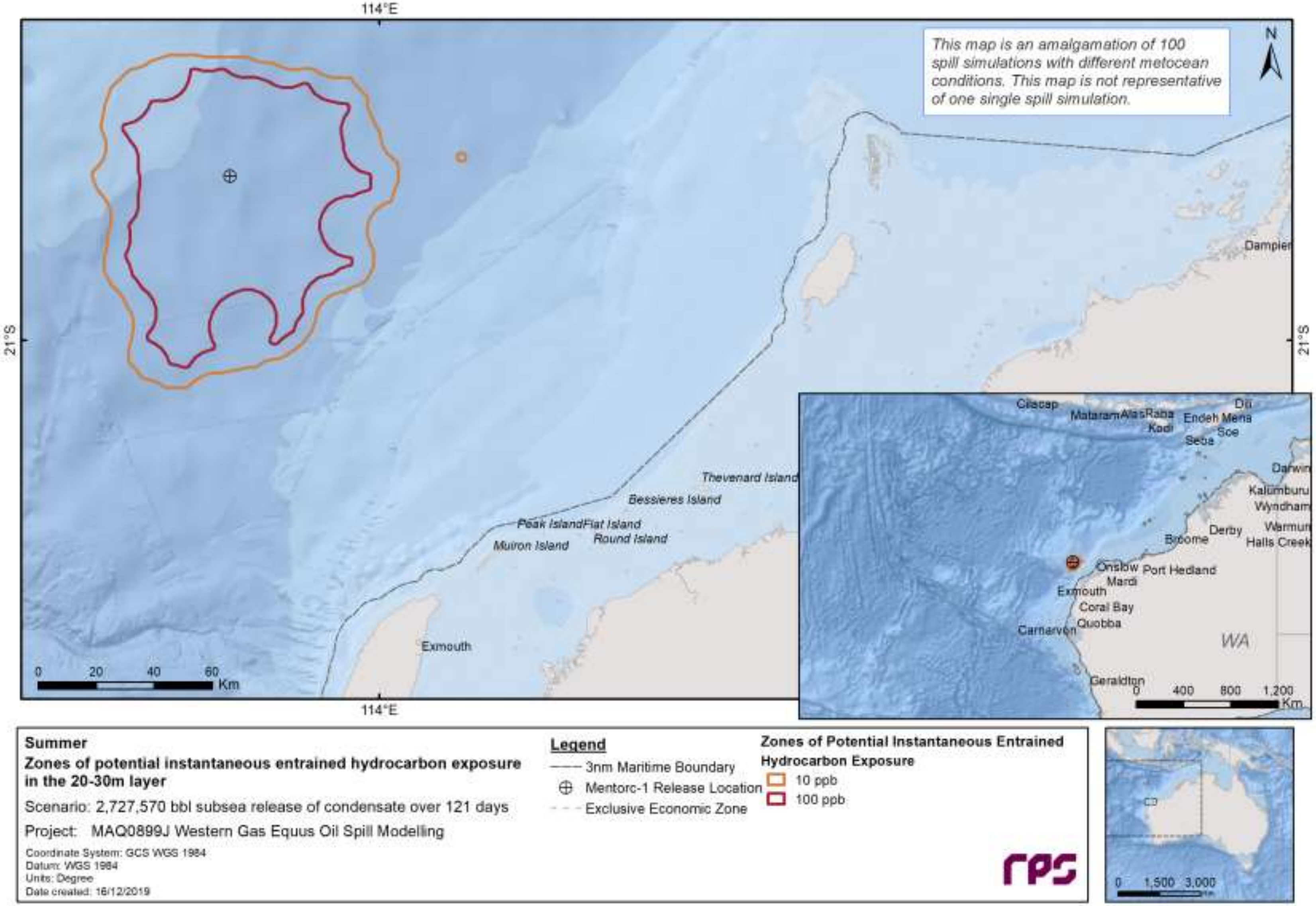


**Figure 11.6 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 20-30 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

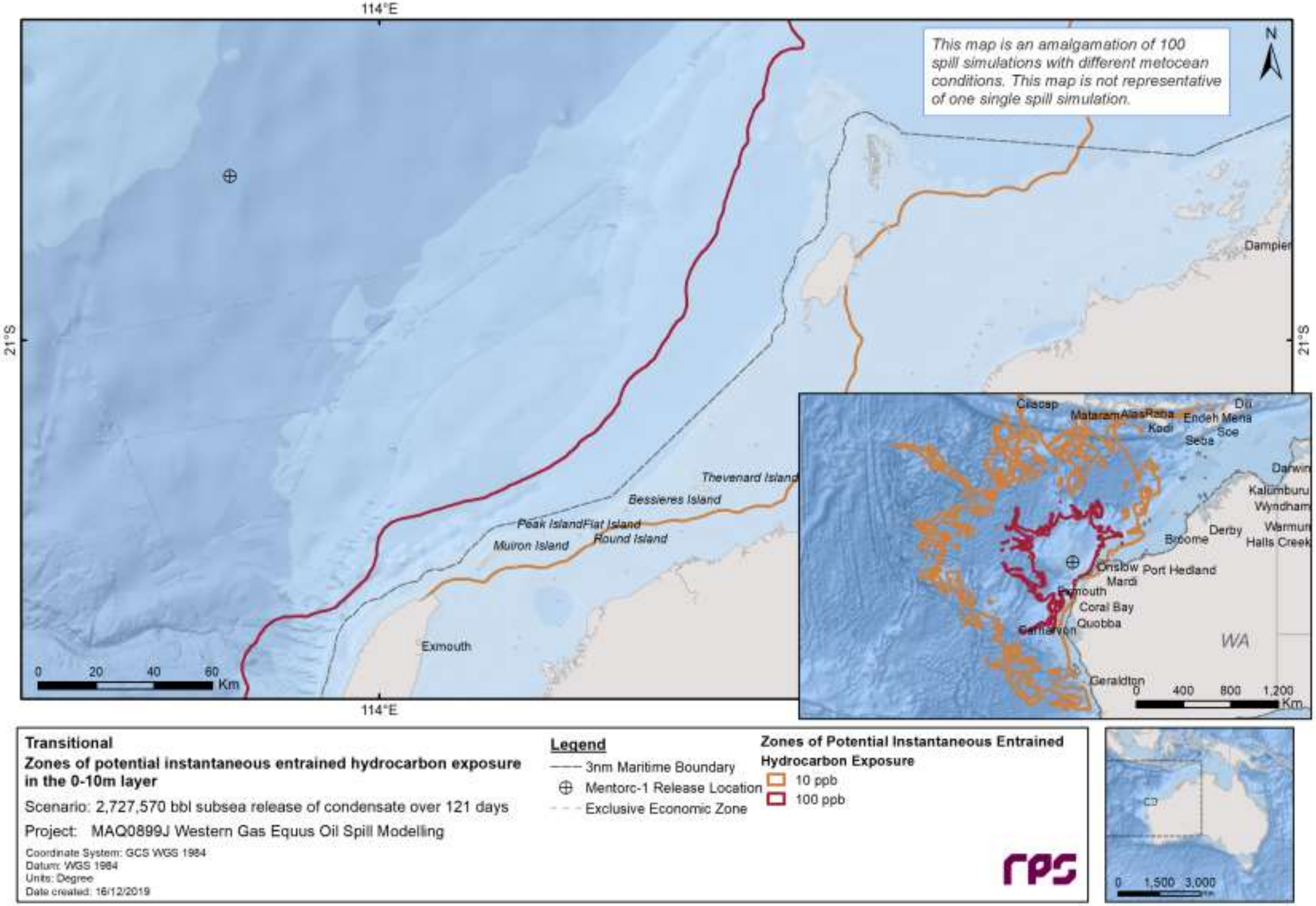


**Figure 11.7 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 0-10 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

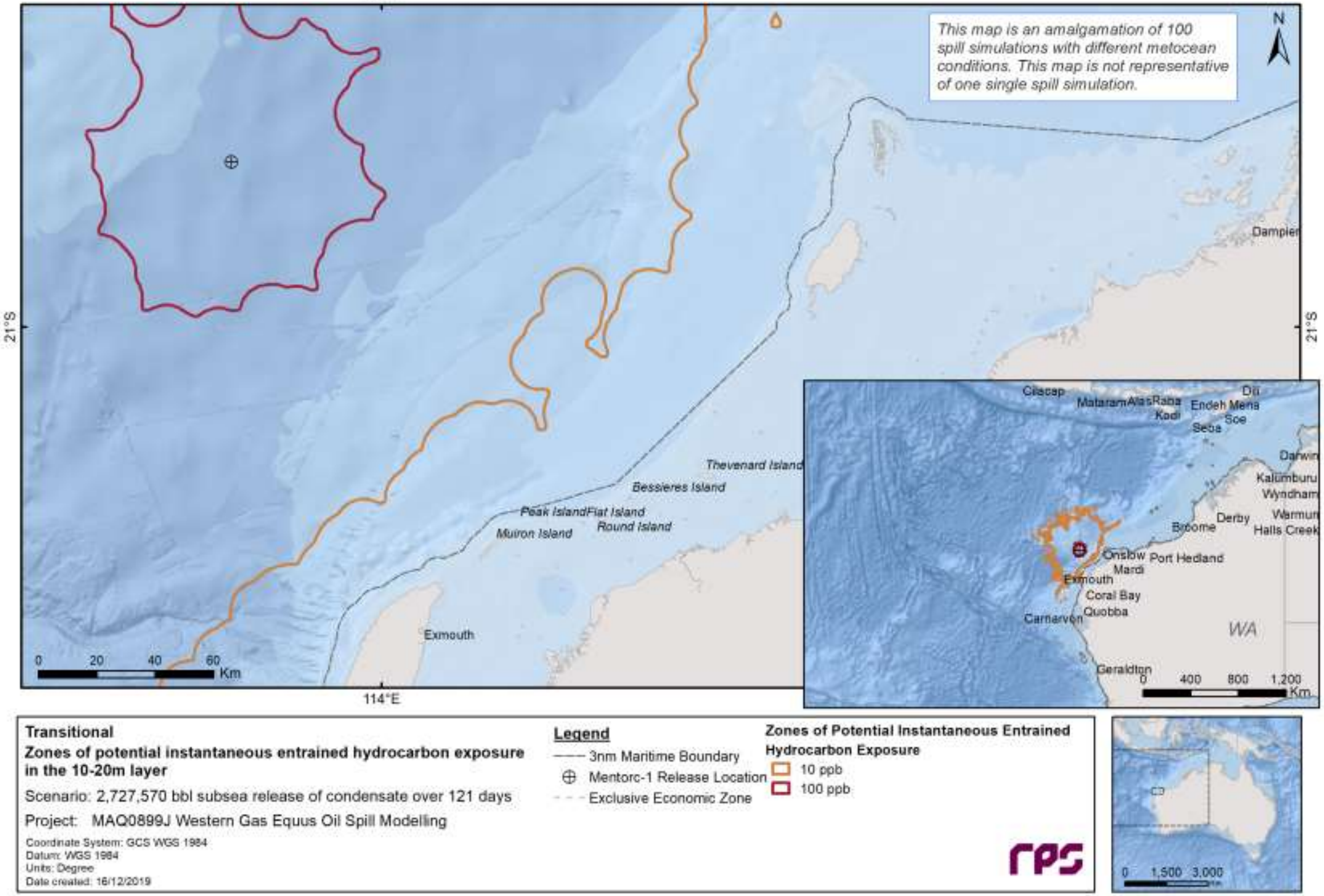


**Figure 11.8 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

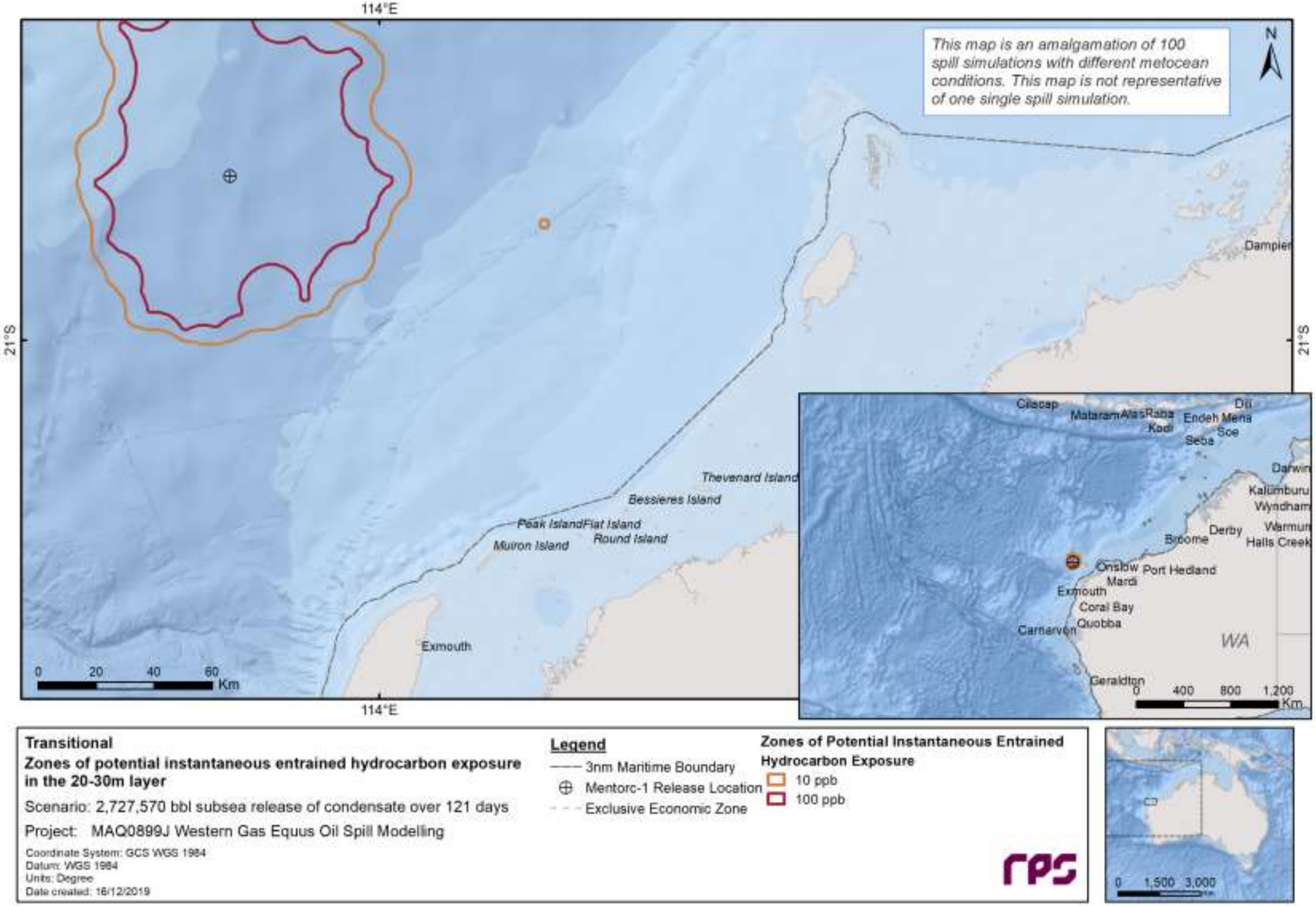


**Figure 11.9 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 20-30 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

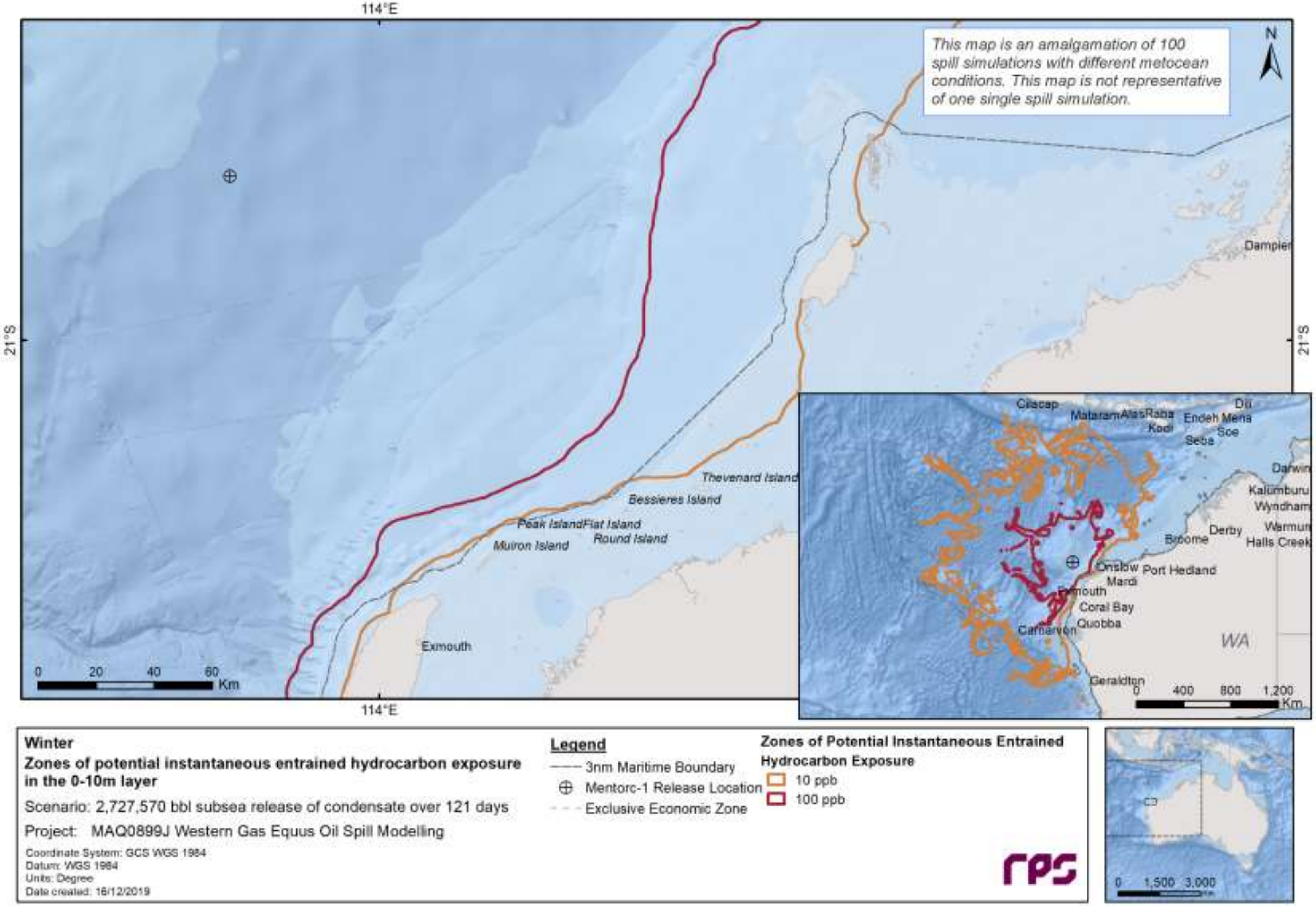


**Figure 11.10 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 0-10 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

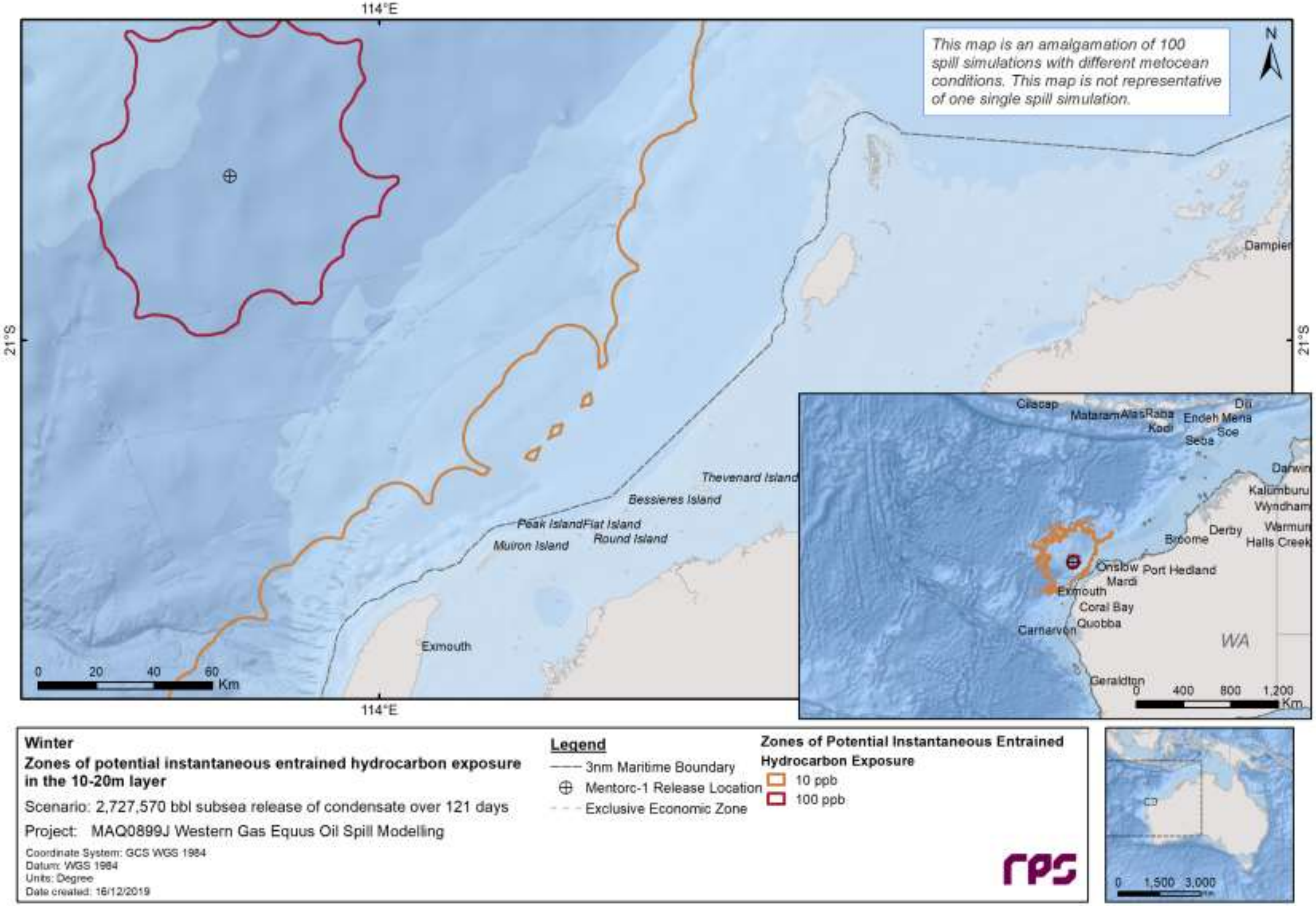


**Figure 11.11 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

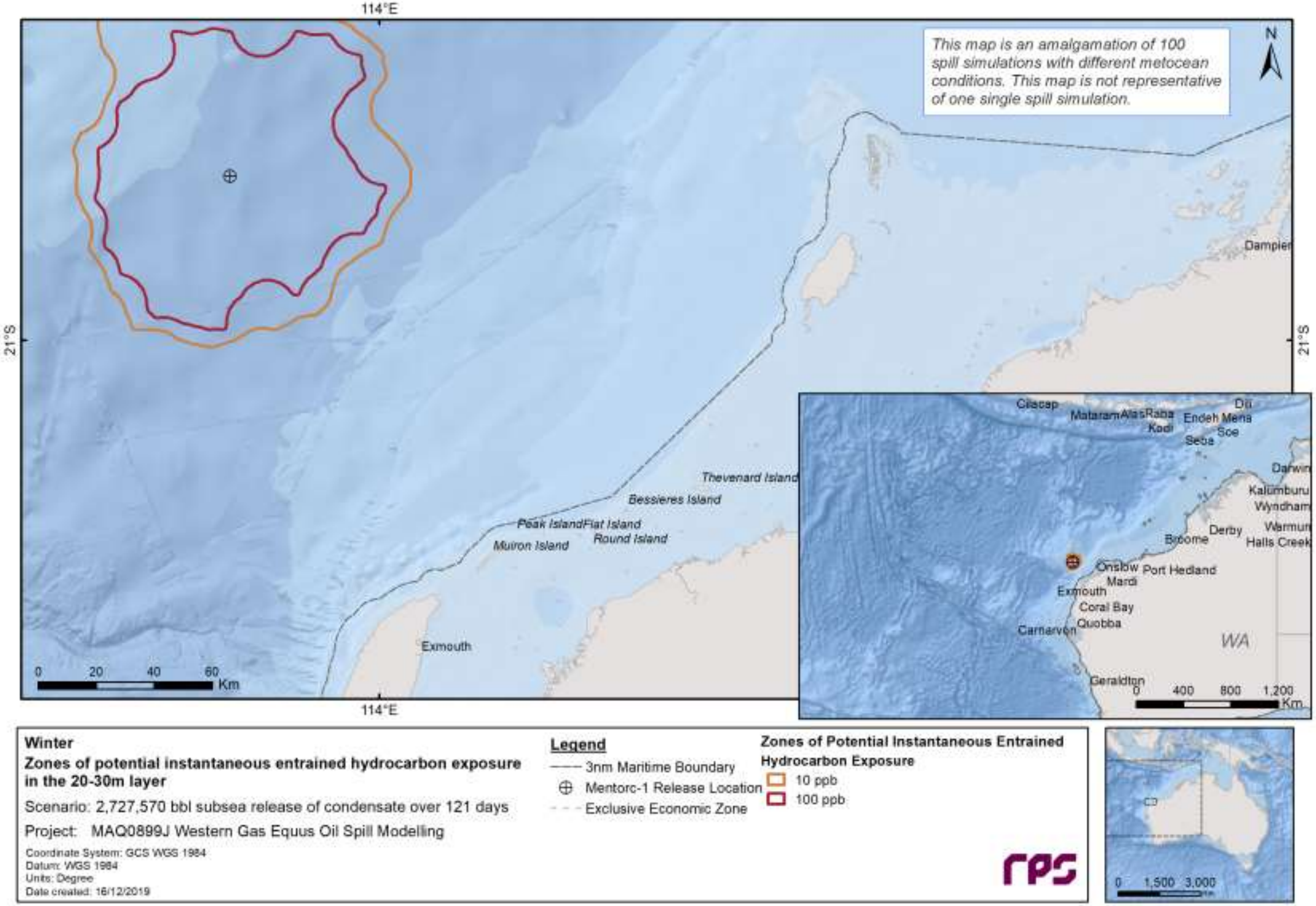


**Figure 11.12 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 20-30 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

## 11.2 Deterministic Trajectory

### 11.2.1 Deterministic Case: Largest area of exposure on the sea surface

The simulation that resulted in the largest area of exposure on the sea surface above 10 $g/m^2$ (moderate threshold and actionable surface oil) was identified as run number 85, to commence during transitional conditions, 6 pm on the 3rd of August 2017.

Zones of oil exposure on the sea surface (swept area) over the entire simulation (141 days) is presented in Figure 11.13.

Figure 11.14 is a graph of area of exposure on the sea surface at the visible oil (≥1 $g/m^2$) and actionable oil (10 $g/m^2$) exposure levels over the 141-day simulation. The largest area of exposure at the visible oil threshold was predicted to occur 8 days after the spill started and covered approximately 91 $km^2$. The maximum area at actionable surface oil threshold was 6 $km^2$, approximately 2 days into the simulation.

Figure 11.15 presents the fates and weathering graph for the identified simulation. At the conclusion of the simulation (day-141), approximately 1,976,743 bbl (72%) spilled oil was lost to the atmosphere through evaporation. Approximately 645,504 bbl (24%) of the condensate was predicted to have decayed, while approximately 104,561 bbl (4%) was predicted to remain within the water column and no condensate was predicted to accumulate on the shorelines.

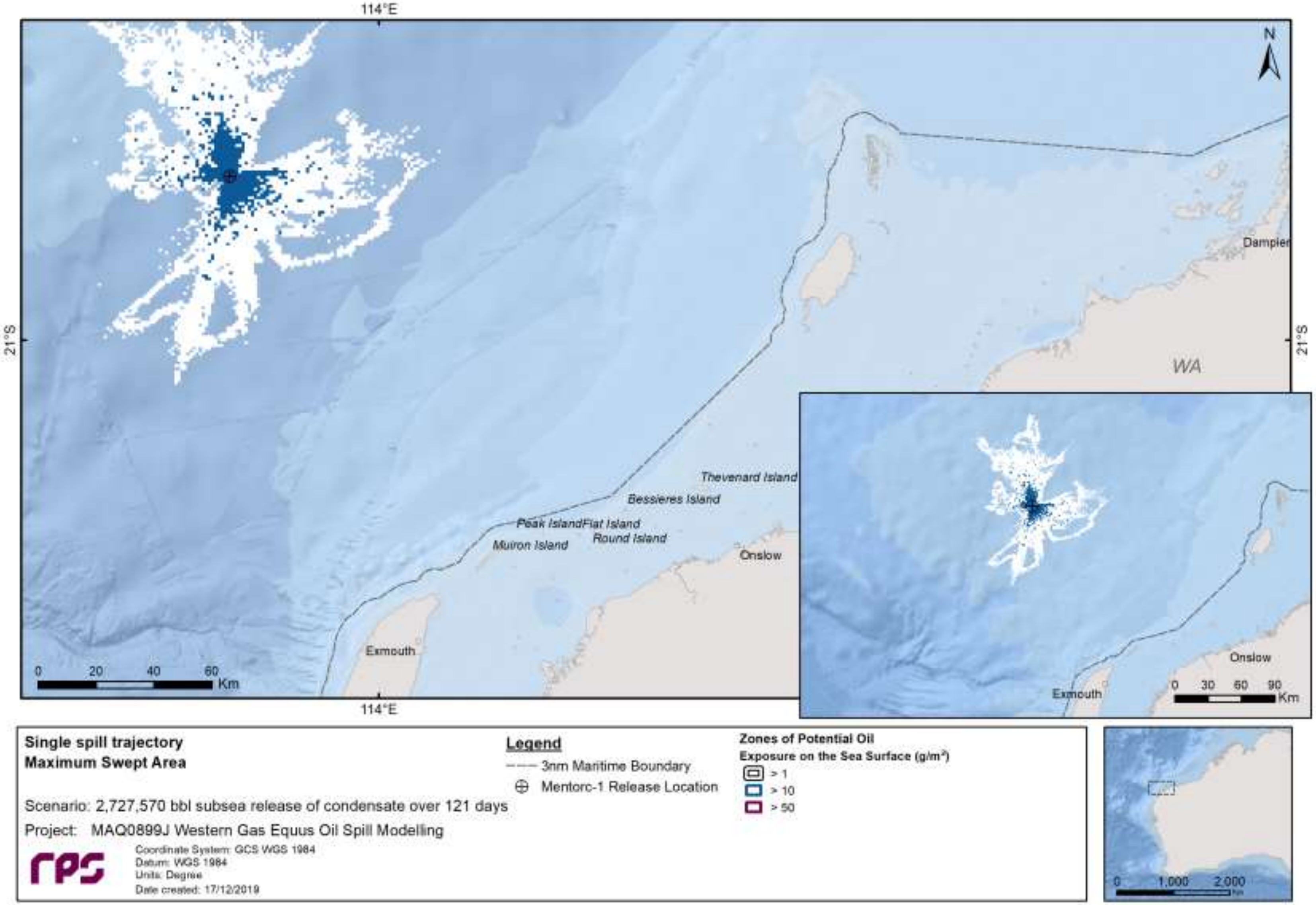


**Figure 11.13 Zones of potential oil exposure on the sea surface (over 141 days) for the trajectory with the largest area of oil exposure on the sea surface above 10 g/m$^2$ (moderate threshold and actionable surface oil). Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, commencing at 6 pm on the 3$^{rd}$ of August 2017.**

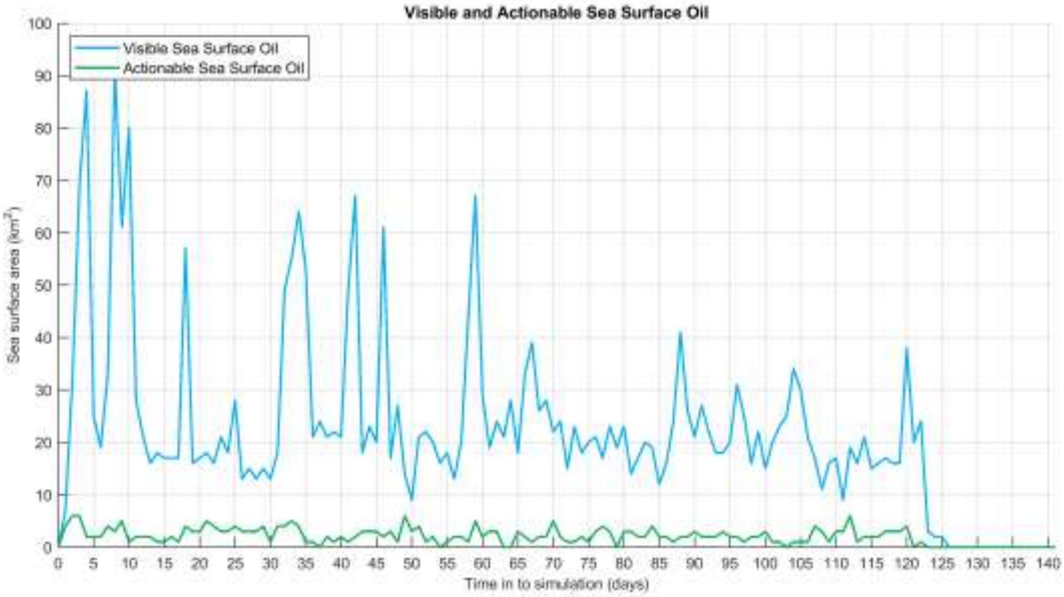


**Figure 11.14 Area of exposure at low (1 g/m²) and actionable (10 g/m²) surface oil thresholds for the trajectory with the largest area of oil on the sea surface above 10 g/m². Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, commcencing at 6 pm on the 3rd of August 2017.**

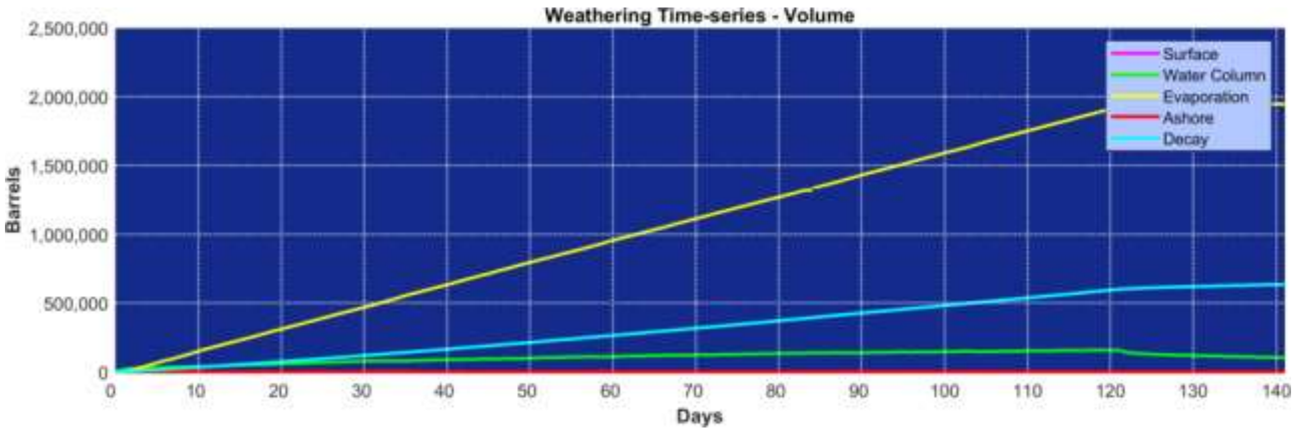


**Figure 11.15 Predicted weathering and fates graph for the trajectory with the largest swept area of oil on the sea surface above 10 g/m². Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, commencing at 6 pm on the 3rd of August 2017.**

# 12 RESULTS: SCENARIO 2: 1,000 M$^3$ SURFACE RELEASE OF MARINE GAS OIL

This scenario examined a 1,000 m$^3$ surface release of MGO from Point 1 and Point 4 over 6 hours, tracked for 40 days. A total of 300 spill trajectories were simulated across three seasons; summer, transitional and winter (i.e. 100 spills per season).

Section 12.1.1 presents the seasonal analysis and Section 12.1.2 presents the deterministic results for Point 1.

## 12.1 Point 1

### 12.1.1 Seasonal Analysis

#### 12.1.1.1 Sea Surface Exposure

Table 12.1 summarises the maximum distances from the release location to oil exposure zones on the sea surface for each season.

The maximum distance from the release location to the low (≥ 1 g/m$^2$), moderate (≥ 10 g/m$^2$) and high (≥ 50 g/m$^2$) exposure thresholds was 69.5 km west-southwest (transitional), 35.3 km west (transitional) and 7.6 km west-southwest (summer and transitional), respectively.

Table 12.2 presents potential sea surface exposure to individual receptors during summer, transitional and winter conditions. Low sea surface exposure was predicted at the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF during all three seasons with probabilities ranging from 1% (Ningaloo IMCRA, summer) to 32% (Ancient coastline at 125 m depth contour KEF, transitional conditions). Additionally, exposure was predicted at the moderate threshold during all seasons with probabilities ranging from 1% (multiple receptors) to 8% (Ancient coastline at 125 m depth contour KEF, transitional conditions). Minimum times before sea surface exposure (at the low threshold) ranged from 0.38 days (9 hours) at Cape Range IMCRA and nearshore waters adjacent to Peak Island during winter conditions to 2.29 days (55 hours) for nearshore waters along Table Island during transitional conditions.

Figure 12.1 to Figure 12.3 present the zones of sea surface exposure at the low (≥ 1 g/m$^2$), moderate (≥ 10 g/m$^2$) and high (≥ 50 g/m$^2$) thresholds in summer, transitional and winter conditions.

Note, the release location resides within the Pilbarra (Offshore) IMCRA, hence it is not presented in the tabulated results.

**Table 12.1 Maximum distance and direction from Point 1 to oil exposure thresholds on the sea surface. Results are based on a 1,000 $m^3$ surface release of MGO over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Distance and direction | Zones of potential sea surface exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Max. distance from release site (km) | 55.9 | 33.9 | 7.6 |
| | Max distance from release site (km) (99th percentile) | 43.5 | 30.1 | 7.6 |
| | Direction | W | W | WSW |
| Transitional | Max. distance from release site (km) | 69.5 | 35.3 | 7.6 |
| | Max distance from release site (km) (99th percentile) | 61.4 | 32.4 | 7.5 |
| | Direction | WSW | W | WSW |
| Winter | Max. distance from release site (km) | 42.7 | 23.4 | 4.9 |
| | Max distance from release site (km) (99th percentile) | 37.8 | 21.8 | 4.9 |
| | Direction | WSW | WSW | NNE |

Table 12.2 Summary of the potential sea surface exposure to receptors. Results are based on a 1,000 $m^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

| Season | Receptor | | Probability of oil exposure on the sea surface (%) | | | Minimum time before oil exposure on the sea surface (days) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Low | Moderate | High | Low | Moderate | High |
| Summer | IMCRA | Ningaloo | 1 | - | - | 0.92 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 18 | 2 | - | 0.50 | 0.67 | - |
| | KEF | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 4 | - | - | 0.63 | - | - |
| | MMA | Muiron Islands | 2 | - | - | 1.29 | - | - |
| Transitional | AMP | Ningaloo | 3 | - | - | 1.96 | - | - |
| | IBRA | Cape Range | 8 | 3 | - | 0.58 | 0.67 | - |
| | IMCRA | Ningaloo | 6 | - | - | 1.50 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 32 | 8 | - | 0.58 | 0.79 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 16 | 1 | - | 0.83 | 1.46 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 3 | - | - | 2.04 | - | - |
| | MMA | Muiron Islands | 3 | 1 | - | 0.88 | 0.96 | - |
| | Nearshore Waters | Flat Island | 5 | 4 | - | 0.58 | 0.63 | - |
| | | Peak Island | 2 | - | - | 0.54 | - | - |
| | | Round Island | 2 | - | - | 1.00 | - | - |
| | | Serrurier Island | 2 | - | - | 1.04 | - | - |
| | | Table Island | 1 | - | - | 2.29 | - | - |
| Winter | IBRA | Cape Range | 2 | 1 | - | 0.38 | 0.50 | - |
| | IMCRA | Ningaloo | 2 | - | - | 1.38 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 22 | 1 | - | 0.67 | 1.33 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 12 | 1 | - | 0.92 | 1.46 | - |
| | MMA | Muiron Islands | 6 | 1 | - | 0.58 | 0.83 | - |
| | Nearshore Waters | Murion Islands | 1 | - | - | 0.75 | - | - |
| | | Peak Island | 2 | 1 | - | 0.38 | 0.50 | - |

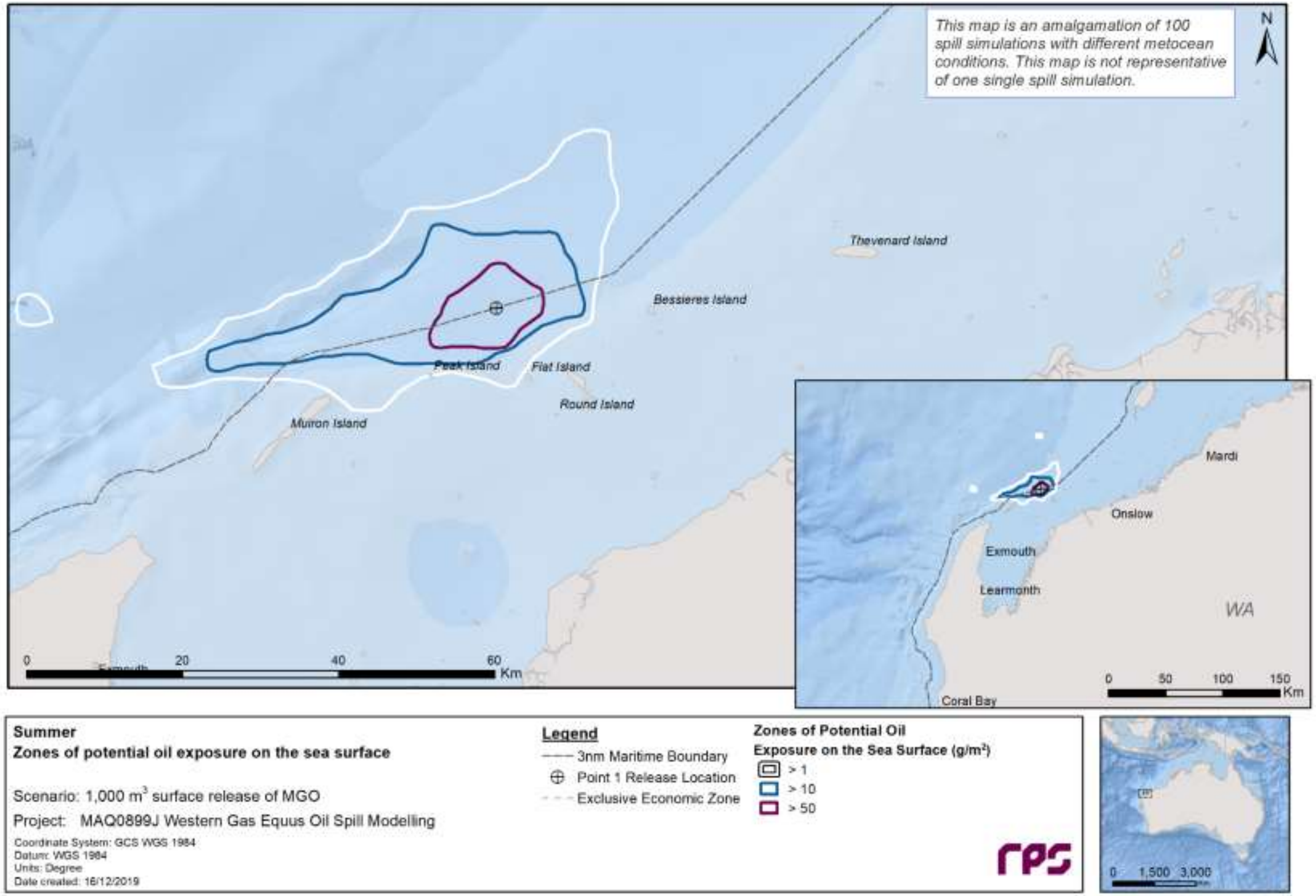


**Figure 12.1 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

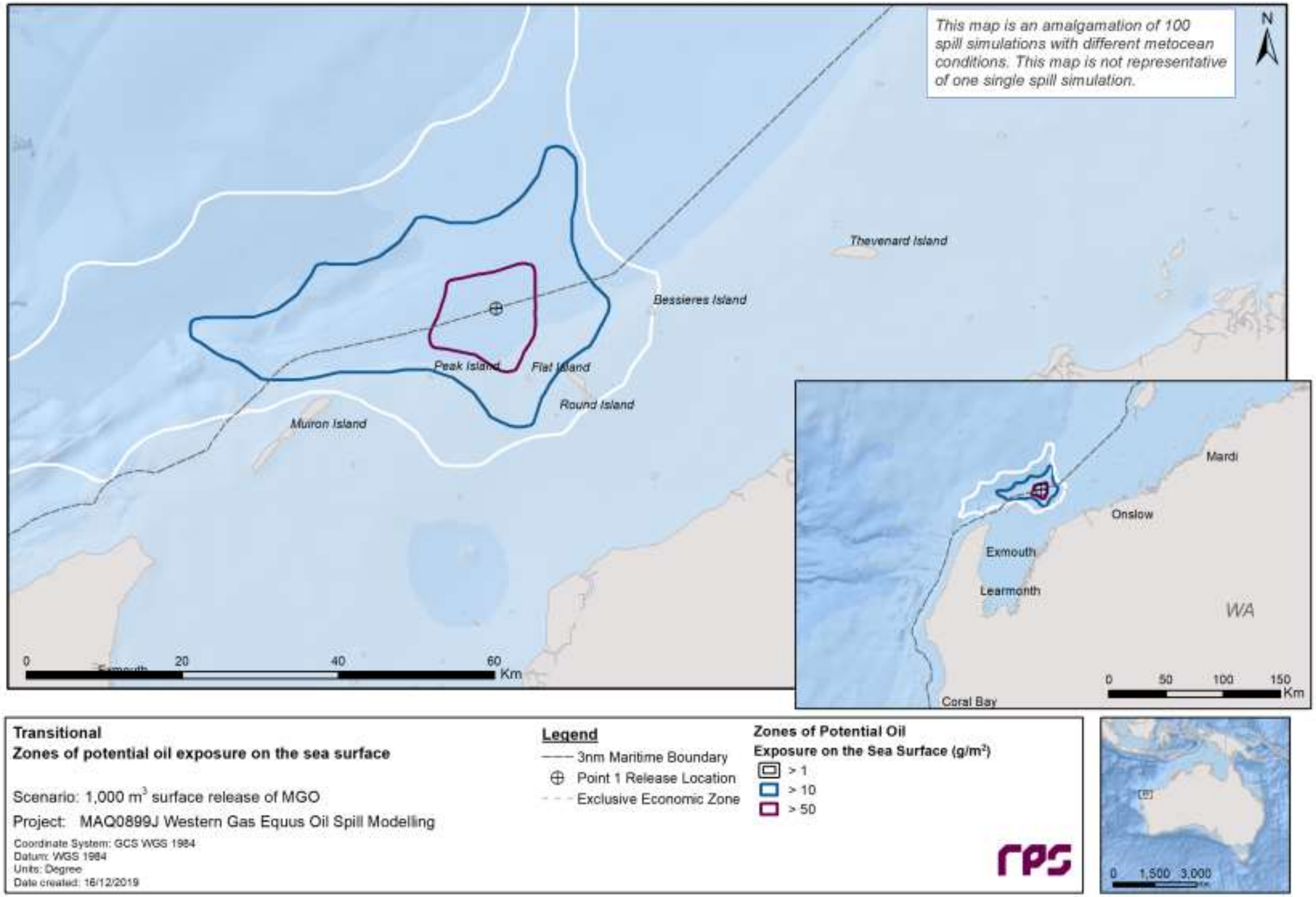


**Figure 12.2 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

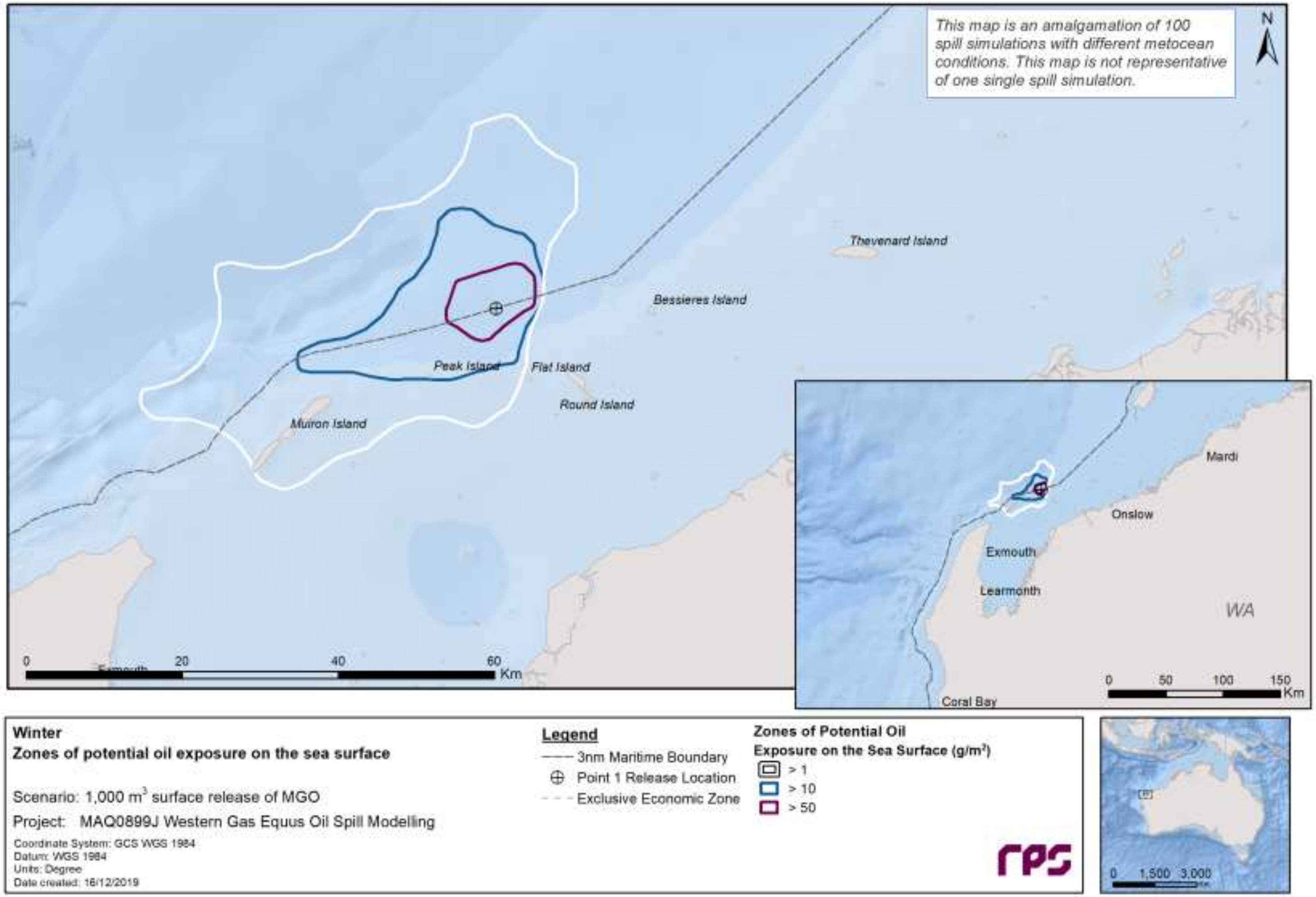


**Figure 12.3 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

#### 12.1.1.2 Shoreline Contact

Table 12.3 presents a summary of the predicted shoreline contact during summer, transitional and winter conditions. The probability of contact to any shoreline at, or above, the low threshold (≥ 10 g/m$^2$) was 3% in summer and winter, and 9% during transitional conditions. The minimum time before shoreline contact was approximately 0.4 days (~9 hours) during winter and the maximum volume of oil ashore was 147.8 m$^3$, recorded during transitional conditions.

Table 12.4 summarises the contact to nearby islands during summer, transitional and winter conditions. The probability of shoreline contact (at the low threshold) ranged from 1%, recorded by Peak Island in summer, Bessieres Island, Exmouth and Table Island in transitional conditions, to 6% at Flat Island during transitional conditions. The predicted minimum time before shoreline accumulation above the low threshold ranged from 0.38 days (~9 hours), recorded at Peak Island during winter, to 2.58 days (~62 hours) at Exmouth during transitional conditions.

The maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented for summer, winter and transitional conditions in Figure 12.4 to Figure 12.6.

**Table 12.3 Summary of oil contact across all shorelines. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Shoreline Statistics | Summer | Transitional | Winter |
|---|---|---|---|
| Probability of contact to any shoreline (%) | 3 | 9 | 3 |
| Absolute minimum time for oil to accumulate on the shoreline at **10 g/m$^2$** (days) | 0.88 | 0.50 | 0.38 |
| Maximum volume of hydrocarbons ashore (m$^3$) | 10.4 | 147.8 | 59.2 |
| Average volume of hydrocarbons ashore (m$^3$) | 3.8 | 45.0 | 22.4 |
| Maximum length of the shoreline at **10 g/m$^2$** (km) | 5.0 | 5.0 | 9.0 |
| Average shoreline length (km) at **10 g/m$^2$** (km) | 2.7 | 3.3 | 4.7 |
| Maximum length of the shoreline at **100 g/m$^2$** (km) | 4.0 | 5.0 | 7.0 |
| Average shoreline length (km) at **100 g/m$^2$** (km) | 4.0 | 2.4 | 3.3 |
| Maximum length of the shoreline at **1,000 g/m$^2$** (km) | - | 2.0 | 1.0 |
| Average shoreline length (km) at **1,000 g/m$^2$** (km) | - | 1.7 | 1.0 |

**Table 12.4 Summary of oil contact to nearby islands. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories.**

| Season | Shoreline receptor | 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 | Moderate | High | Low | Moderate | High | Mean | Peak | Mean | Peak | Low | Moderate | High | Low | Moderate | High |
| Summer | Exmouth | 2 | 1 | - | 2.29 | 2.46 | - | 104.9 | 326.7 | 3.6 | 10.4 | 3.5 | 4.0 | - | 5.0 | 4.0 | - |
| | Peak Island | 1 | - | - | 0.88 | - | - | 41.9 | 41.9 | <1 | <1 | 1.0 | - | - | 1.0 | - | - |
| Transitional | Bessieres Island | 1 | 1 | - | 1.54 | 1.63 | - | 242.5 | 287.5 | 0.9 | 8.2 | 3.0 | 3.0 | - | 3.0 | 3.0 | - |
| | Exmouth | 1 | 1 | - | 2.58 | 2.92 | - | 45.9 | 117.2 | 0.2 | 1.6 | 2.0 | 1.0 | - | 2.0 | 1.0 | - |
| | Flat Island | 6 | 6 | 4 | 0.54 | 0.63 | 0.67 | 1,807.2 | 9,756.2 | 40.5 | 147.8 | 2.5 | 2.2 | 1.5 | 3.0 | 3.0 | 2.0 |
| | Peak Island | 2 | 2 | - | 0.50 | 0.54 | - | 170.9 | 391.3 | 0.6 | 4.5 | 1.0 | 1.0 | - | 1.0 | 1.0 | - |
| | Round Island | 2 | 1 | 1 | 1.04 | 1.71 | 1.79 | 780.5 | 1,514.1 | 2.0 | 17.2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| | Serrurier Island | 2 | 1 | - | 2.29 | 2.38 | - | 94.5 | 273.1 | 0.8 | 6.4 | 2.5 | 2.0 | - | 4.0 | 2.0 | - |
| | Table Island | 1 | - | - | 2.29 | - | - | 97.6 | 97.6 | 0.1 | 1.1 | 1.0 | - | - | 1.0 | - | - |
| Winter | Murion Islands | 2 | 2 | - | 0.79 | 0.79 | - | 215.5 | 954.2 | 12.0 | 31.0 | 6.0 | 4.0 | - | 8.0 | 6.0 | - |
| | Peak Island | 2 | 2 | 1 | 0.38 | 0.38 | 0.42 | 1,367.6 | 2,479.0 | 10.4 | 28.3 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

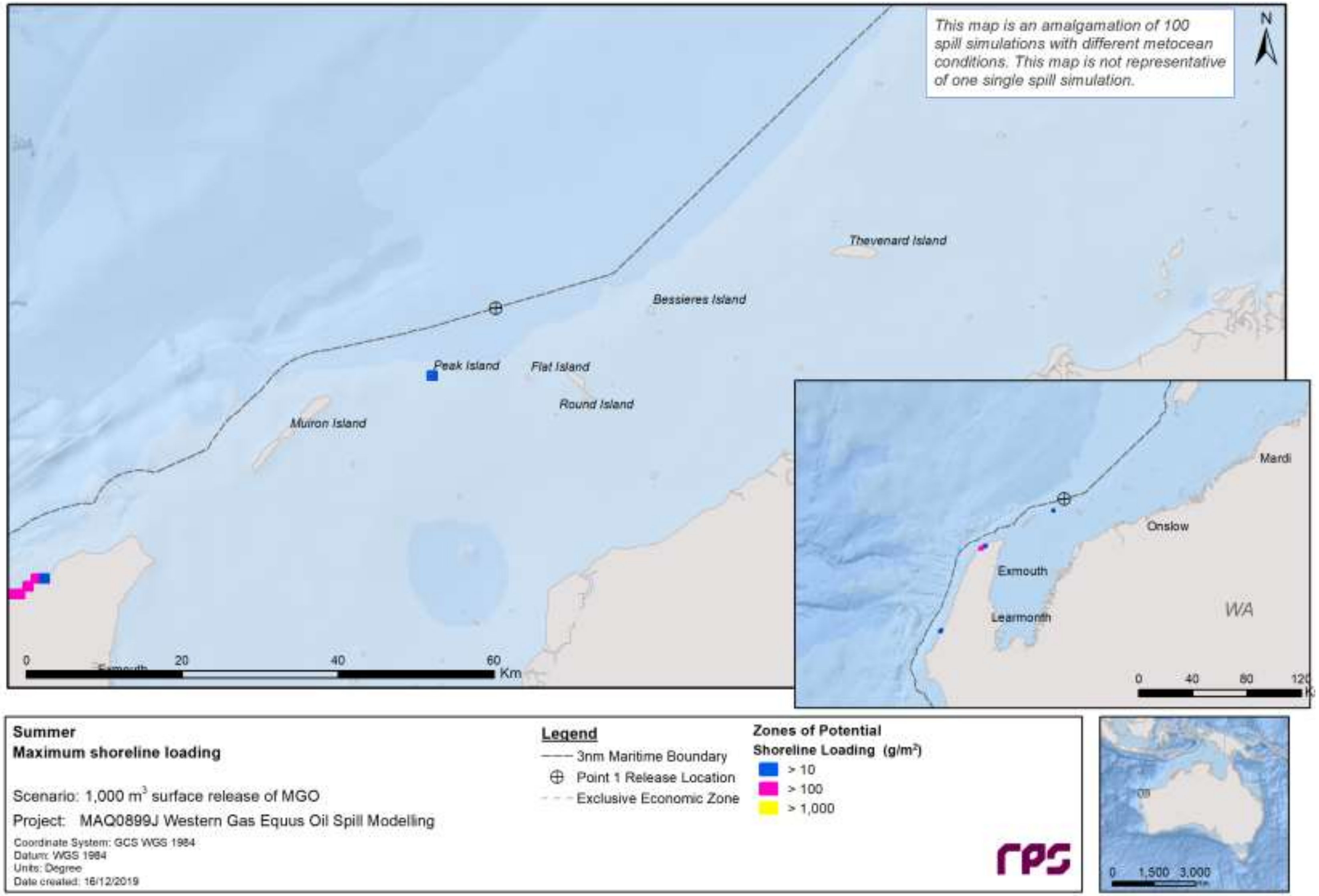


**Figure 12.4 Maximum potential shoreline loading in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during summer (September to March) conditions. The results were calculated from 100 spill trajectories.**

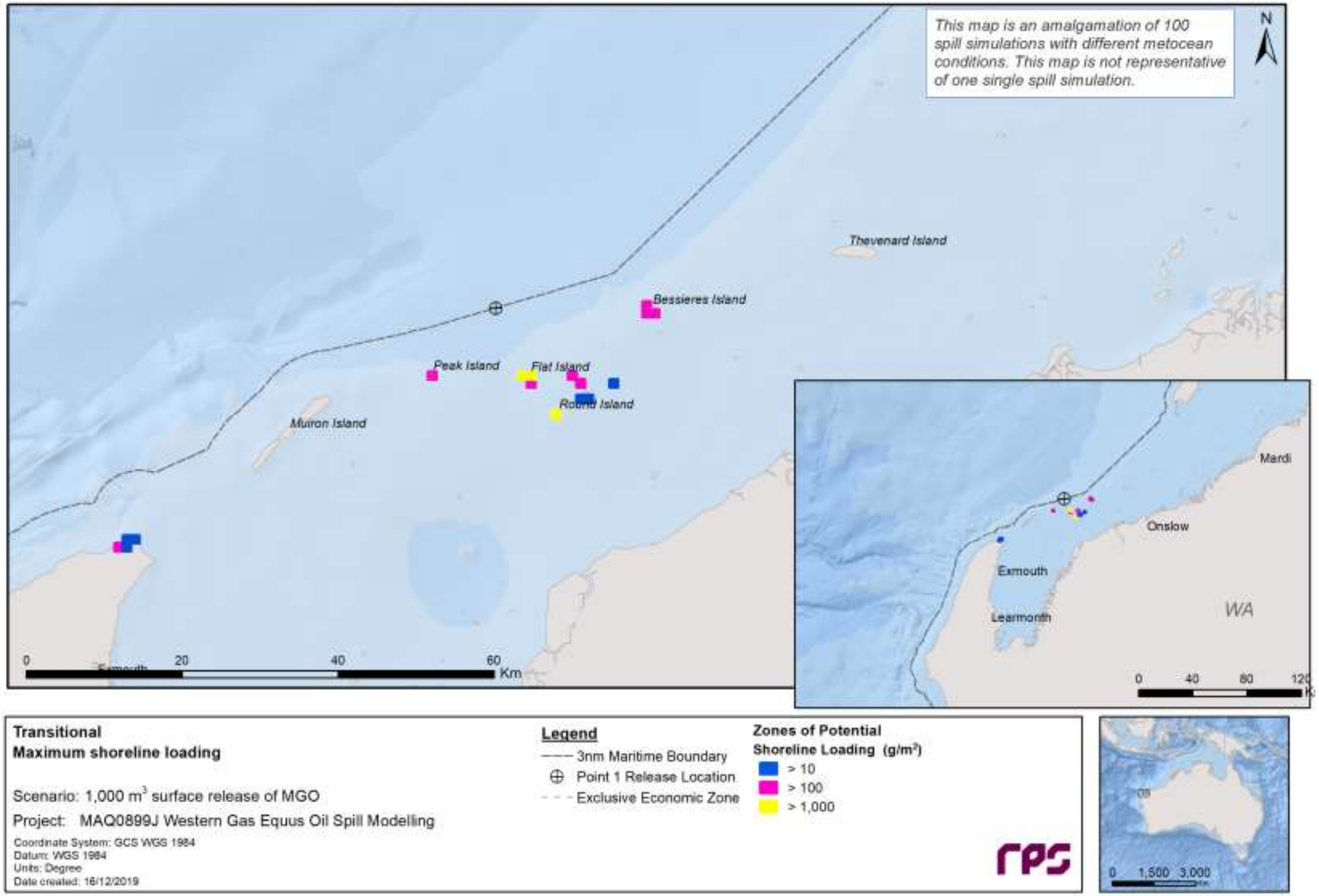


**Figure 12.5 Maximum potential shoreline loading in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during transitional (April and August) conditions. The results were calculated from 100 spill trajectories.**

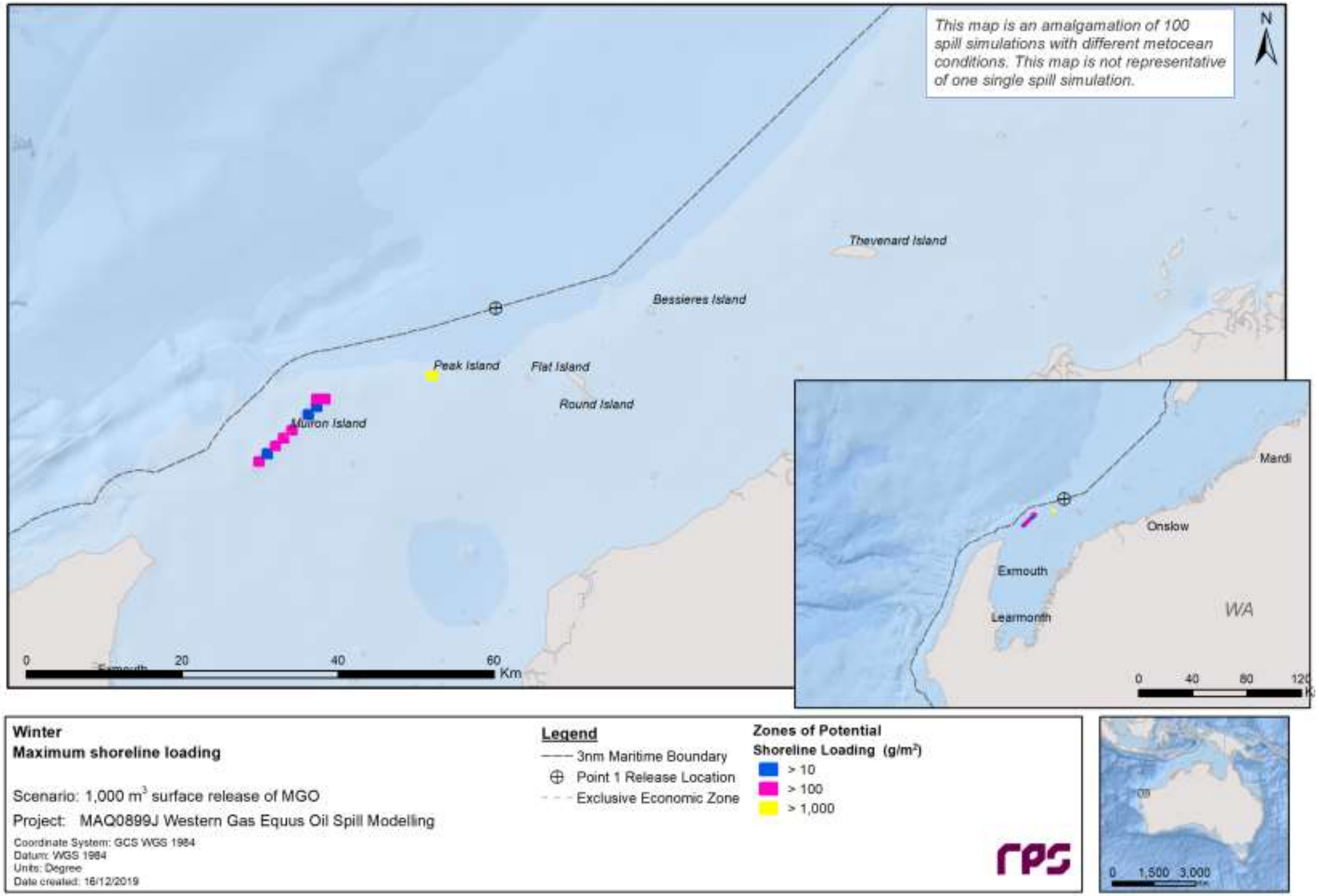


**Figure 12.6 Maximum potential shoreline loading in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during winter (May to July) conditions. The results were calculated from 100 spill trajectories.**

### 12.1.1.3 Water Column Exposure

#### 12.1.1.3.1 Dissolved Hydrocarbons

Table 12.5 summarises the maximum distance and direction from the release location to dissolved hydrocarbon exposure zones at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and moderate dissolved hydrocarbon exposure was 402.4 km (southwest) and 1.7 km (southwest), recorded during winter conditions, respectively. No dissolved hydrocarbon exposure was predicted at the high threshold.

Table 12.6 to Table 12.7 summarise the seasonal probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m, 10-20 m and 20-30 m depth layers, respectively, at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) exposure thresholds (NOPSEMA, 2019).

In the surface (0-10 m) depth layer, the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF were all predicted to be exposed at the low threshold during every season with probabilities of exposure ranging from 3% to 9% in summer, 4% to 13% during transitional conditions and 3% to 8% in winter. No receptors were predicted to be exposed at or above the moderate threshold.

The greatest probability of dissolved hydrocarbon exposure for the 10-20 m layer above the low threshold was predicted as 3%, recorded by the Ningaloo IMCRA during winter, the Ancient coastline at 125 m depth contour KEF during transitional conditions and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF during transitional and winter conditions. No receptors were predicted to be exposed at or above the moderate dissolved hydrocarbon threshold within this depth layer.

In the 20-30 m layer, the Ningaloo AMP, Ningaloo IMCRA and the Commonwealth waters adjacent to Ningaloo Reef KEF were the only receptors predicted to be exposed at the low dissolved hydrocarbon threshold, each recording a 1% probability of exposure during transitional conditions. No receptors were predicted to be exposed to dissolved hydrocarbons during summer and winter conditions.

Figure 12.7 to Figure 12.12 presents the zones of potential instantaneous dissolved hydrocarbon exposure for the 0-10 m and 10-20 m depth layers for the summer, transitional and winter periods, respectively.

**Table 12.5 Maximum distance and direction from the release location to dissolved hydrocarbon exposure (0 – 10m). Results are based on a 1,000 $m^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential dissolved hydrocarbon exposure | | |
|---|---|---|---|---|
| | | Low<br>6 ppb | Moderate<br>50 ppb | High<br>400 ppb |
| Summer | Maximum distance (km) from the release location | 161.9 | 1.5 | - |
| | Direction | NW | NNW | - |
| Transitional | Maximum distance (km) from the release location | 175.2 | 0.8 | - |
| | Direction | WSW | WNW | - |
| Winter | Maximum distance (km) from the release location | 402.4 | 1.7 | - |
| | Direction | SW | W | - |

**Table 12.6 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Maximum exposure to dissolved hydrocarbons (ppb) | Probability of exposure to dissolved hydrocarbons (%) | | |
|---|---|---|---|---|---|---|
| | | | | Low | Moderate | High |
| Summer | AMP | Gascoyne | 16 | 1 | - | - |
| | AMP | Ningaloo | 22 | 2 | - | - |
| | IBRA | Cape Range | 21 | 3 | - | - |
| | IMCRA | Ningaloo | 25 | 3 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 44 | 9 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 46 | 7 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 22 | 2 | - | - |
| | | Exmouth Plateau | 11 | 1 | - | - |
| | MMA | Muiron Islands | 31 | 5 | - | - |
| | MP | Ningaloo | 25 | 3 | - | - |
| | RSB | Ningaloo Reef | 22 | 2 | - | - |
| | Nearshore Waters | Exmouth | 21 | 3 | - | - |
| | | Murion Islands | 14 | 1 | - | - |
| | | Peak Island | 18 | 2 | - | - |
| Transitional | AMP | Gascoyne | 18 | 2 | - | - |
| | | Ningaloo | 28 | 4 | - | - |
| | IBRA | Cape Range | 27 | 2 | - | - |
| | IMCRA | Ningaloo | 28 | 4 | - | - |
| | | Pilbarra (nearshore) | 13 | 1 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 32 | 13 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 35 | 7 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 28 | 4 | - | - |
| | MMA | Muiron Islands | 19 | 4 | - | - |
| | MP | Ningaloo | 20 | 2 | - | - |
| | RSB | Ningaloo Reef | 20 | 1 | - | - |
| | Nearshore Waters | Exmouth | 27 | 2 | - | - |
| | | Murion Islands | 10 | 1 | - | - |
| | | Peak Island | 12 | 1 | - | - |
| Winter | AMP | Gascoyne | 19 | 3 | - | - |
| | | Ningaloo | 25 | 2 | - | - |
| | IBRA | Cape Range | 15 | 3 | - | - |
| | IMCRA | Ningaloo | 25 | 3 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 36 | 8 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 34 | 6 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 25 | 2 | - | - |

| Season | Receptor | | Maximum exposure to dissolved hydrocarbons (ppb) | Probability of exposure to dissolved hydrocarbons (%) | | |
|---|---|---|---|---|---|---|
| | | | | Low | Moderate | High |
| | MMA | Muiron Islands | 25 | 2 | - | - |
| | MP | Ningaloo | 25 | 2 | - | - |
| | RSB | Ningaloo Reef | 11 | 1 | - | - |
| | Nearshore Waters | Exmouth | 15 | 1 | - | - |
| | | Murion Islands | 11 | 1 | - | - |
| | | Peak Island | 13 | 3 | - | - |

**Table 12.7 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 10-20 m depth layer. Results are based on a 1,000 $m^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Maximum exposure to dissolved hydrocarbons (ppb) | Probability of exposure to dissolved hydrocarbons (%) | | |
|---|---|---|---|---|---|---|
| | | | | Low | Moderate | High |
| Summer | AMP | Gascoyne | 14 | 1 | - | - |
| | AMP | Ningaloo | 12 | 1 | - | - |
| | IBRA | Cape Range | 12 | 1 | - | - |
| | IMCRA | Ningaloo | 16 | 2 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 21 | 2 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 24 | 2 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 12 | 1 | - | - |
| | MMA | Muiron Islands | 16 | 1 | - | - |
| | MP | Ningaloo | 16 | 1 | - | - |
| | RSB | Ningaloo Reef | 12 | 1 | - | - |
| | Nearshore Waters | Exmouth | 12 | 1 | - | - |
| Transitional | AMP | Gascoyne | 14 | 1 | - | - |
| | | Ningaloo | 17 | 2 | - | - |
| | IBRA | Cape Range | 15 | 1 | - | - |
| | IMCRA | Ningaloo | 22 | 2 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 25 | 3 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 22 | 3 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 17 | 2 | - | - |
| | MMA | Muiron Islands | 11 | 1 | - | - |
| | MP | Ningaloo | 18 | 1 | - | - |
| | RSB | Ningaloo Reef | 13 | 1 | - | - |
| | Nearshore Waters | Exmouth | 15 | 1 | - | - |
| | | Murion Islands | 11 | 1 | - | - |
| Winter | AMP | Gascoyne | 16 | 1 | - | - |
| | | Ningaloo | 15 | 2 | - | - |
| | IMCRA | Ningaloo | 25 | 3 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 22 | 2 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 28 | 3 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 15 | 2 | - | - |
| | MMA | Muiron Islands | 23 | 1 | - | - |
| | MP | Ningaloo | 18 | 1 | - | - |

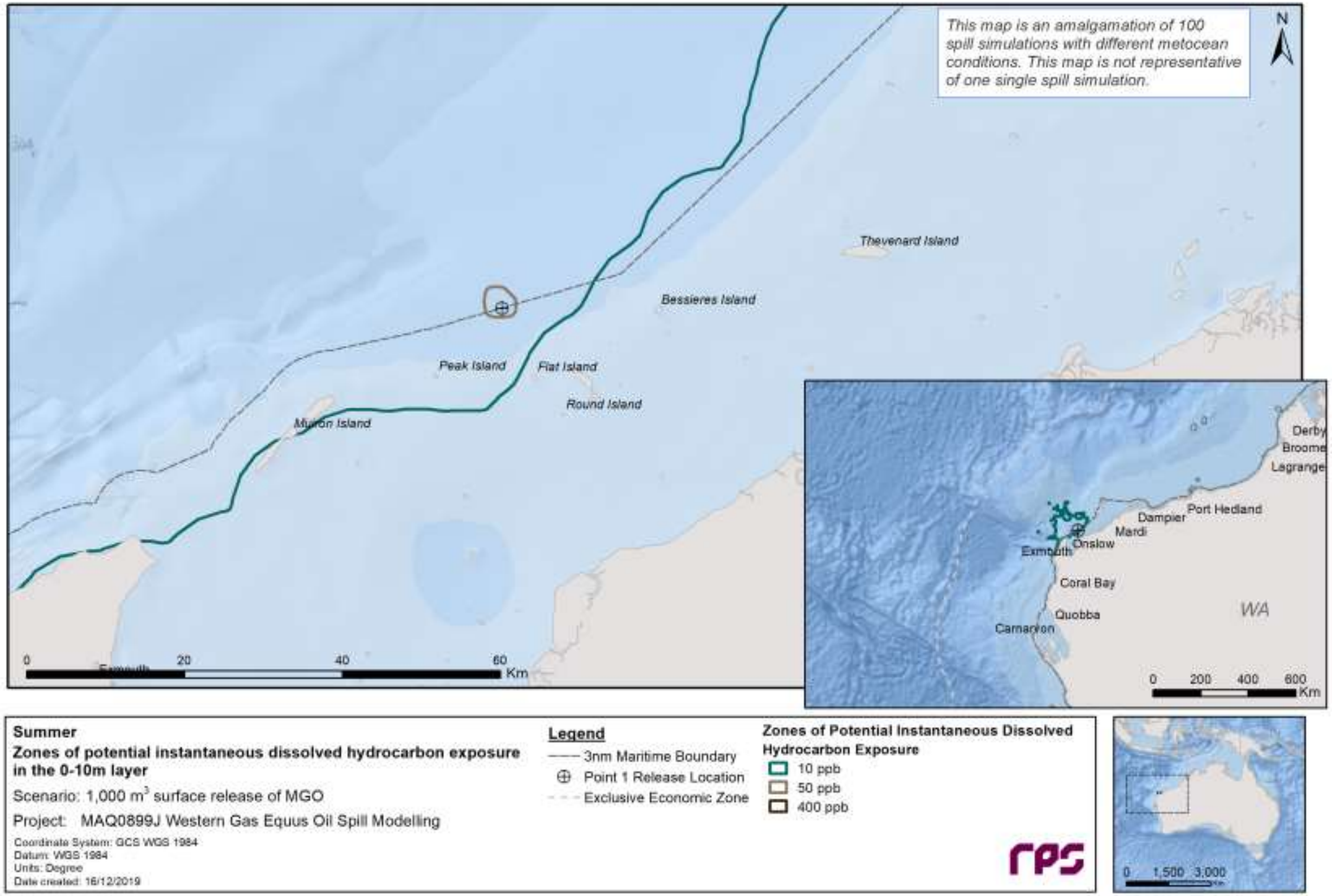


**Figure 12.7 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

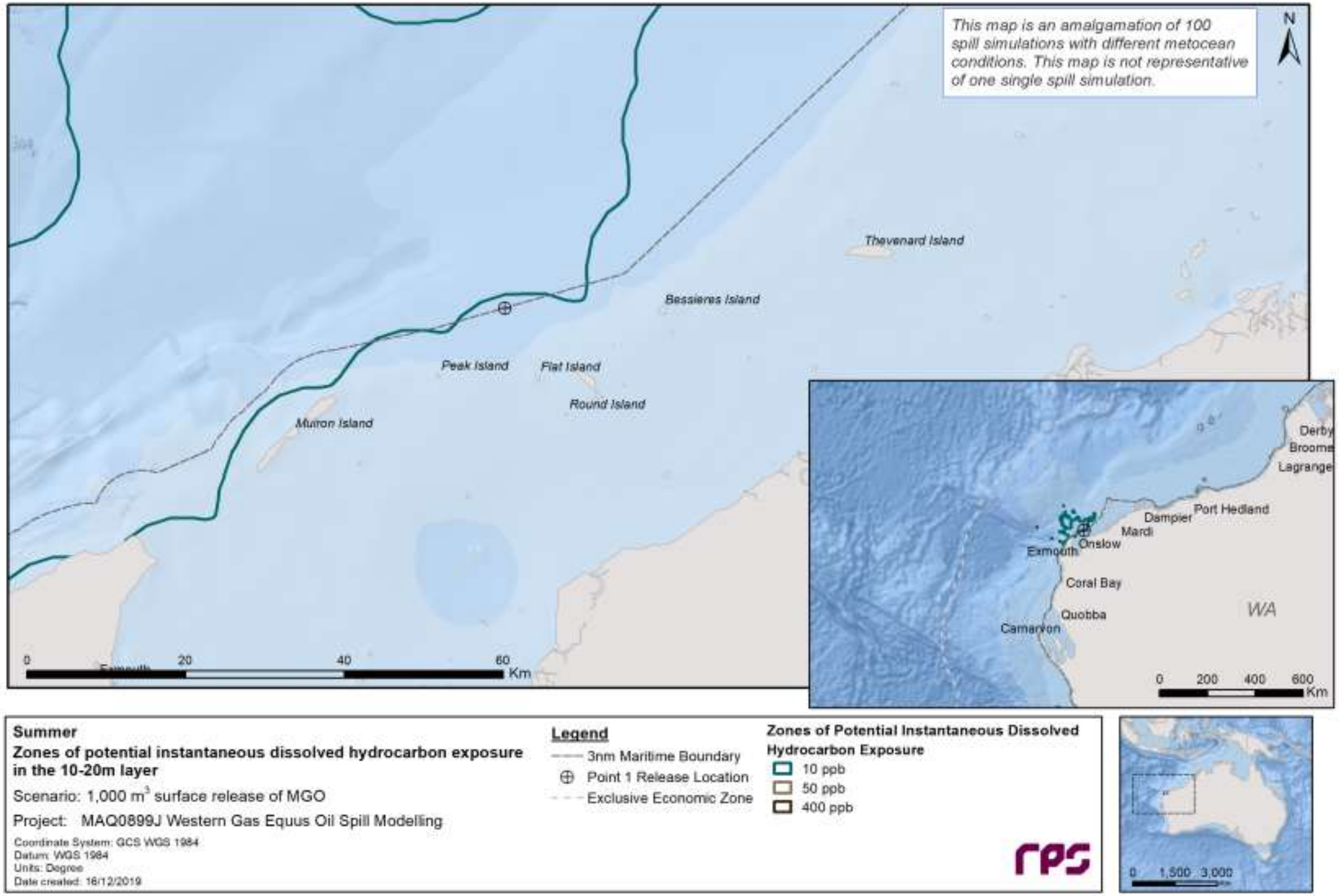


**Figure 12.8 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

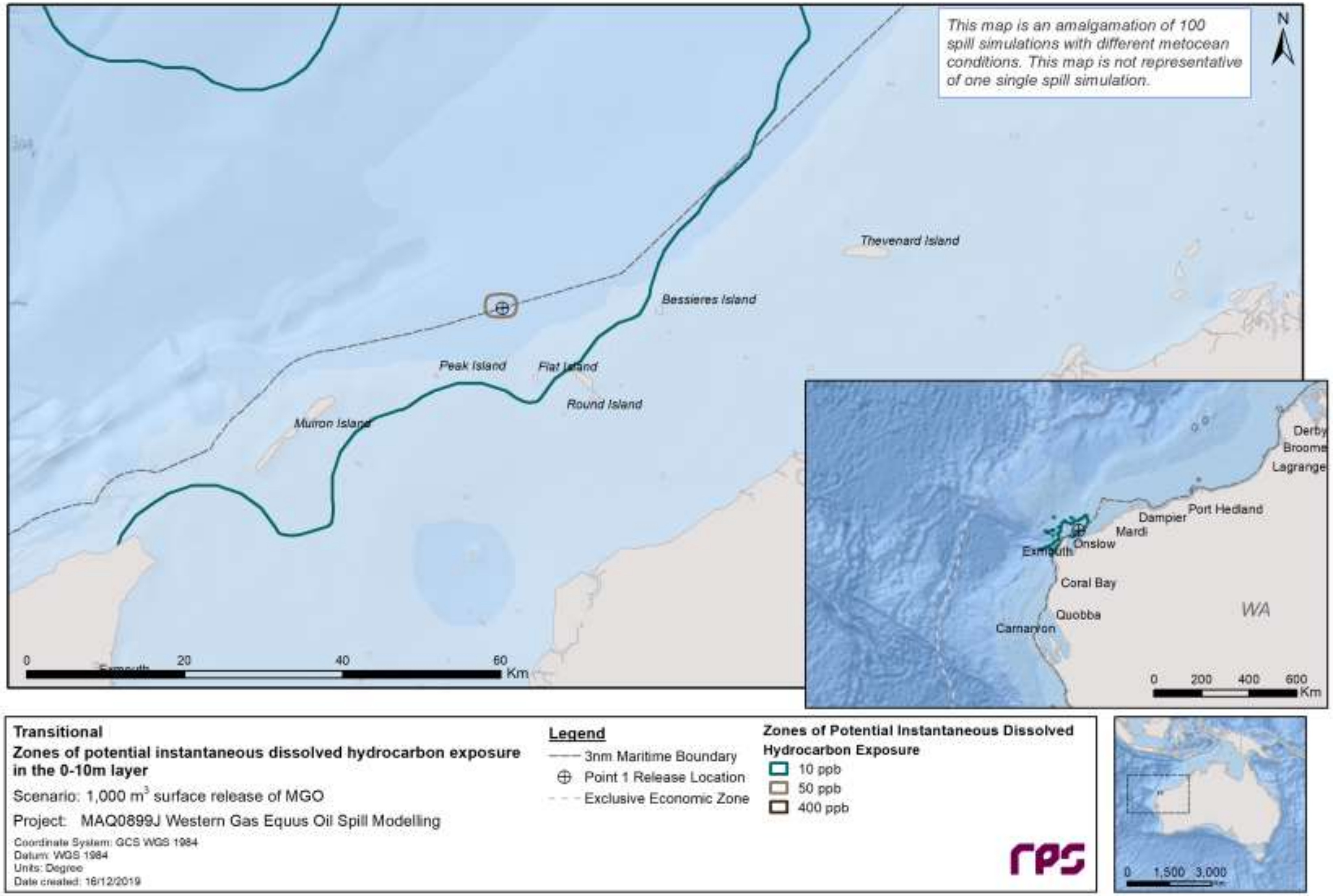


**Figure 12.9 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

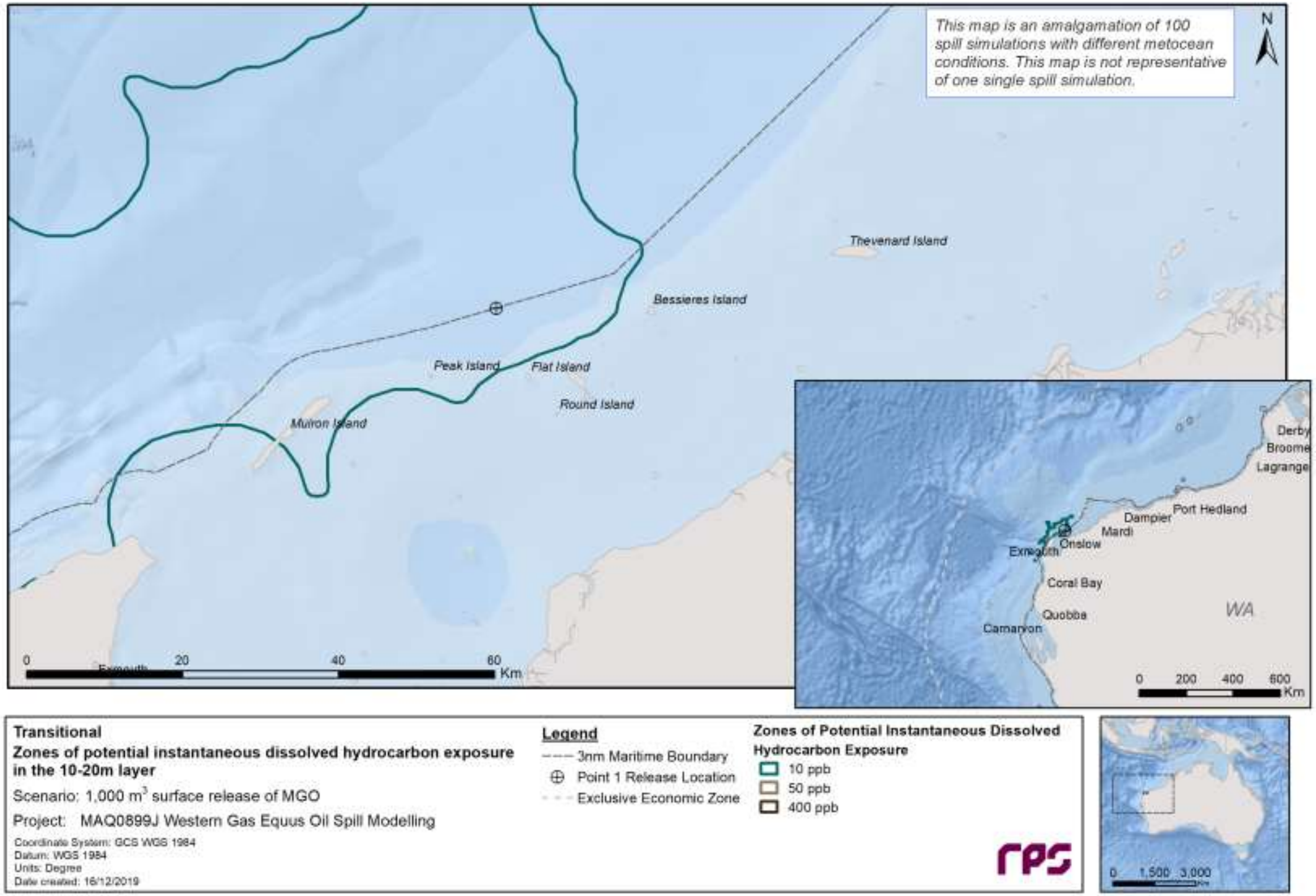


**Figure 12.10 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

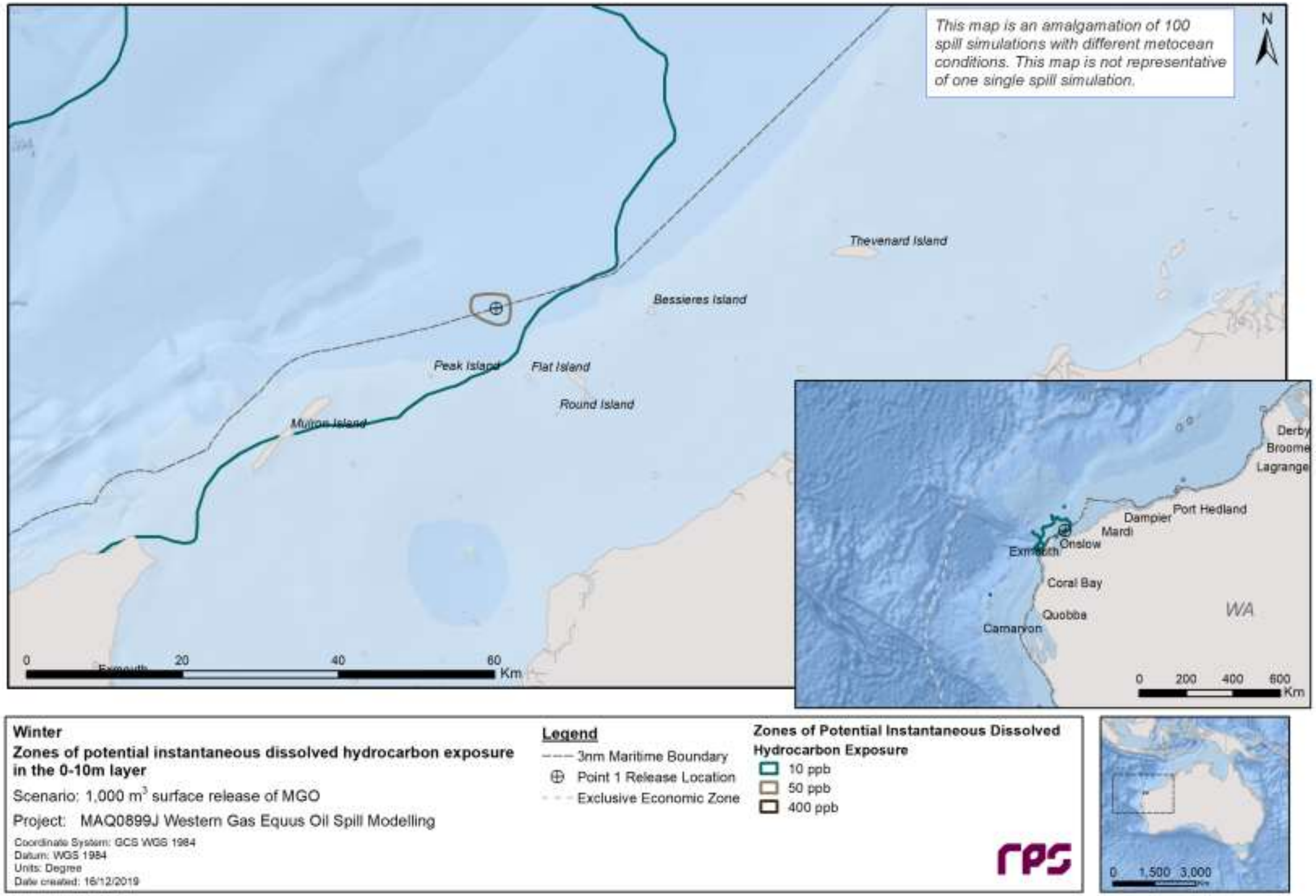


**Figure 12.11 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

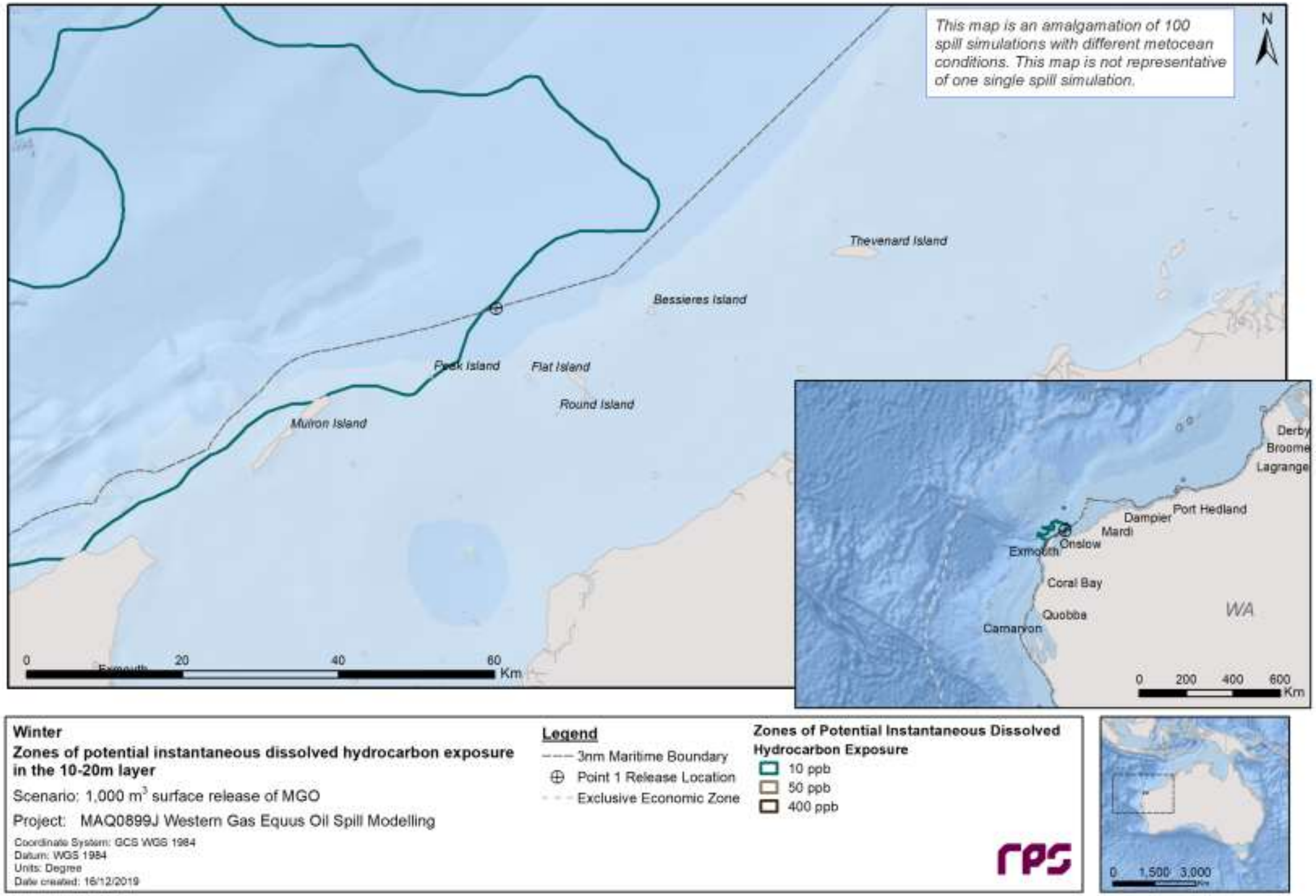


**Figure 12.12 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

#### 12.1.1.3.2 Entrained Hydrocarbons

Table 12.8 summarises the maximum distance and direction from the release location to entrained hydrocarbon exposure zones at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and high entrained hydrocarbon exposure was 824.3 km (south-southwest) and 367.3 km (west-southwest), recorded during winter conditions, respectively.

Table 12.9 to Table 12.11 summarise the probability of exposure to receptors from entrained hydrocarbons in the 0-10 m depth layer, in summer, transitional and winter conditions, at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds (NOPSEMA, 2019).

At the surface layer (0-10 m), the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF were predicted to be exposed at the low threshold with probabilities ranging from 53% to 58% in summer, 46% to 48% in transitional conditions and 51% to 52% in winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 42% at the Ancient coastline at 125 m depth contour KEF during summer while it also recorded 38% and 42% probabilities of high entrained hydrocarbon exposure during transitional and winter conditions.

Table 12.12 summarises the probability of exposure to receptors from entrained hydrocarbons in the 10-20 m depth layer, during all seasonal conditions and at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds.

The greatest probabilities of low exposure in the 10-20 m layer were recorded at the Ancient coastline at 125 m depth contour KEF during all seasons with predicted probabilities of 11%, 13% and 10% during summer, transitional and winter conditions, respectively. The Ningaloo IMCRA and the Canyons KEF were also predicted to be exposed at the low entrained hydrocarbon threshold, with probabilities of 3% and 8% during summer and transitional conditions, respectively, and 5% and 7% during winter. No receptors were predicted to be exposed at, or above the low entrained hydrocarbon threshold in the 20-30 m depth layer.

Figure 12.13 to Figure 12.18 illustrates the zones of potential entrained hydrocarbon exposure for the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon thresholds in the 0-10 m and 10-20 m depth layers in summer, transitional and winter conditions.

**Table 12.8 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential entrained hydrocarbon exposure | |
|---|---|---|---|
| | | Low<br>10 ppb | High<br>100 ppb |
| Summer | Maximum distance (km) from the release location | 727.5 | 288.2 |
| | Direction | WSW | NNW |
| Transitional | Maximum distance (km) from the release location | 625.5 | 337.0 |
| | Direction | NNE | SW |
| Winter | Maximum distance (km) from the release location | 824.3 | 367.3 |
| | Direction | SSW | WSW |

**Table 12.9 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, during summer (September to March) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 16 | 2 | - |
| | Carnarvon Canyon | 39 | 2 | - |
| | Gascoyne | 659 | 32 | 11 |
| | Montebello | 85 | 4 | - |
| | Ningaloo | 1,308 | 34 | 15 |
| | Shark Bay | 50 | 6 | - |
| IBRA | Cape Range | 1,729 | 20 | 11 |
| IMCRA | Ningaloo | 1,326 | 53 | 29 |
| | Northwest Shelf | 43 | 4 | - |
| | Pilbarra (nearshore) | 573 | 8 | 5 |
| | Zuytdorp | 50 | 6 | - |
| KEF | Ancient coastline at 125 m depth contour | 3,338 | 58 | 42 |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 2,738 | 57 | 35 |
| | Commonwealth waters adjacent to Ningaloo Reef | 1,308 | 34 | 15 |
| | Exmouth Plateau | 297 | 16 | 5 |
| | Glomar Shoals | 32 | 2 | - |
| | Wallaby Saddle | 15 | 2 | - |
| | Western demersal slope and associated fish communities | 28 | 1 | - |
| MMA | Barrow Island | 36 | 2 | - |
| | Muiron Islands | 1,960 | 35 | 24 |
| MP | Montebello Islands | 61 | 2 | - |
| | Ningaloo | 1,223 | 23 | 13 |
| RSB | Baylis Patches | 23 | 1 | - |
| | Beryl Reef | 26 | 2 | - |
| | Locker Reef | 27 | 1 | - |
| | Montebello Shoals | 28 | 2 | - |
| | Ningaloo Reef | 1,118 | 13 | 7 |
| | Pearl Reef | 11 | 1 | - |
| | Penguin Bank | 20 | 1 | - |
| | Rankin Bank | 17 | 1 | - |
| | Tryal Rocks | 31 | 3 | - |
| Nearshore Waters | Bessieres Island | 11 | 1 | - |
| | Exmouth | 1,077 | 13 | 7 |
| | Flat Island | 261 | 6 | 1 |
| | Fly Island | 52 | 1 | - |
| | Hermite Island | 22 | 2 | - |
| | Locker Island | 19 | 1 | - |
| | Murion Islands | 768 | 20 | 8 |
| | Observation Island | 98 | 4 | - |

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| | Peak Island | 1,734 | 17 | 11 |
| | Round Island | 42 | 2 | - |
| | Serrurier Island | 68 | 4 | - |
| | Sunday Island | 122 | 6 | 1 |
| | Table Island | 22 | 3 | - |

**Table 12.10 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, during transitional (April and August) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 13 | 1 | - |
| | Argo-Rowley Terrace | 12 | 2 | - |
| | Carnarvon Canyon | 19 | 2 | - |
| | Gascoyne | 646 | 31 | 9 |
| | Montebello | 11 | 1 | - |
| | Ningaloo | 1,563 | 41 | 24 |
| | Shark Bay | 25 | 3 | - |
| IBRA | Cape Range | 1,119 | 21 | 12 |
| IMCRA | Ningaloo | 1,549 | 46 | 27 |
| | Northwest Shelf | 32 | 2 | - |
| | Pilbarra (nearshore) | 527 | 7 | 4 |
| | Zuytdorp | 25 | 5 | - |
| KEF | Ancient coastline at 125 m depth contour | 3,825 | 48 | 38 |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 2,575 | 48 | 31 |
| | Commonwealth waters adjacent to Ningaloo Reef | 1,563 | 41 | 24 |
| | Exmouth Plateau | 143 | 16 | 2 |
| | Wallaby Saddle | 11 | 1 | - |
| | Western demersal slope and associated fish communities | 12 | 1 | - |
| MMA | Muiron Islands | 2,686 | 36 | 28 |
| MP | Ningaloo | 1,502 | 28 | 13 |
| RSB | Brewis Reef | 12 | 1 | - |
| | Ningaloo Reef | 860 | 18 | 10 |
| Nearshore Waters | Bessieres Island | 274 | 5 | 1 |
| | Exmouth | 897 | 15 | 8 |
| | Flat Island | 931 | 8 | 5 |
| | Murion Islands | 957 | 20 | 10 |
| | Observation Island | 39 | 2 | - |
| | Peak Island | 1,119 | 21 | 12 |

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| | Round Island | 180 | 5 | 2 |
| | Serrurier Island | 201 | 7 | 2 |
| | Sunday Island | 324 | 2 | 2 |
| | Table Island | 99 | 5 | - |
| | Tortoise Island | 19 | 3 | - |

**Table 12.11 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, during winter (May to July) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 15 | 3 | - |
| | Carnarvon Canyon | 61 | 7 | - |
| | Gascoyne | 987 | 47 | 22 |
| | Montebello | 20 | 1 | - |
| | Ningaloo | 1,233 | 43 | 23 |
| | Shark Bay | 23 | 5 | - |
| IBRA | Cape Range | 1,505 | 25 | 15 |
| IMCRA | Ningaloo | 1,632 | 52 | 30 |
| | Northwest Shelf | 25 | 1 | - |
| | Pilbarra (nearshore) | 361 | 9 | 5 |
| | Zuytdorp | 26 | 5 | - |
| KEF | Ancient coastline at 125 m depth contour | 3,641 | 51 | 40 |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 2,504 | 51 | 32 |
| | Commonwealth waters adjacent to Ningaloo Reef | 1,233 | 44 | 23 |
| | Exmouth Plateau | 175 | 15 | 3 |
| | Perth Canyon and adjacent shelf break, and other west coast canyons | 30 | 1 | - |
| | Perth Canyon and adjacent shelf break, and other west coast canyons | 30 | 1 | - |
| | Western demersal slope and associated fish communities | 36 | 3 | - |
| MMA | Muiron Islands | 1,632 | 52 | 41 |
| MP | Ningaloo | 860 | 28 | 18 |
| RSB | Ningaloo Reef | 599 | 17 | 5 |
| Nearshore Waters | Exmouth | 607 | 16 | 5 |
| | Flat Island | 32 | 1 | - |
| | Murion Islands | 902 | 25 | 14 |
| | Peak Island | 1,505 | 20 | 15 |
| | Sunday Island | 136 | 4 | 1 |

**Table 12.12 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 10-20 m depth layer for each season. Results are based on a 1,000 $m^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days.**

| Season | Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|---|
| | | | | Low | High |
| Summer | AMP | Ningaloo | 17 | 3 | - |
| | IBRA | Cape Range | 13 | 1 | - |
| | IMCRA | Ningaloo | 21 | 3 | - |
| | KEF | Ancient coastline at 125 m depth contour | 31 | 11 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 31 | 8 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 17 | 2 | - |
| | MMA | Muiron Islands | 21 | 5 | - |
| | MP | Ningaloo | 18 | 2 | - |
| | RSB | Ningaloo Reef | 13 | 1 | - |
| | Nearshore Waters | Exmouth | 15 | 1 | - |
| | | Murion Islands | 10 | 1 | - |
| | | Peak Island | 13 | 1 | - |
| Transitional | AMP | Gascoyne | 15 | 1 | - |
| | | Ningaloo | 15 | 2 | - |
| | IBRA | Cape Range | 14 | 1 | - |
| | IMCRA | Ningaloo | 18 | 3 | - |
| | KEF | Ancient coastline at 125 m depth contour | 28 | 13 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 21 | 8 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 15 | 2 | - |
| | MMA | Muiron Islands | 20 | 5 | - |
| | MP | Ningaloo | 15 | 1 | - |
| | RSB | Ningaloo Reef | 10 | 1 | - |
| | Nearshore Waters | Exmouth | 14 | 1 | - |
| Winter | AMP | Gascoyne | 16 | 1 | - |
| | | Ningaloo | 17 | 3 | - |
| | IBRA | Cape Range | 17 | 2 | - |
| | IMCRA | Ningaloo | 22 | 5 | - |
| | KEF | Ancient coastline at 125 m depth contour | 26 | 10 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 23 | 7 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 17 | 3 | - |
| | MMA | Muiron Islands | 18 | 10 | - |
| | MP | Ningaloo | 14 | 2 | - |
| | RSB | Ningaloo Reef | 10 | 1 | - |
| | Nearshore Waters | Exmouth | 11 | 1 | - |
| | | Murion Islands | 12 | 1 | - |
| | | Peak Island | 17 | 2 | - |

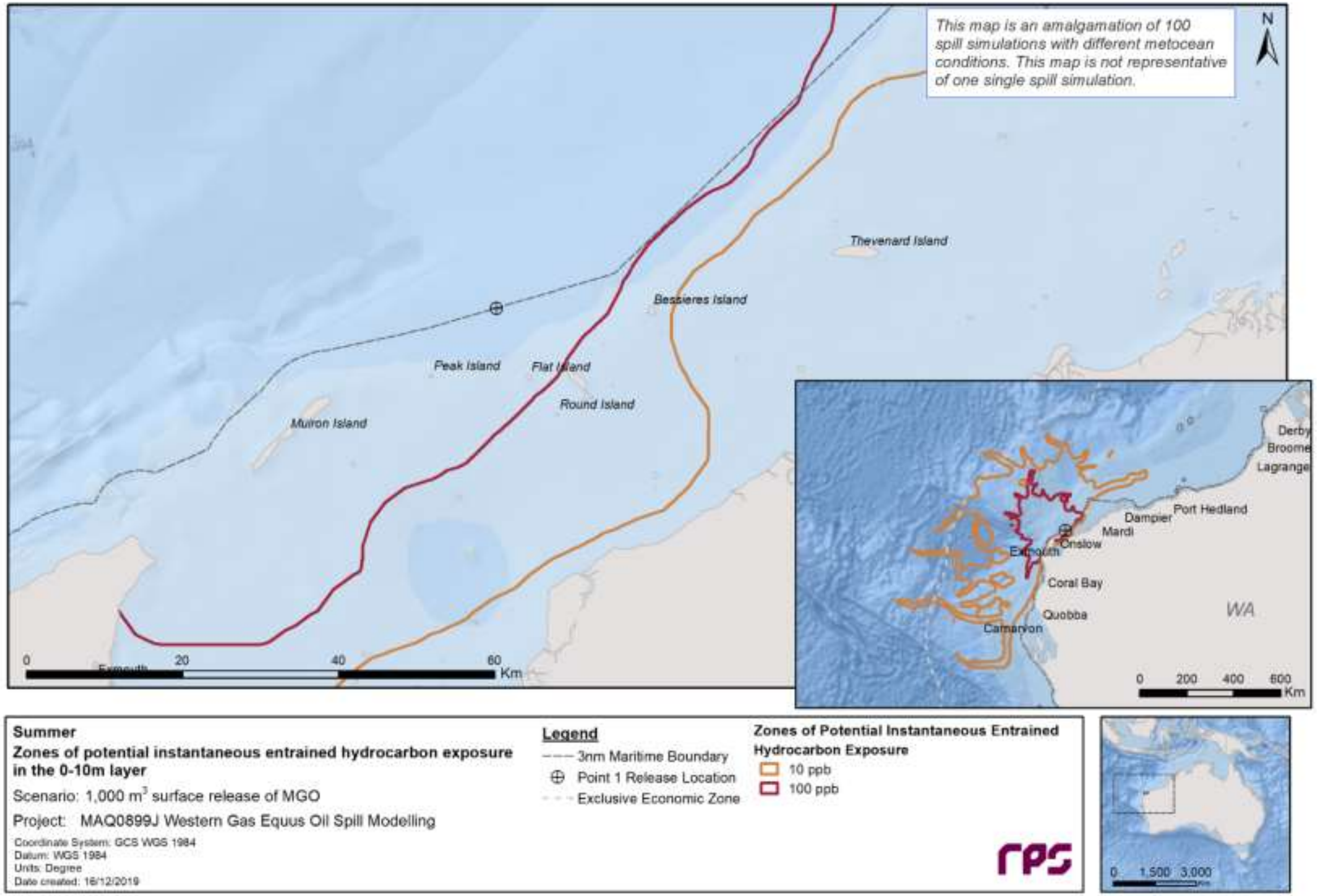


**Figure 12.13 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

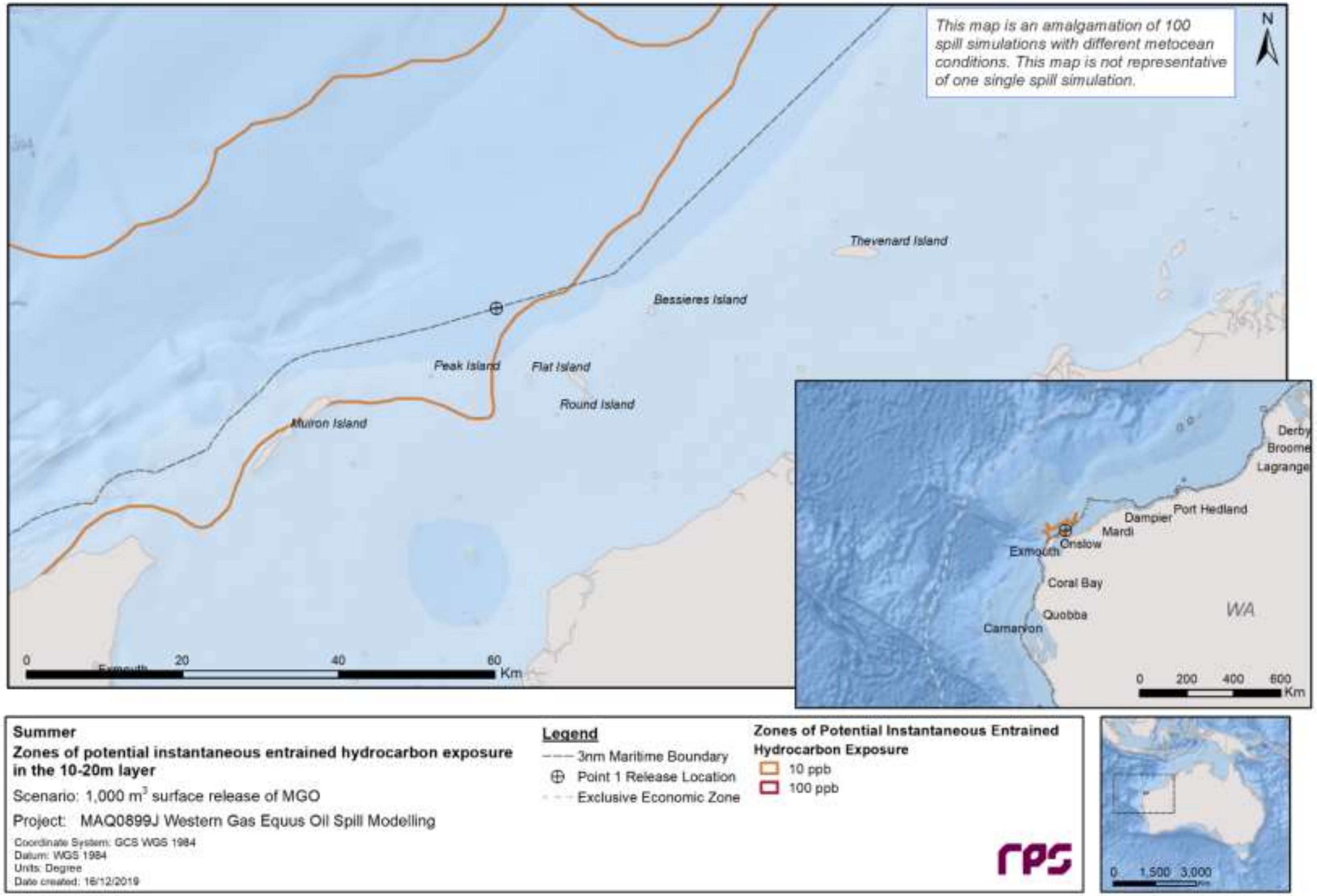


**Figure 12.14 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

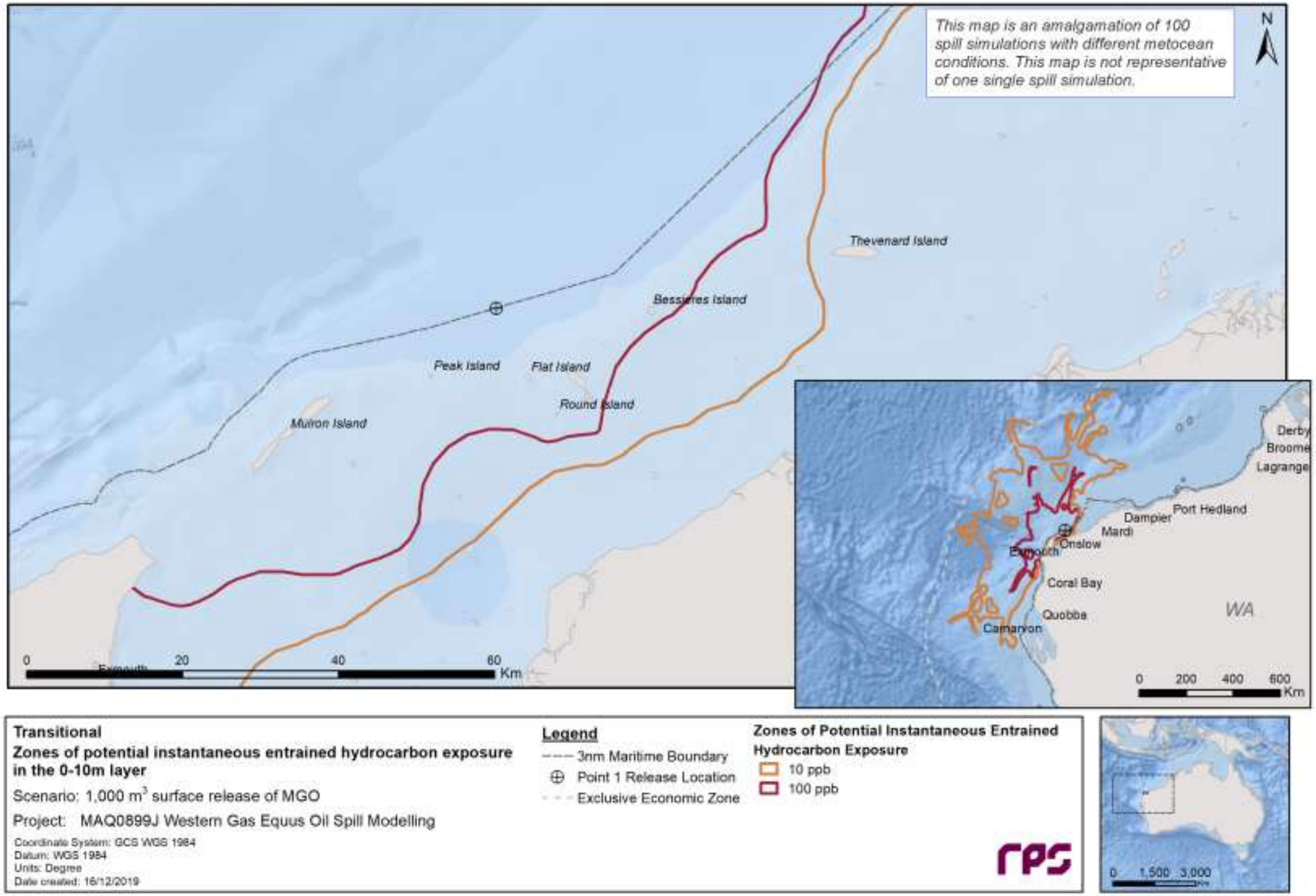


**Figure 12.15 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

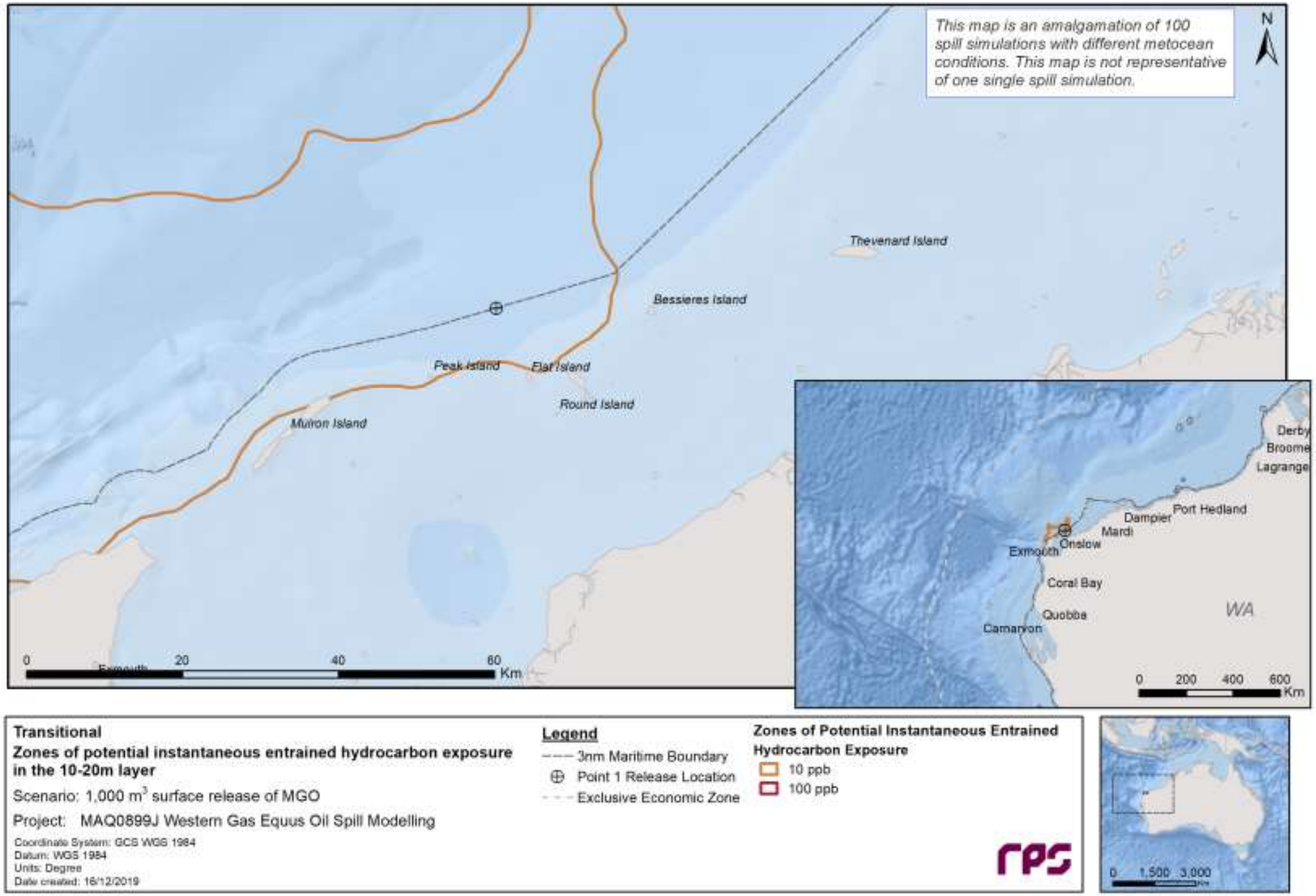


**Figure 12.16 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

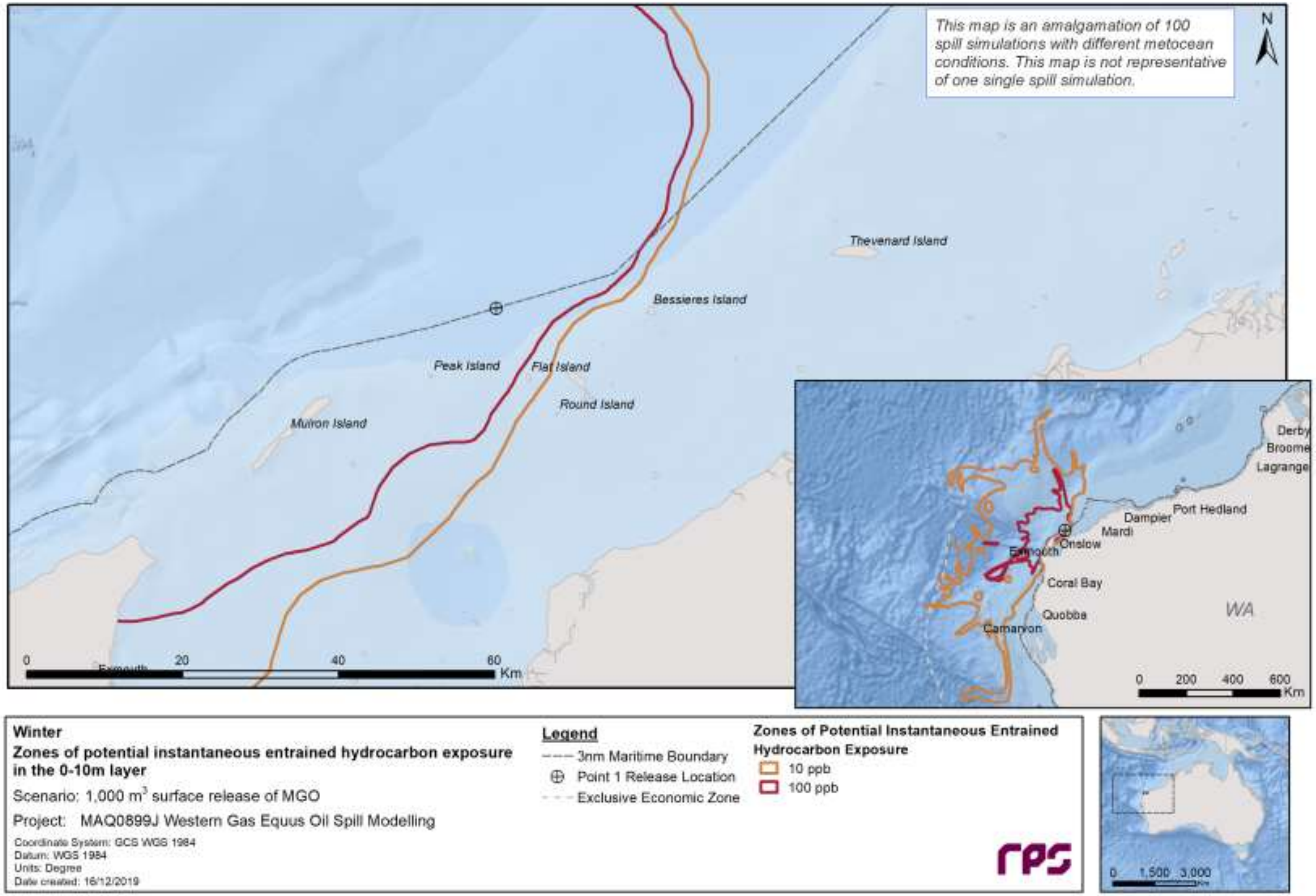


**Figure 12.17 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

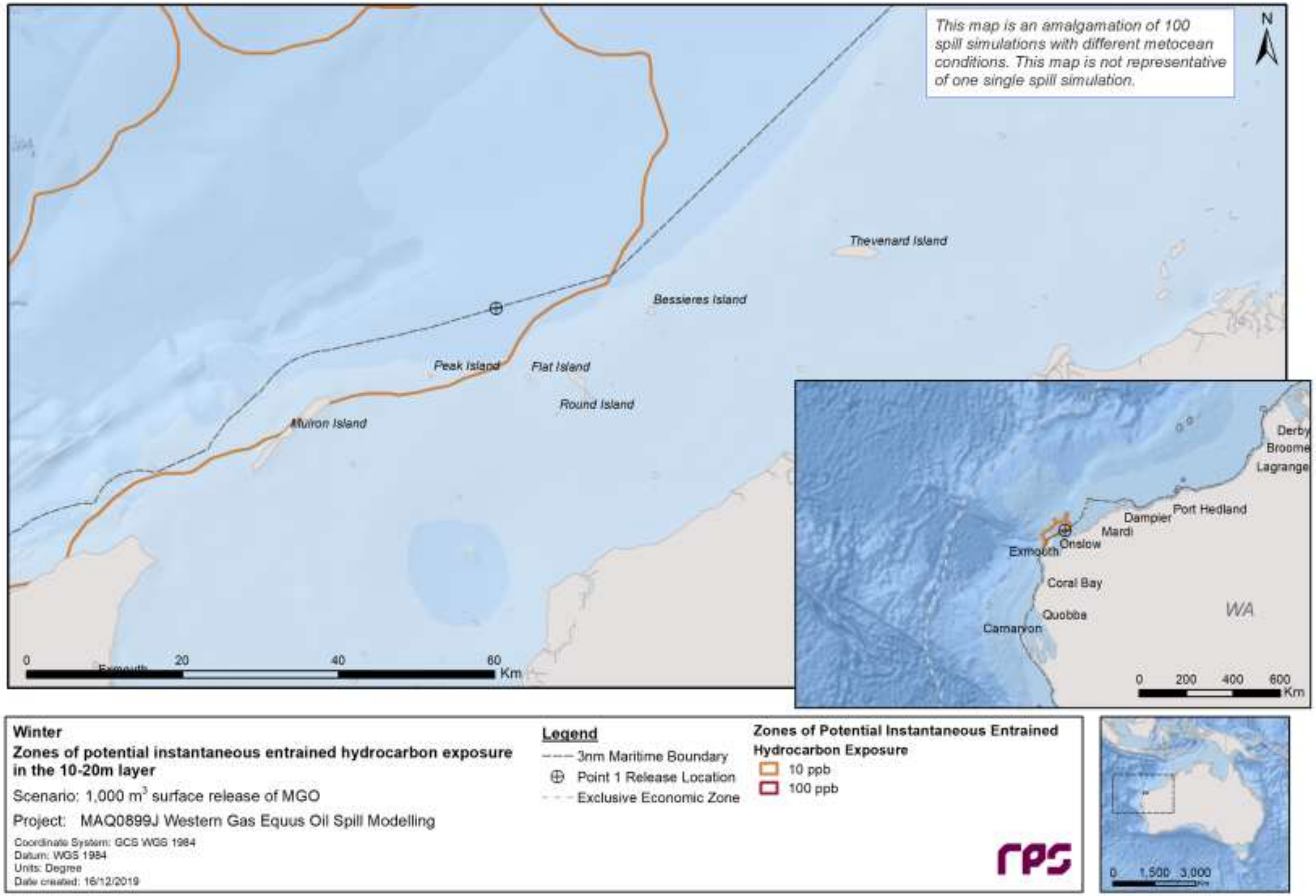


**Figure 12.18 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

## 12.1.2 Deterministic Trajectory

### 12.1.2.1 Deterministic Cases: Largest volume of oil ashore

The simulation that resulted in the largest volume of oil ashore was identified in transitional conditions, as run number 86, which commenced at 6 pm on the 24th of April 2014.

Zones of oil exposure on the sea surface (swept area) and shoreline loading over the entire simulation (40 days) is presented in Figure 12.19. The spill was predicted to travel south from the release location towards Flat Island where shoreline contact was predicted 18 hours after the spill started.

Figure 12.20 displays the area of exposure at low (1 g/m$^2$) and actionable (10 g/m$^2$) surface oil thresholds, and length of oil contact to shorelines at the actionable threshold (100 g/m$^2$). The maximum area of coverage of visible oil on the sea surface was predicted to occur 12 hours after the spill commenced and covered approximately 14 km$^2$. The maximum area of actionable sea surface oil above 10 g/m$^2$ at any given time was predicted as 6 km$^2$.The maximum length of shoreline above the actionable oil threshold was predicted as 3 km on day 1 of the simulation. Figure 12.21 is a time series of the mass on shore at the low (10 g/m$^2$), moderate (100 g/m$^2$) and high (1,000 g/m$^2$) thresholds.

Figure 12.22 presents the fates and weathering graph for the corresponding single spill trajectory. At the conclusion of the simulation period (day-40), approximately 755 m$^3$ (76%) spilled oil was lost to the atmosphere through evaporation. Approximately 81 m$^3$ (8%) of the oil was predicted to have decayed, while approximately 23 m$^3$ (2%) was predicted to remain within the water column and 141 m$^3$ (13%) was predicted to arrive ashore.

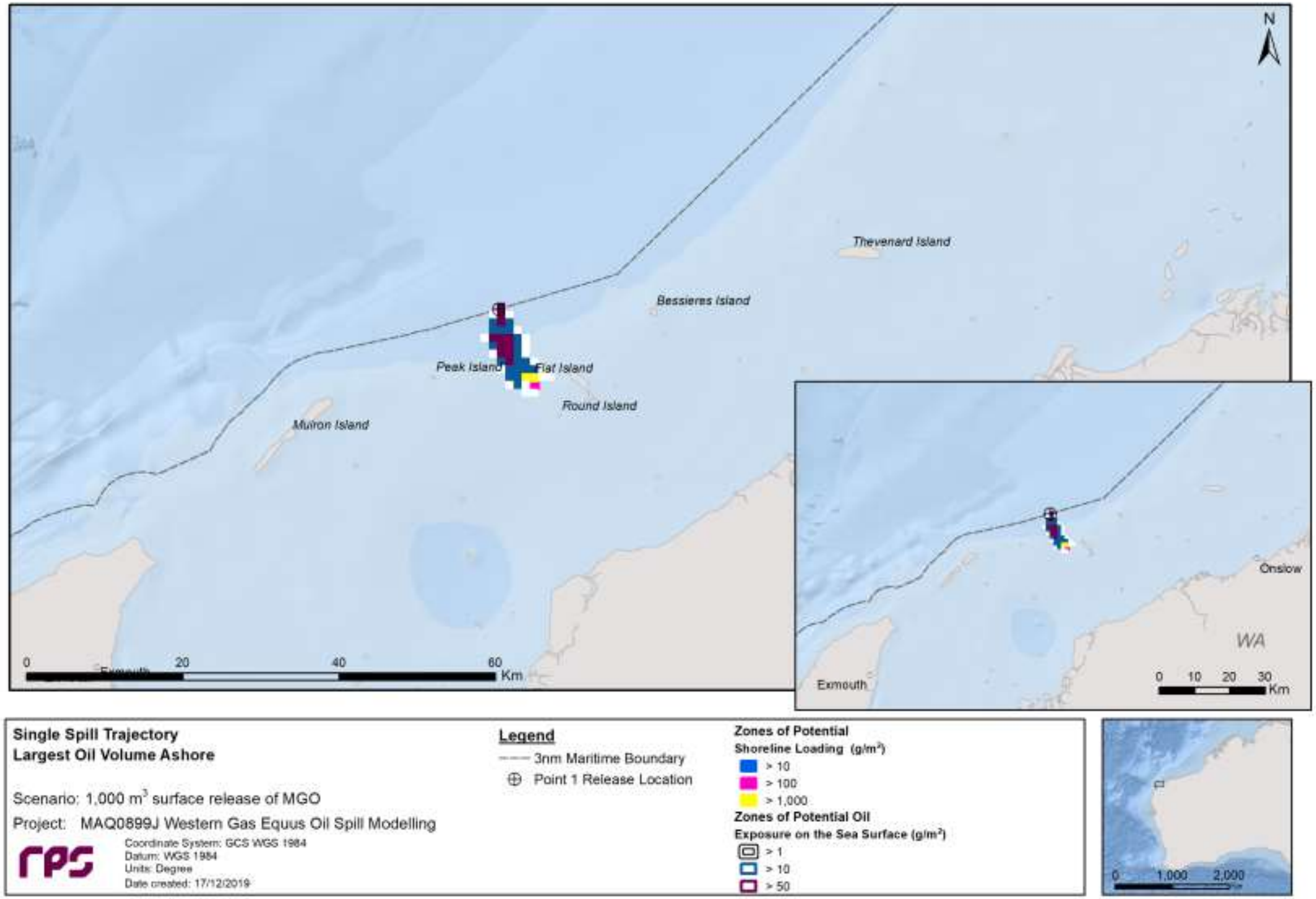


**Figure 12.19 Zones of oil exposure on the sea surface (swept area) and shoreline loading over the entire simulation (40 days), for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, commencing at 6 pm on the 24$^{th}$ of April 2014.**

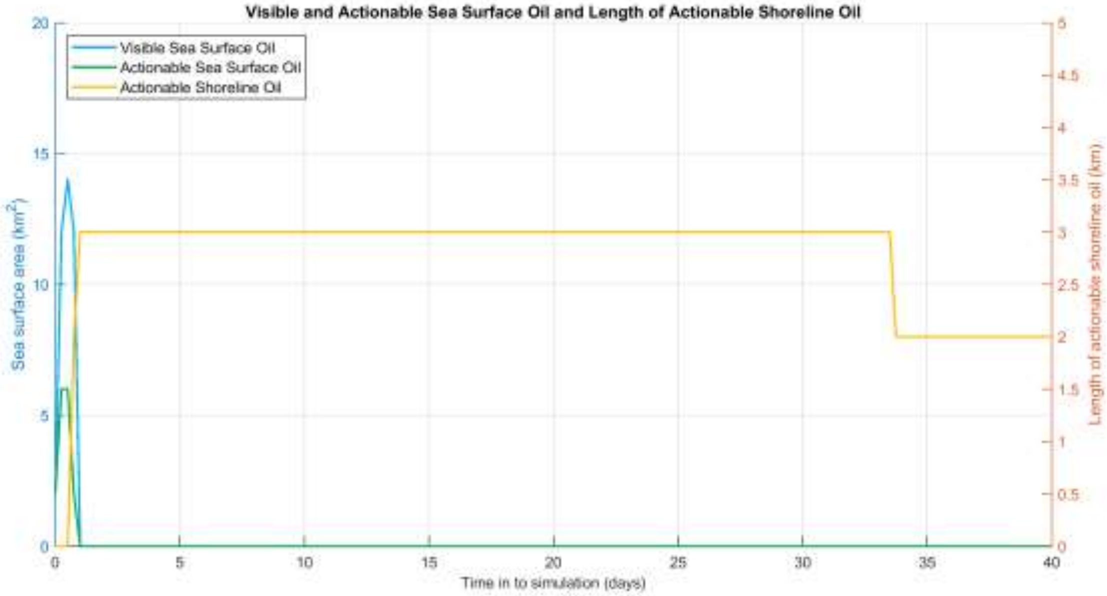


**Figure 12.20 Area of exposure at low (1 g/m$^2$) and actionable (10 g/m$^2$) surface oil thresholds and length of oil contact to shorelines at the actionable threshold (100 g/m$^2$); for the simulation identified to result in the largest volume of oil ashore from Point 1. Results are based on 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, 6 pm on the 24th of April 2014.**

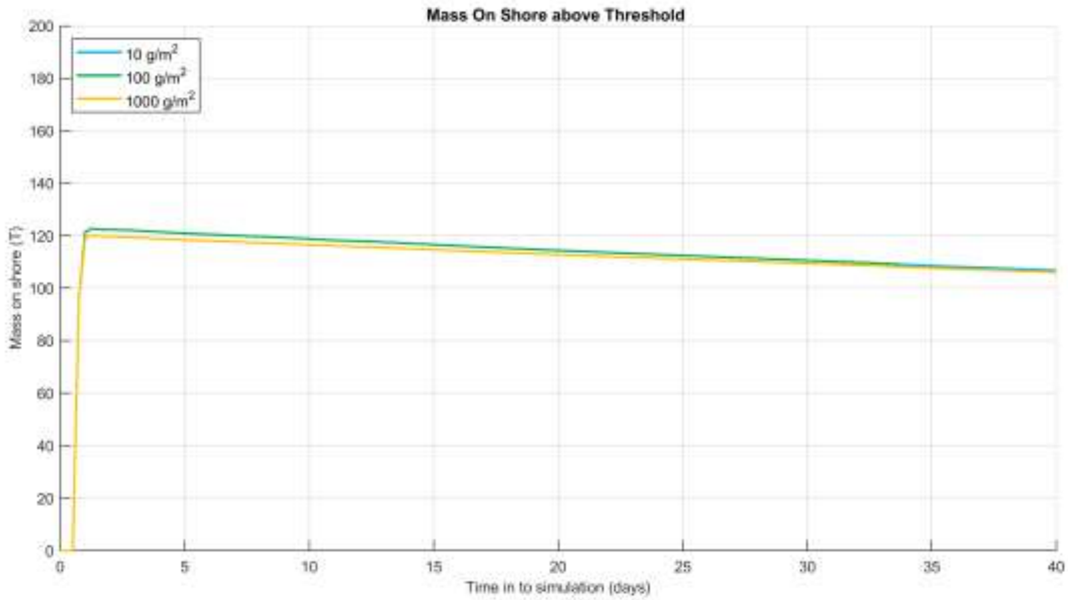


**Figure 12.21 Time series of the mass ashore at each threshold for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, commencing at 6 pm on the 24th of April 2014.**

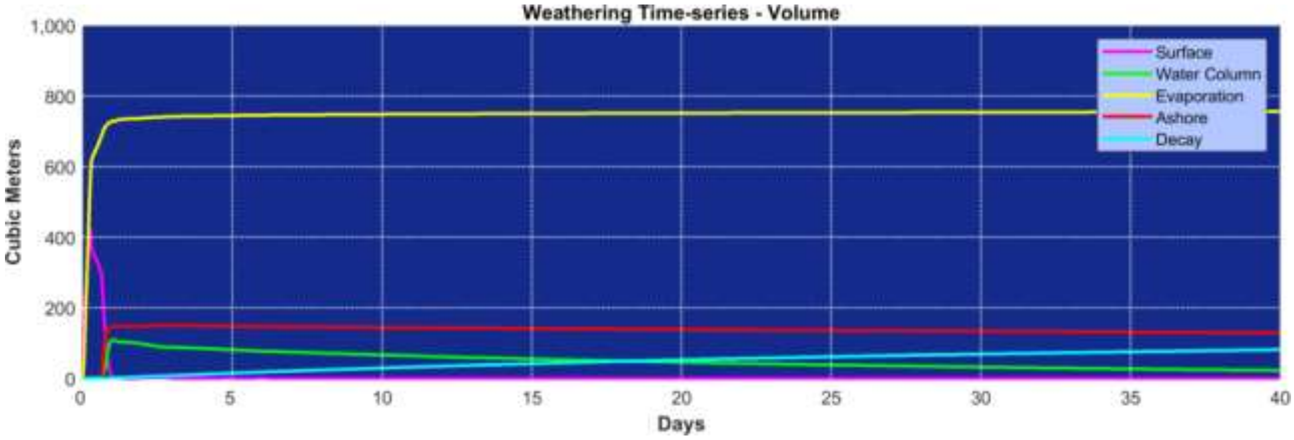


**Figure 12.22 Predicted weathering and fates graph for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, commencing at 6 pm on the 24th of April 2014.**

## 12.2 Point 4

### 12.2.1 Seasonal analysis

#### 12.2.1.1 Sea Surface Exposure

Table 12.13 summarises the maximum distances from the release location to oil exposure zones on the sea surface for each season.

The maximum distance from the release location to the low (≥ 1 $g/m^2$), moderate (≥ 10 $g/m^2$) and high (≥ 50 $g/m^2$) exposure thresholds was 97.5 km west-southwest, 26.8 km west and 8.8 km west, all during transitional conditions, respectively.

Table 12.14 presents potential sea surface exposure to individual receptors during summer, transitional and winter conditions. Low sea surface exposure was predicted at the Ancient coastline at 125 m depth contour KEF during summer, transitional and winter conditions with probabilities of 3%, 17% and 9%, respectively. Additionally, the Ningaloo IMCRA and the Canyons KEF recorded probabilities of low sea surface exposure during transitional conditions of 3% and 9%, respectively. The Ancient coastline at 125 m depth contour KEF was the only receptor predicted to be exposed at the moderate threshold with a probability of 1% during transitional conditions. Minimum times before sea surface exposure (at the low threshold) ranged from 0.63 days (15 hours) at the Ancient coastline at 125 m depth contour KEF to 2.17 days (52 hours) at Commonwealth waters adjacent to Ningaloo Reef KEF, both during transitional conditions.

Figure 12.23 to Figure 12.25 present the zones of sea surface exposure for low moderate and high thresholds during summer, transitional and winter conditions.

Note, the release location resides within the Pilbarra (Offshore) IMCRA, hence it is not presented in the tabulated results.

**Table 12.13 Maximum distance and direction from Point 4 to oil exposure thresholds on the sea surface. Results are based on a 1,000 m$^3$ surface release of MGO over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Distance and direction | Zones of potential sea surface exposure | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Summer | Max. distance from release site (km) | 57.3 | 19.4 | 7.4 |
| | Max. distance from release site (km) (99th percentile) | 35.9 | 17.9 | 7.4 |
| | Direction | N | WSW | WSW |
| Transitional | Max. distance from release site (km) | 97.5 | 26.8 | 8.8 |
| | Max. distance from release site (km) (99th percentile) | 92.0 | 25.2 | 8.8 |
| | Direction | WSW | W | W |
| Winter | Max. distance from release site (km) | 46.3 | 21.1 | 5.2 |
| | Max. distance from release site (km) (99th percentile) | 40.2 | 20.0 | 5.2 |
| | Direction | WSW | WSW | WSW |

**Table 12.14 Summary of the potential sea surface exposure to receptors. Results are based on a 1,000 $m^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Probability of oil exposure on the sea surface (%) | | | Minimum time before oil exposure on the sea surface (days) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Low | Moderate | High | Low | Moderate | High |
| Summer | KEF | Ancient coastline at 125 m depth contour | 3 | - | - | 0.71 | - | - |
| Transitional | AMP | Ningaloo | 2 | - | - | 2.13 | - | - |
| | IMCRA | Ningaloo | 3 | - | - | 2.04 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 17 | 1 | - | 0.63 | 2.08 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 9 | - | - | 1.33 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 2 | - | - | 2.17 | - | - |
| | MMA | Muiron Islands | 2 | - | - | 1.71 | - | - |
| | Nearshore Waters | Bessieres Island | 1 | - | - | 1.50 | - | - |
| Winter | KEF | Ancient coastline at 125 m depth contour | 9 | - | - | 0.79 | - | - |
| | Nearshore Waters | Bessieres Island | 1 | - | - | 1.29 | - | - |

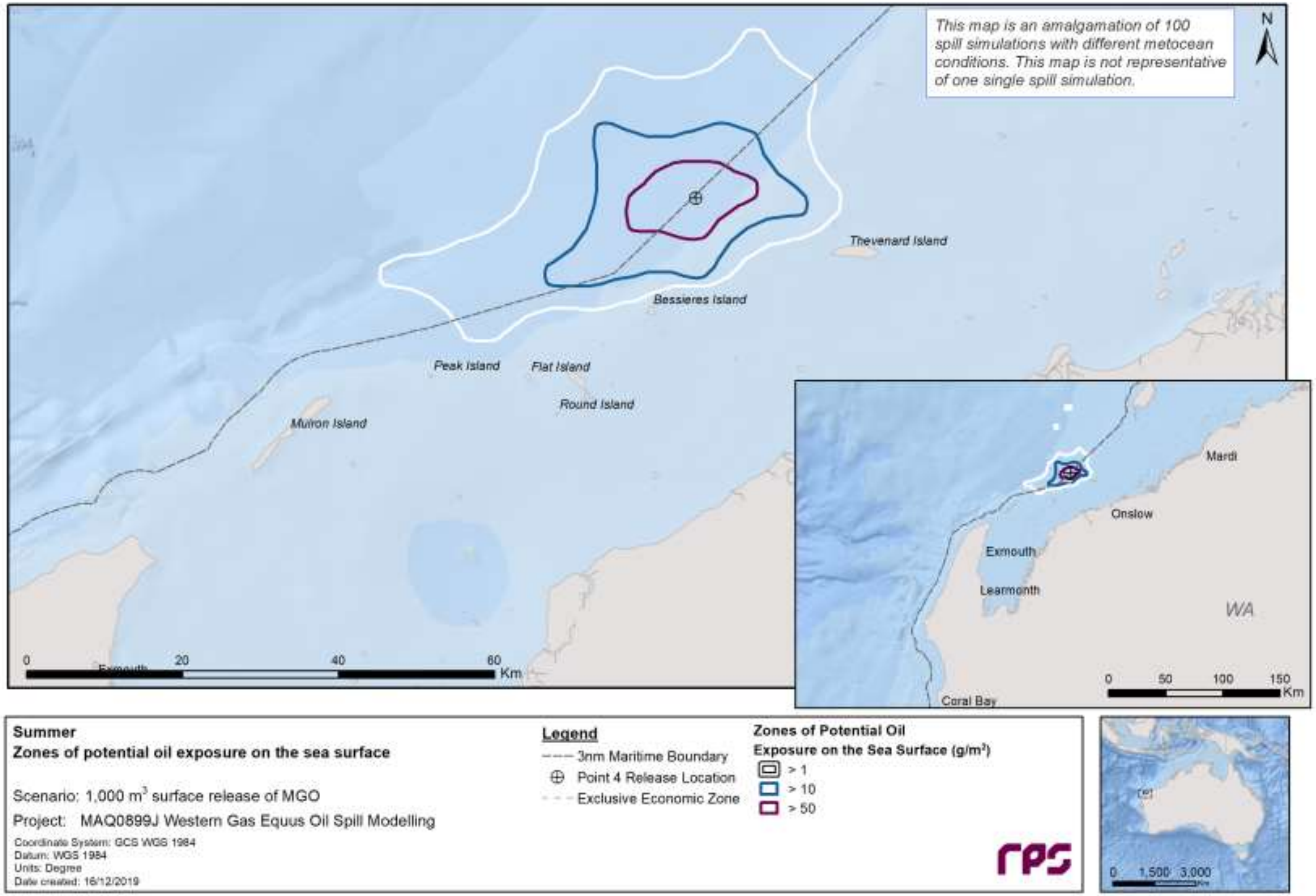


**Figure 12.23 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

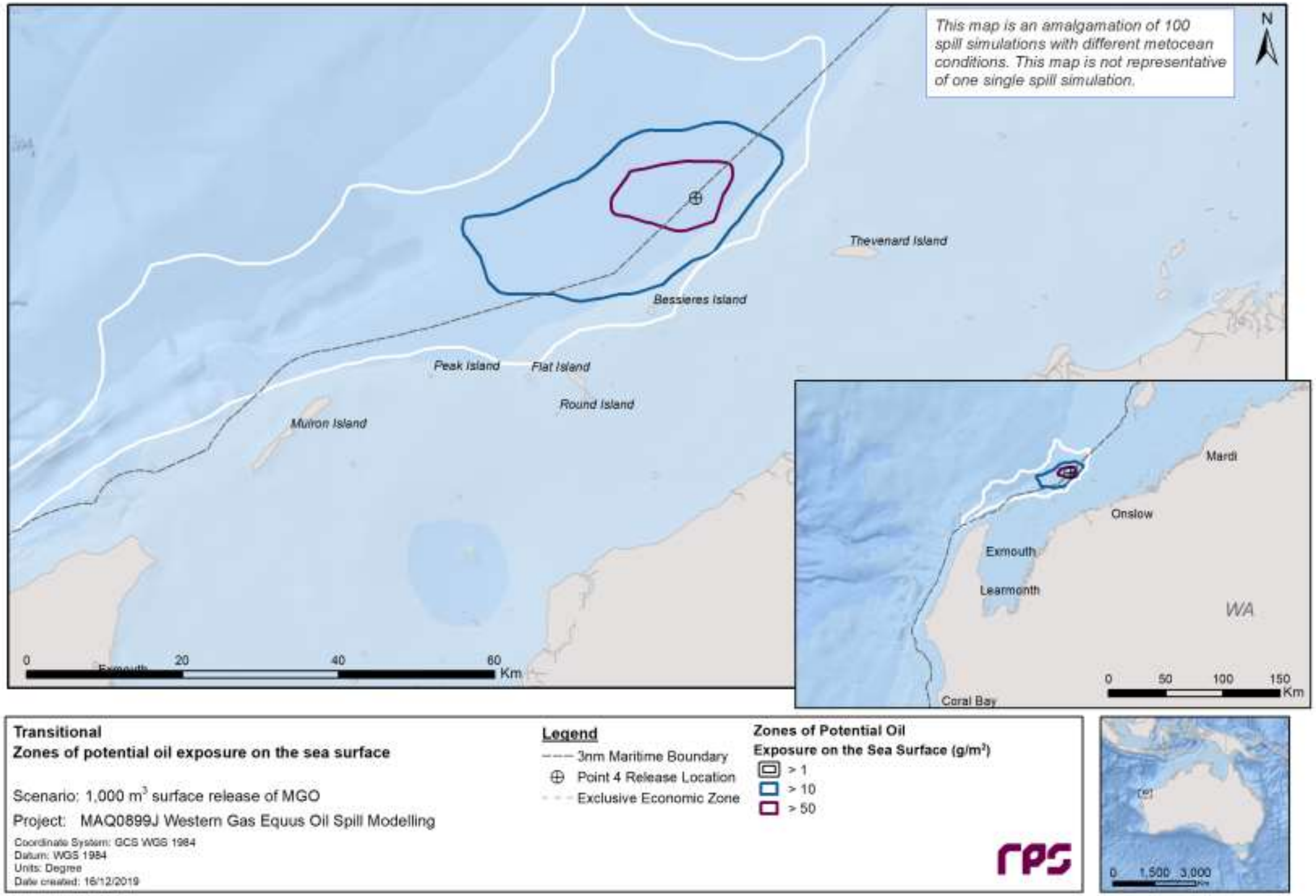


**Figure 12.24 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

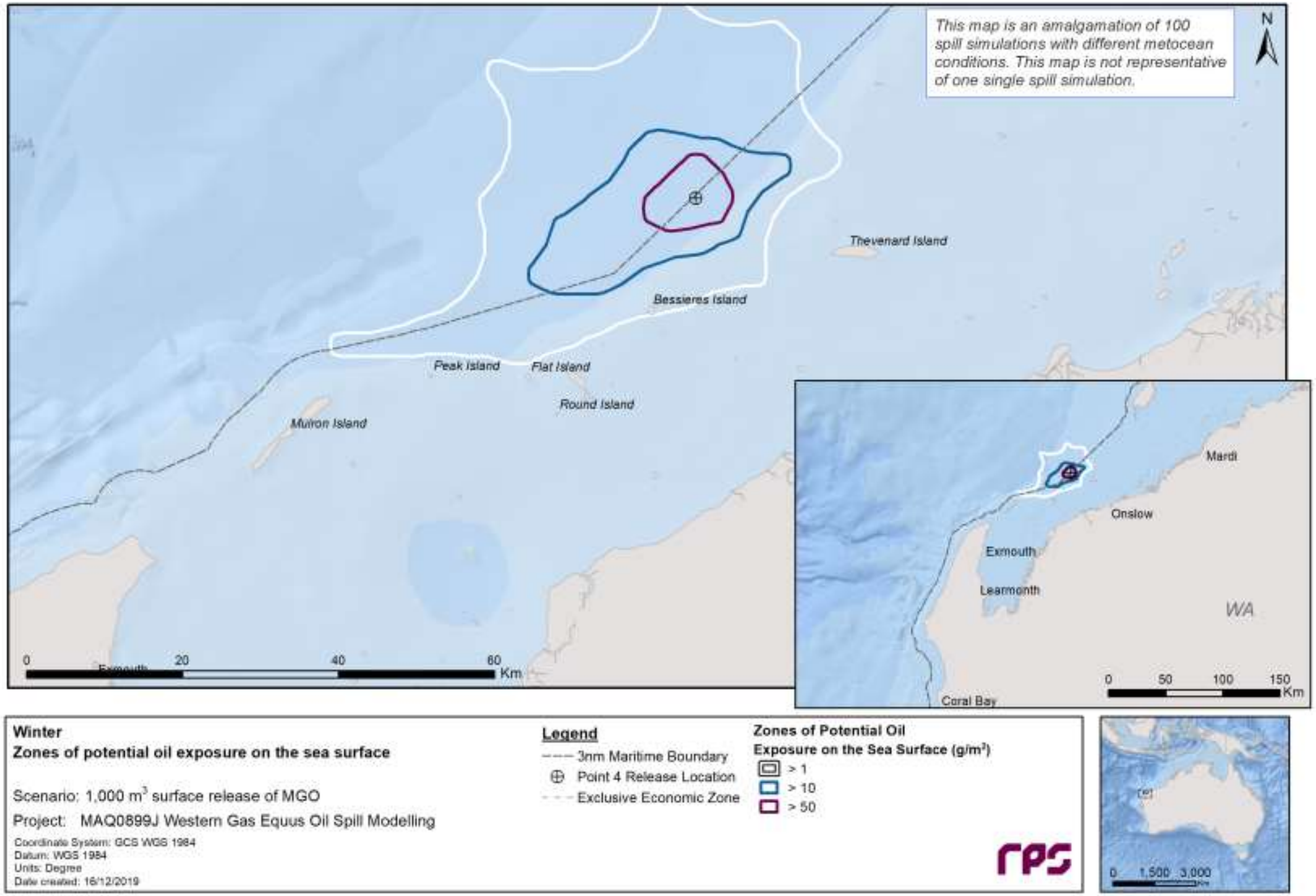


**Figure 12.25 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

### 12.2.1.2 Shoreline Contact

Table 12.15 presents a summary of the predicted shoreline contact during summer, transitional and winter conditions. The probability of contact to any shoreline at, or above, the low threshold (≥ 10 g/m$^2$) was 5% during both transitional and winter conditions, with no contact predicted in summer months. The minimum time before shoreline contact was approximately 1.1 days (26 hours) in transitional conditions and 0.8 days (20 hours) during winter and the maximum volume of oil ashore was predicted during winter with 6.5 m$^3$.

Table 12.16 summarises the shoreline contact to nearby islands during summer, transitional and winter conditions. Bessieres Island and Flat Island were both predicted to be contacted by oil at the low threshold during transitional and winter conditions with probabilities of exposure ranging from 1% to 3%. Additionally, Peak Island was predicted to be contacted during winter conditions at the low and moderate thresholds with probabilities of 2% and 1%, respectively. No receptors were predicted to be contacted during summer conditions.

The maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented for transitional and winter conditions in Figure 12.26 and Figure 12.27.

**Table 12.15 Summary of oil contact across all shorelines. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Shoreline Statistics | Summer | Transitional | Winter |
|---|---|---|---|
| Probability of contact to any shoreline (%) | - | 5 | 5 |
| Absolute minimum time for oil to accumulate on the shoreline at **10 g/m$^2$** (days) | - | 1.1 | 0.8 |
| Maximum volume of hydrocarbons ashore (m$^3$) | - | 5.0 | 6.5 |
| Average volume of hydrocarbons ashore (m$^3$) | - | 1.6 | 2.4 |
| Maximum length of the shoreline at **10 g/m$^2$** (km) | - | 4.0 | 3.0 |
| Average shoreline length (km) at **10 g/m$^2$** (km) | - | 2.0 | 1.6 |
| Maximum length of the shoreline at **100 g/m$^2$** (km) | - | 2.0 | 2.0 |
| Average shoreline length (km) at **100 g/m$^2$** (km) | - | 1.5 | 1.7 |
| Maximum length of the shoreline at **1,000 g/m$^2$** (km) | - | - | - |
| Average shoreline length (km) at **1,000 g/m$^2$** (km) | - | - | - |

**Table 12.16 Summary of oil contact to nearby islands. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories.**

| Season | Shoreline receptor | 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 | Moderate | High | Low | Moderate | High | Mean | Peak | Mean | Peak | Low | Moderate | High | Low | Moderate | High |
| Summer | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Transitional | Bessieres Island | 3 | 2 | - | 1.08 | 1.54 | - | 79.3 | 301.4 | 1.3 | 5.0 | 2.3 | 1.5 | - | 4.0 | 2.0 | - |
| | Flat Island | 2 | - | - | 1.79 | - | - | 43.3 | 76.7 | <1 | 1.3 | 1.5 | - | - | 2.0 | - | - |
| Winter | Bessieres Island | 2 | 1 | - | 0.83 | 1.29 | - | 91.7 | 339.3 | 1.2 | 6.5 | 2.0 | 2.0 | - | 3.0 | 2.0 | - |
| | Flat Island | 1 | 1 | - | 1.17 | 1.75 | - | 162.2 | 184.5 | <1 | 3.7 | 2.0 | 2.0 | - | 2.0 | 2.0 | - |
| | Peak Island | 2 | 1 | - | 1.33 | 1.96 | - | 143.5 | 207.8 | <1 | 2.4 | 1.0 | 1.0 | - | 1.0 | 1.0 | - |

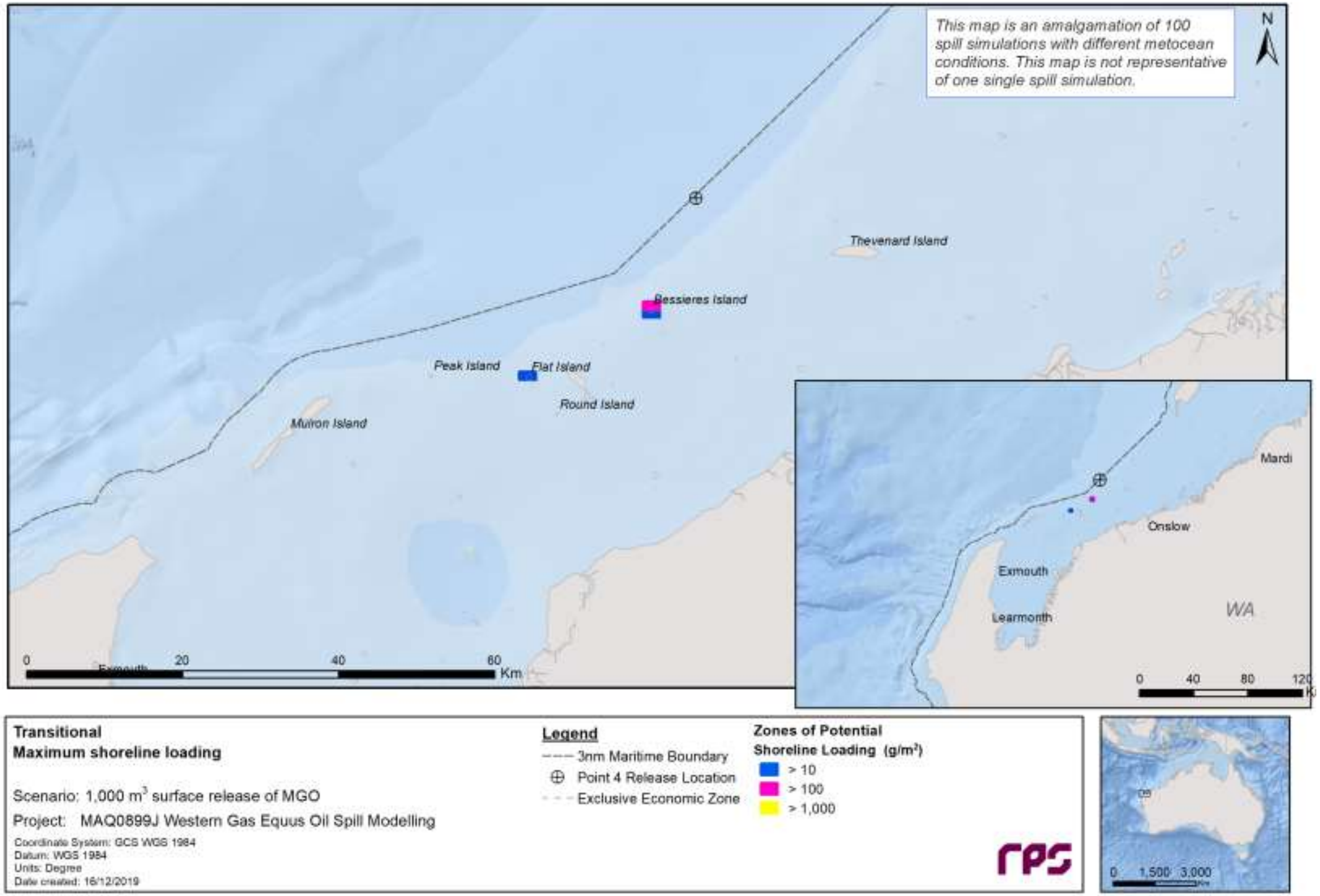


**Figure 12.26 Maximum potential shoreline loading in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days during transitional (April and August) conditions. The results were calculated from 100 spill trajectories.**

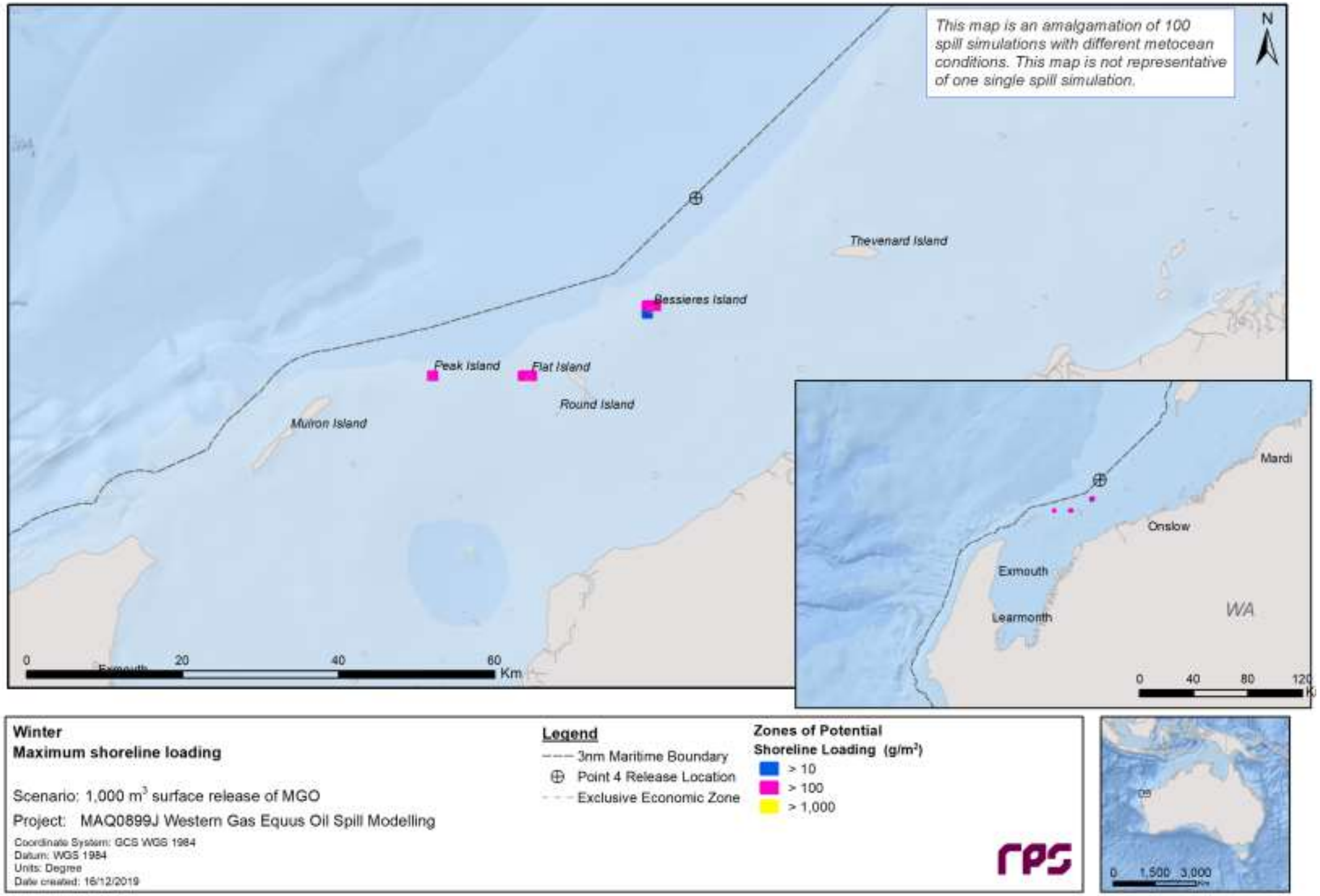


**Figure 12.27 Maximum potential shoreline loading in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days during winter (May to July) conditions. The results were calculated from 100 spill trajectories.**

### 12.2.1.3 Water Column Exposure

#### 12.2.1.3.1 Dissolved Hydrocarbons

Table 12.17 summarises the maximum distance and direction from the release location to dissolved hydrocarbon exposure zones at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and moderate dissolved hydrocarbon exposure was 199.9 km (southwest) and 8.6 km (northeast), recorded during winter conditions, respectively. No dissolved hydrocarbon exposure was predicted at the high threshold.

Table 12.18 and Table 12.19 summarise the seasonal probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m and 10-20 m depth layers, respectively, at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) exposure thresholds (NOPSEMA, 2019).

In the surface (0-10 m) the Ancient coastline at 125 m depth contour KEF recorded the greatest probability of exposure at the low threshold during all seasons with 6%, 5% and 4% in summer, transitional and winter conditions, respectively. The Ningaloo IMCRA and the Canyons KEF were also predicted to be exposed at the low threshold during summer, transitional and winter conditions with probabilities ranging between 1% to 3%.

In the 10-20 m layer, the greatest probabilities of low exposure was predicted at the Ancient coastline at 125 m depth contour KEF with 3%, during summer and transitional conditions. Additionally, a 2% probability of low dissolved hydrocarbon exposure was predicted at the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF during summer and transitional conditions, the Murion Islands MMA during winter and the Ancient coastline at 125 m depth contour KEF during winter.

Figure 12.28 to Figure 12.33 presents the zones of potential instantaneous dissolved hydrocarbon exposure for the 0-10 m and 10-20 m depth layers for the summer, transitional and winter periods, respectively.

**Table 12.17 Maximum distance and direction from the release location to dissolved hydrocarbon exposure (0 – 10m). Results are based on a 1,000 $m^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential dissolved hydrocarbon exposure | | |
|---|---|---|---|---|
| | | Low<br>6 ppb | Moderate<br>50 ppb | High<br>400 ppb |
| Summer | Maximum distance (km) from the release location | 192.4 | 0.8 | - |
| | Direction | SW | S | - |
| Transitional | Maximum distance (km) from the release location | 152.3 | 1.5 | - |
| | Direction | SW | NW | - |
| Winter | Maximum distance (km) from the release location | 199.9 | 8.6 | - |
| | Direction | SW | NE | - |

**Table 12.18 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 $m^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Maximum exposure to dissolved hydrocarbons (ppb) | Probability of exposure to dissolved hydrocarbons (%) | | |
|---|---|---|---|---|---|---|
| | | | | Low | Moderate | High |
| Summer | AMP | Gascoyne | 15 | 1 | - | - |
| | | Montebello | 12 | 1 | - | - |
| | | Ningaloo | 14 | 1 | - | - |
| | IBRA | Cape Range | 25 | 1 | - | - |
| | IMCRA | Ningaloo | 19 | 1 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 29 | 6 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 19 | 2 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 16 | 1 | - | - |
| | | Exmouth Plateau | 11 | 1 | - | - |
| | MMA | Muiron Islands | 17 | 1 | - | - |
| | MP | Ningaloo | 12 | 1 | - | - |
| | RSB | Ningaloo Reef | 11 | 1 | - | - |
| | Nearshore Waters | Exmouth | 10 | 1 | - | - |
| | | Flat Island | 12 | 1 | - | - |
| | | Serrurier Island | 18 | 2 | - | - |
| Transitional | AMP | Gascoyne | 18 | 1 | - | - |
| | | Ningaloo | 22 | 2 | - | - |
| | IBRA | Cape Range | 15 | 1 | - | - |
| | IMCRA | Ningaloo | 22 | 2 | - | - |

| Season | Receptor | | Maximum exposure to dissolved hydrocarbons (ppb) | Probability of exposure to dissolved hydrocarbons (%) | | |
|---|---|---|---|---|---|---|
| | | | | Low | Moderate | High |
| | KEF | Ancient coastline at 125 m depth contour | 32 | 5 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 18 | 3 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 22 | 2 | - | - |
| | MMA | Muiron Islands | 16 | 2 | - | - |
| | MP | Ningaloo | 17 | 1 | - | - |
| | RSB | Penguin Bank | 15 | 1 | - | - |
| | Nearshore Waters | Bessieres Island | 12 | 1 | - | - |
| | | Exmouth | 15 | 1 | - | - |
| | | Murion Islands | 12 | 1 | - | - |
| Winter | AMP | Gascoyne | 13 | 1 | - | - |
| | | Ningaloo | 20 | 2 | - | - |
| | IBRA | Cape Range | 19 | 1 | - | - |
| | IMCRA | Ningaloo | 20 | 2 | - | - |
| | | Pilbarra (nearshore) | 12 | 1 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 24 | 4 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 21 | 2 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 20 | 2 | - | - |
| | MMA | Muiron Islands | 17 | 2 | - | - |
| | MP | Ningaloo | 16 | 2 | - | - |
| | RSB | Ningaloo Reef | 11 | 1 | - | - |
| | Nearshore Waters | Bessieres Island | 11 | 1 | - | - |
| | | Exmouth | 11 | 1 | - | - |
| | | Murion Islands | 15 | 1 | - | - |
| | | Peak Island | 17 | 1 | - | - |

**Table 12.19 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 10-20 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.**

| Season | Receptor | | Maximum exposure to dissolved hydrocarbons (ppb) | Probability of exposure to dissolved hydrocarbons (%) | | |
|---|---|---|---|---|---|---|
| | | | | Low | Moderate | High |
| Summer | AMP | Gascoyne | 15 | 1 | - | - |
| | | Montebello | 11 | 1 | - | - |
| | | Ningaloo | 14 | 1 | - | - |
| | IMCRA | Ningaloo | 16 | 1 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 22 | 3 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 16 | 2 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 14 | 1 | - | - |
| Transitional | AMP | Gascoyne | 14 | 1 | - | - |
| | | Ningaloo | 21 | 1 | - | - |
| | IBRA | Cape Range | 11 | 1 | - | - |
| | IMCRA | Ningaloo | 14 | 1 | - | - |
| | | Pilbarra (nearshore) | 10 | 1 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 18 | 3 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 14 | 2 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 21 | 1 | - | - |
| | MMA | Muiron Islands | 12 | 1 | - | - |
| | MP | Ningaloo | 12 | 1 | - | - |
| | RSB | Penguin Bank | 11 | 1 | - | - |
| | Nearshore Waters | Exmouth | 12 | 1 | - | - |
| Winter | AMP | Gascoyne | 13 | 1 | - | - |
| | | Ningaloo | 17 | 1 | - | - |
| | IBRA | Cape Range | 16 | 1 | - | - |
| | IMCRA | Ningaloo | 17 | 1 | - | - |
| | KEF | Ancient coastline at 125 m depth contour | 19 | 2 | - | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 17 | 1 | - | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 17 | 1 | - | - |
| | MMA | Muiron Islands | 21 | 2 | - | - |
| | MP | Ningaloo | 15 | 1 | - | - |
| | Nearshore Waters | Exmouth | 12 | 1 | - | - |
| | | Murion Islands | 14 | 1 | - | - |
| | | Peak Island | 16 | 1 | - | - |

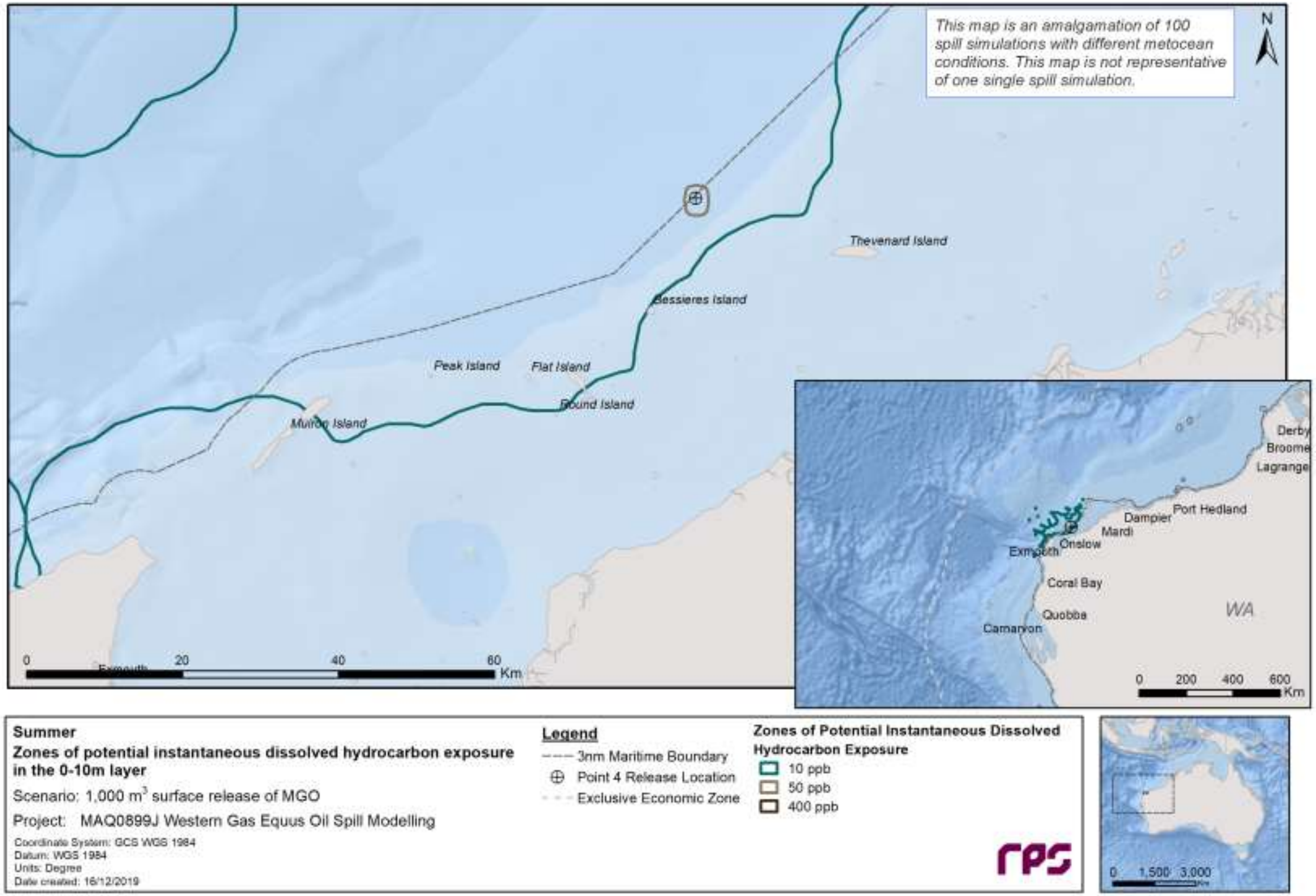


**Figure 12.28 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

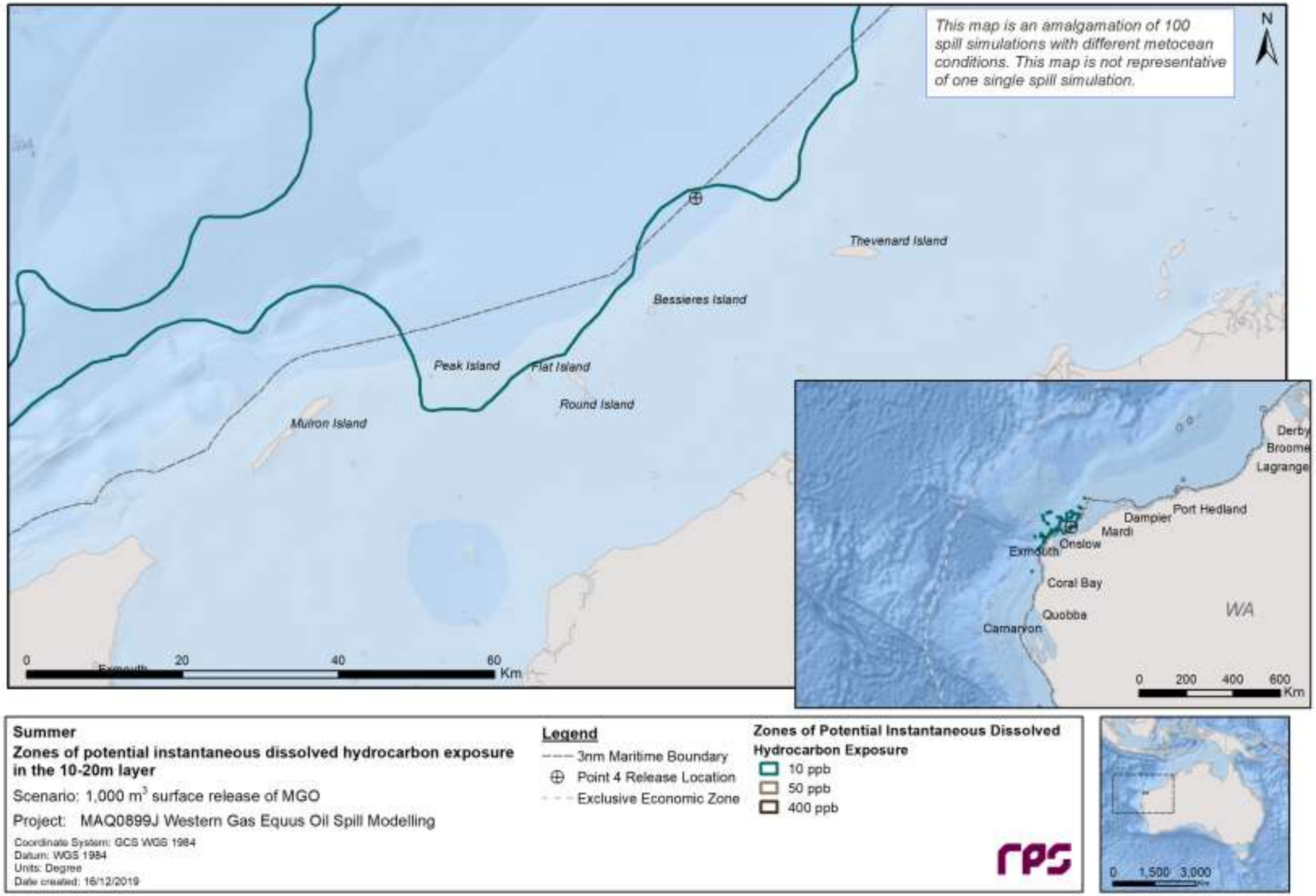


**Figure 12.29 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

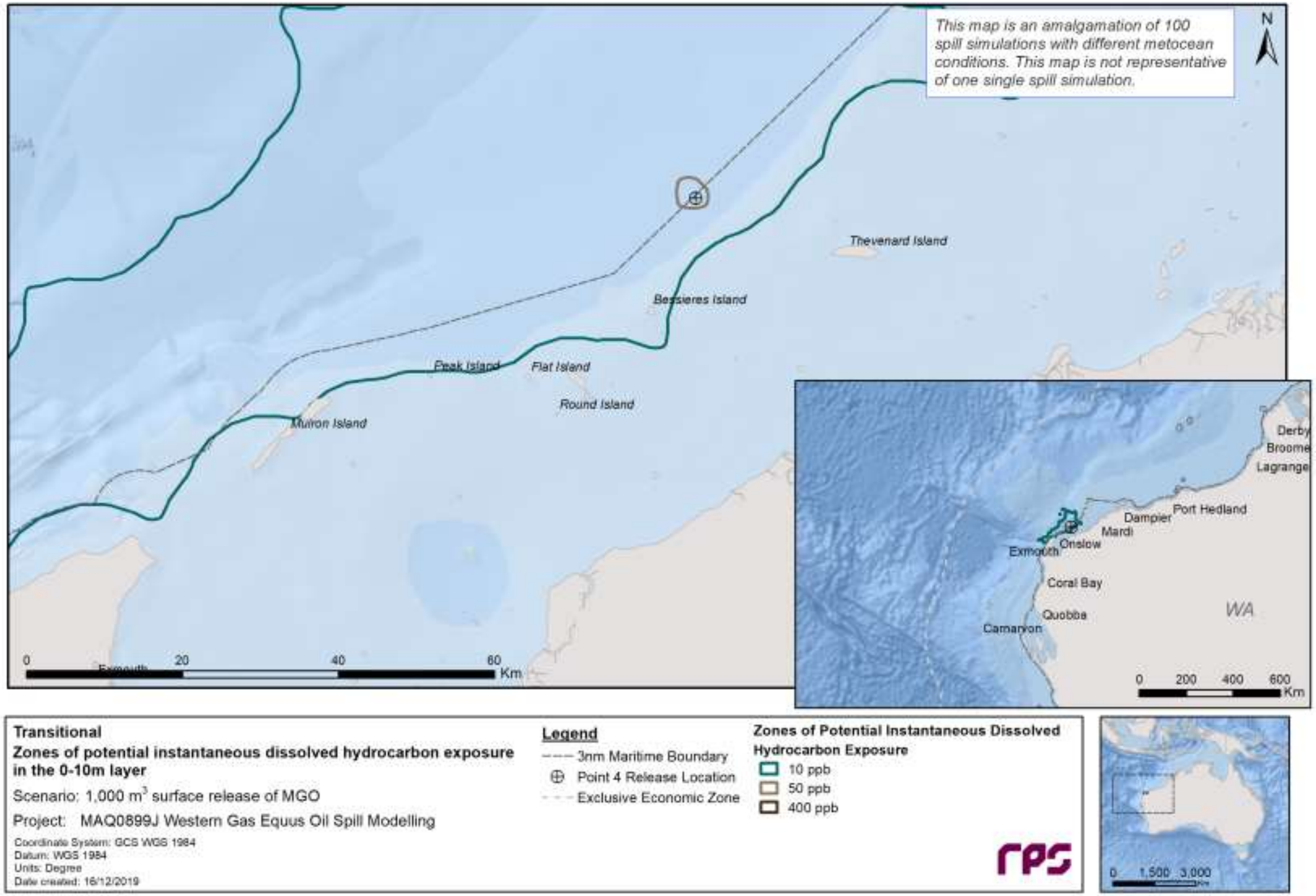


**Figure 12.30 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

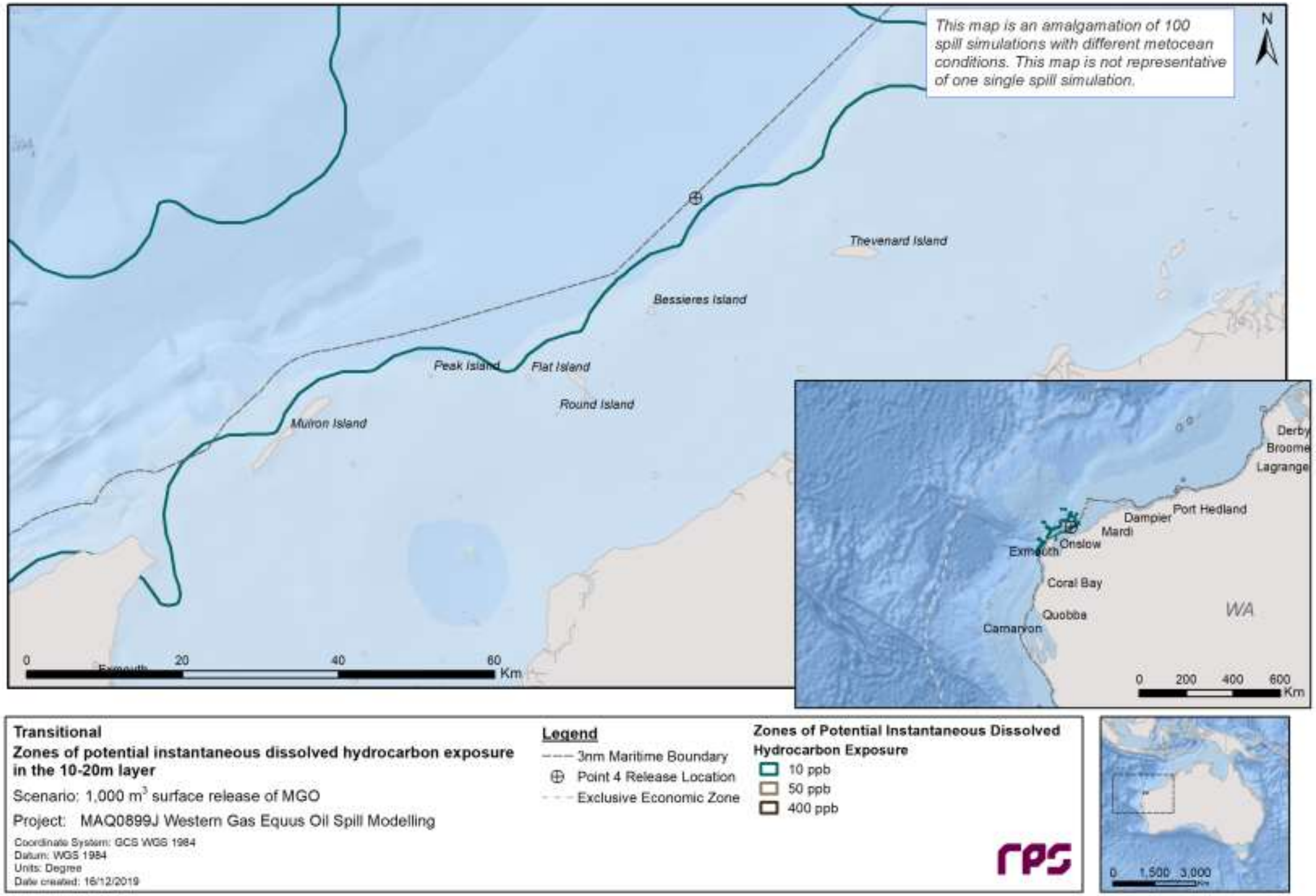


**Figure 12.31 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

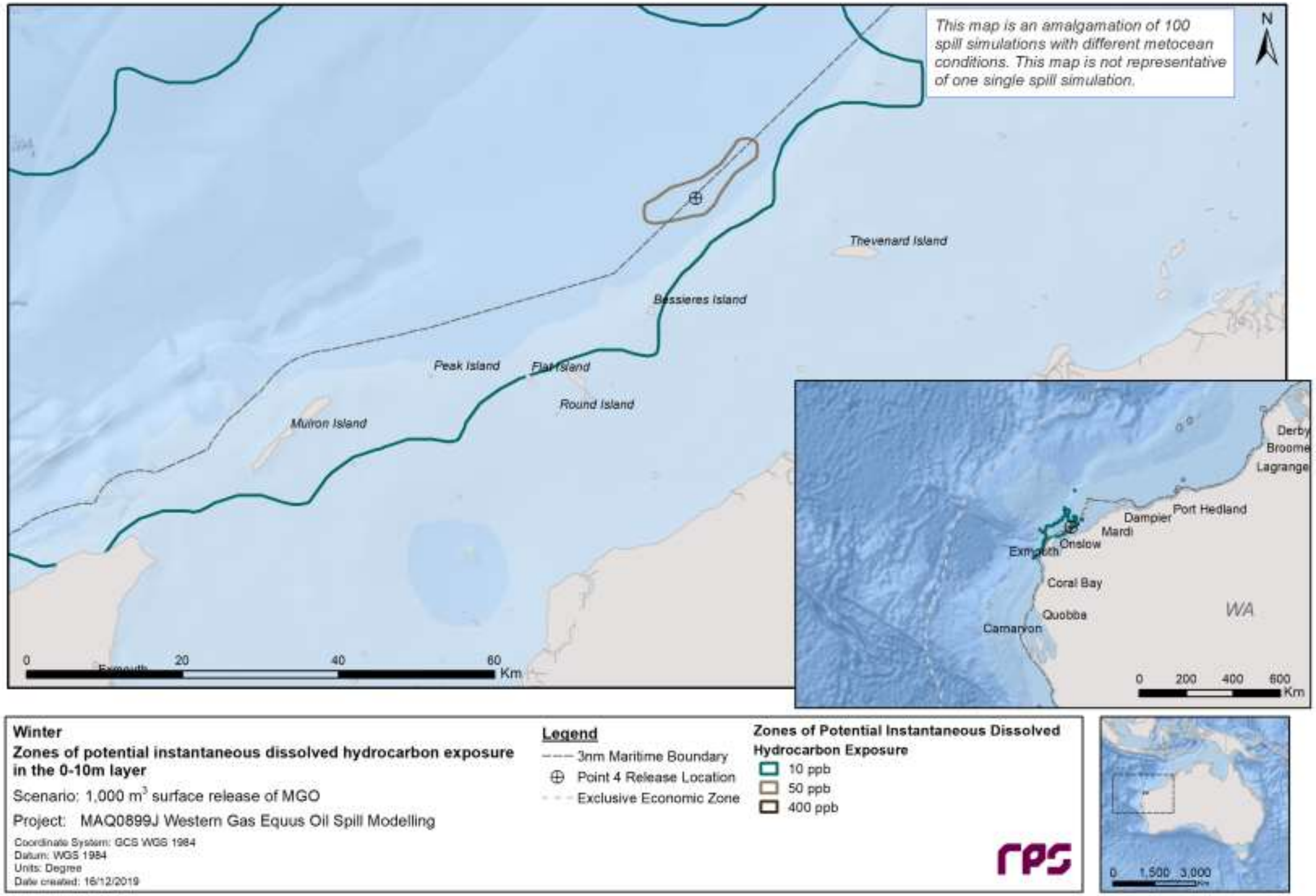


**Figure 12.32 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

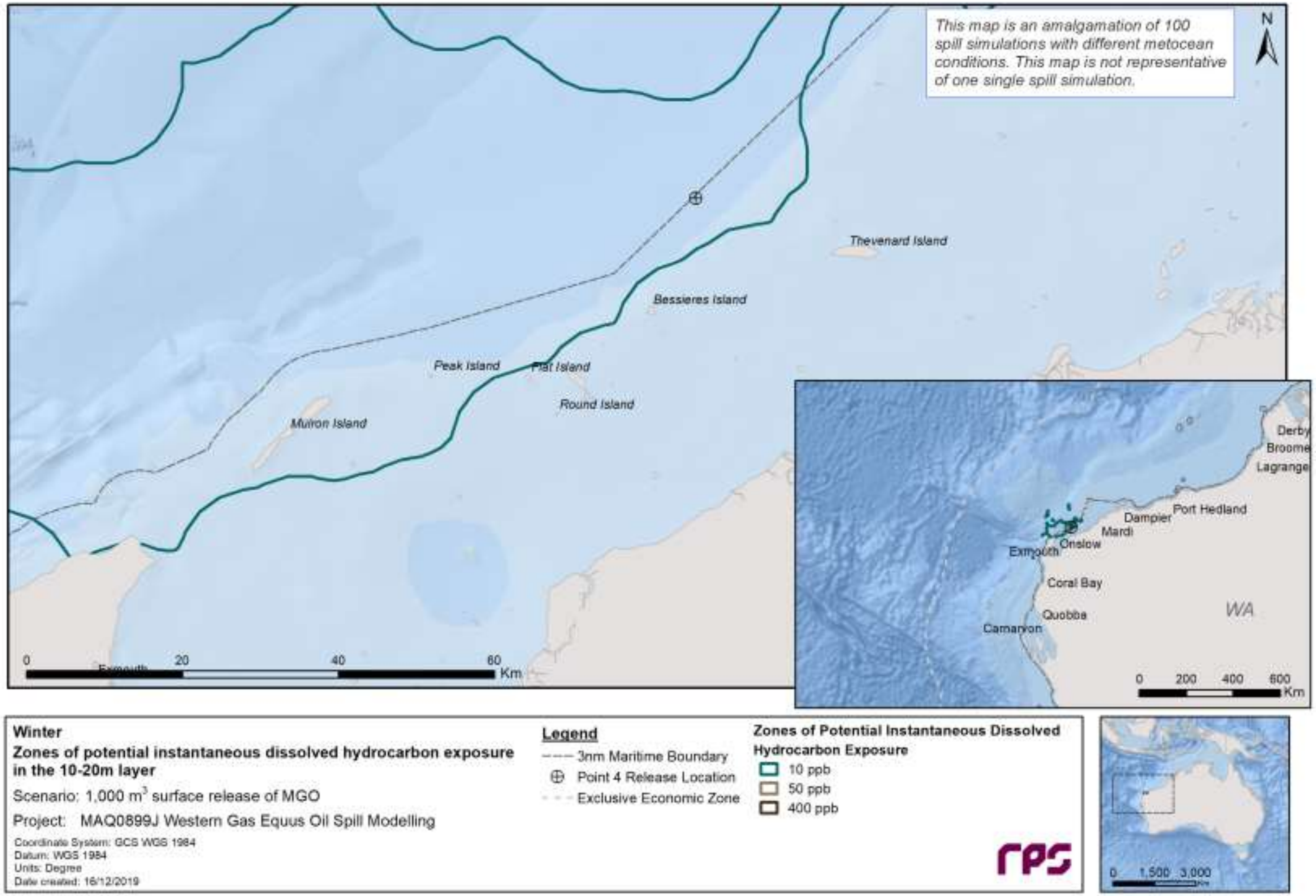


**Figure 12.33 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

#### 12.2.1.3.2 Entrained Hydrocarbons

Table 12.20 summarises the maximum distance and direction from the release location to entrained hydrocarbon exposure zones at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and high entrained hydrocarbon exposure was 849.5 km (southwest) and 337.7 km (southwest), recorded during transitional conditions, respectively.

Table 12.21 to Table 12.23 summarise the probability of exposure to receptors from entrained hydrocarbons in the 0-10 m depth layer, in summer, transitional and winter conditions, at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds (NOPSEMA, 2019).

At the surface layer (0-10 m), the Ningaloo IMCRA, Ancient coastline at 125 m depth contour and the Canyons KEFs were predicted to be exposed at the low entrained hydrocarbon threshold with probabilities ranging from 37% to 54% in summer, 36% to 49% in transitional conditions and 45% to 49% during winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 31% at the Ancient coastline at 125 m depth contour KEF during transitional conditions, while it also recorded 26% and 28% probabilities of high entrained hydrocarbon exposure during summer and winter conditions.

Table 12.24 summarises the probability of exposure to receptors from entrained hydrocarbons in the 10-20 m depth layer, during all seasonal conditions at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds.

The greatest probabilities of low entrained hydrocarbon exposure in the 10-20 m layer were recorded at the Ancient coastline at 125 m depth contour KEF during all seasons with predicted probabilities of 5% during summer and transitional conditions and 6% in winter. The Ningaloo IMCRA and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF were also predicted to be exposed to low entrained hydrocarbons during summer, transitional and winter conditions with probabilities of 1% and 2% in summer, 1% for both receptors during transitional conditions and 3% during winter. No receptors were predicted to be exposed at the high entrained hydrocarbon threshold.

Figure 12.34 to Figure 12.39 illustrates the zones of potential entrained hydrocarbon exposure for the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon thresholds in the 0-10 m and 10-20 m depth layers in summer, transitional and winter conditions.

**Table 12.20 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.**

| Season | Distance and direction travelled | Zones of potential entrained hydrocarbon exposure | |
|---|---|---|---|
| | | Low<br>10 ppb | High<br>100 ppb |
| Summer | Maximum distance (km) from the release location | 614.6 | 317.7 |
| | Direction | SSW | SW |
| Transitional | Maximum distance (km) from the release location | 849.5 | 337.7 |
| | Direction | SW | SW |
| Winter | Maximum distance (km) from the release location | 684.7 | 336.5 |
| | Direction | SSW | WSW |

**Table 12.21 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days, during summer (September to March) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 21 | 1 | - |
| | Carnarvon Canyon | 19 | 3 | - |
| | Gascoyne | 368 | 33 | 7 |
| | Montebello | 380 | 15 | 5 |
| | Ningaloo | 721 | 28 | 9 |
| | Shark Bay | 68 | 3 | - |
| IBRA | Cape Range | 1,669 | 18 | 8 |
| IMCRA | Ningaloo | 721 | 37 | 11 |
| | Northwest Shelf | 83 | 5 | - |
| | Pilbarra (nearshore) | 100 | 5 | 1 |
| | Zuytdorp | 93 | 3 | - |
| KEF | Ancient coastline at 125 m depth contour | 2,713 | 54 | 26 |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 1,074 | 47 | 19 |
| | Commonwealth waters adjacent to Ningaloo Reef | 721 | 28 | 9 |
| | Exmouth Plateau | 204 | 15 | 2 |
| | Glomar Shoals | 17 | 1 | - |
| | Wallaby Saddle | 17 | 1 | - |
| | Western demersal slope and associated fish communities | 22 | 2 | - |
| MMA | Barrow Island | 71 | 5 | - |
| | Muiron Islands | 758 | 23 | 16 |
| MP | Barrow Island | 37 | 5 | - |

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| | Montebello Islands | 57 | 5 | - |
| | Ningaloo | 472 | 18 | 6 |
| NR | Thevenard Island | 65 | 6 | - |
| RSB | Baylis Patches | 11 | 1 | - |
| | Brewis Reef | 120 | 5 | 1 |
| | Glomar Shoal | 14 | 1 | - |
| | Locker Reef | 26 | 2 | - |
| | Montebello Shoals | 28 | 4 | - |
| | Ningaloo Reef | 443 | 11 | 1 |
| | Penguin Bank | 81 | 7 | - |
| | Rankin Bank | 75 | 4 | - |
| | Rosily Shoals | 459 | 10 | 5 |
| | Tryal Rocks | 116 | 8 | 2 |
| Nearshore Waters | Ashburton Island | 31 | 3 | - |
| | Barrow Island | 24 | 3 | - |
| | Bessieres Island | 475 | 12 | 6 |
| | Exmouth | 297 | 11 | 1 |
| | Flat Island | 678 | 10 | 7 |
| | Hermite Island | 25 | 3 | - |
| | Locker Island | 11 | 1 | - |
| | Lowendal Island | 12 | 2 | - |
| | Middle Island | 14 | 1 | - |
| | Murion Islands | 291 | 17 | 5 |
| | Peak Island | 373 | 18 | 8 |
| | Round Island | 349 | 7 | 3 |
| | Serrurier Island | 1,480 | 11 | 7 |
| | Sunday Island | 31 | 3 | - |
| | Table Island | 489 | 6 | 3 |
| | Thevenard Island | 42 | 7 | - |
| | Tortoise Island | 60 | 4 | - |

**Table 12.22 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days, during transitional (April and August) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 18 | 2 | - |
| | Argo-Rowley Terrace | 21 | 2 | - |
| | Gascoyne | 584 | 28 | 10 |
| | Montebello | 119 | 5 | 1 |
| | Ningaloo | 855 | 29 | 16 |
| | Shark Bay | 52 | 4 | - |
| IBRA | Cape Range | 650 | 15 | 9 |
| IMCRA | Ningaloo | 855 | 36 | 16 |
| | Northwest Shelf | 38 | 2 | - |
| | Pilbarra (nearshore) | 255 | 7 | 2 |
| | Zuytdorp | 70 | 5 | - |
| KEF | Ancient coastline at 125 m depth contour | 2,593 | 49 | 31 |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 1,236 | 42 | 25 |
| | Commonwealth waters adjacent to Ningaloo Reef | 809 | 29 | 15 |
| | Exmouth Plateau | 195 | 17 | 1 |
| | Wallaby Saddle | 11 | 1 | - |
| | Western demersal slope and associated fish communities | 19 | 2 | - |
| MMA | Barrow Island | 26 | 3 | - |
| | Muiron Islands | 1,090 | 24 | 14 |
| MP | Barrow Island | 26 | 3 | - |
| | Montebello Islands | 16 | 2 | - |
| | Ningaloo | 504 | 16 | 7 |
| RSB | Montebello Shoals | 15 | 2 | - |
| | Ningaloo Reef | 329 | 9 | 4 |
| | Penguin Bank | 279 | 4 | 2 |
| | Ripple Shoals | 26 | 2 | - |
| | Rosily Shoals | 505 | 6 | 3 |
| | Tryal Rocks | 12 | 2 | - |
| Nearshore Waters | Airlie Island | 28 | 2 | - |
| | Barrow Island | 19 | 2 | - |
| | Bessieres Island | 559 | 10 | 4 |
| | Boodie Island | 16 | 2 | - |
| | Exmouth | 304 | 9 | 4 |
| | Flat Island | 618 | 10 | 6 |
| | Middle Island | 17 | 2 | - |
| | Murion Islands | 448 | 14 | 8 |

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| | Observation Island | 24 | 2 | - |
| | Peak Island | 650 | 15 | 9 |
| | Round Island | 29 | 4 | - |
| | Serrurier Island | 409 | 9 | 4 |
| | Sunday Island | 49 | 5 | - |
| | Table Island | 141 | 2 | 2 |
| | Thevenard Island | 10 | 1 | - |

**Table 12.23 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days, during winter (May to July) conditions.**

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| AMP | Abrolhos | 13 | 1 | - |
| | Carnarvon Canyon | 23 | 2 | - |
| | Gascoyne | 655 | 41 | 13 |
| | Montebello | 55 | 2 | - |
| | Ningaloo | 791 | 43 | 20 |
| | Shark Bay | 51 | 2 | - |
| IBRA | Cape Range | 1,346 | 30 | 19 |
| IMCRA | Ningaloo | 937 | 49 | 23 |
| | Northwest Shelf | 80 | 2 | - |
| | Pilbarra (nearshore) | 576 | 10 | 3 |
| | Zuytdorp | 68 | 3 | - |
| KEF | Ancient coastline at 125 m depth contour | 2,436 | 49 | 28 |
| | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 1,325 | 45 | 22 |
| | Commonwealth waters adjacent to Ningaloo Reef | 832 | 43 | 22 |
| | Exmouth Plateau | 166 | 12 | 2 |
| | Wallaby Saddle | 11 | 1 | - |
| | Western demersal slope and associated fish communities | 20 | 1 | - |
| MMA | Muiron Islands | 1,193 | 39 | 26 |
| MP | Ningaloo | 604 | 27 | 10 |
| NR | Thevenard Island | 102 | 2 | 1 |
| RSB | Brewis Reef | 40 | 2 | - |
| | Locker Reef | 15 | 1 | - |
| | Ningaloo Reef | 510 | 19 | 4 |

| Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|
| | | | Low | High |
| | Penguin Bank | 517 | 5 | 3 |
| | Rosily Shoals | 944 | 9 | 4 |
| Nearshore Waters | Airlie Island | 41 | 1 | - |
| | Ashburton Island | 11 | 1 | - |
| | Bessieres Island | 529 | 8 | 5 |
| | Exmouth | 527 | 19 | 4 |
| | Flat Island | 688 | 19 | 14 |
| | Murion Islands | 637 | 28 | 9 |
| | Observation Island | 11 | 1 | - |
| | Peak Island | 1,361 | 30 | 19 |
| | Round Island | 73 | 5 | - |
| | Serrurier Island | 538 | 11 | 7 |
| | Sunday Island | 139 | 11 | 1 |
| | Table Island | 199 | 4 | 1 |
| | Thevenard Island | 132 | 2 | 1 |
| | Tortoise Island | 12 | 1 | - |

**Table 12.24 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 10-20 m depth layer for each season. Results are based on a 1,000 $m^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days.**

| Season | Receptor | | Maximum exposure to entrained hydrocarbons (ppb) | Probability of exposure to entrained hydrocarbons | |
|---|---|---|---|---|---|
| | | | | Low | High |
| Summer | AMP | Ningaloo | 11 | 1 | - |
| | IMCRA | Ningaloo | 12 | 1 | - |
| | KEF | Ancient coastline at 125 m depth contour | 20 | 5 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 19 | 2 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 11 | 1 | - |
| | MMA | Muiron Islands | 14 | 1 | - |
| Transitional | AMP | Ningaloo | 11 | 1 | - |
| | IMCRA | Ningaloo | 11 | 1 | - |
| | KEF | Ancient coastline at 125 m depth contour | 24 | 5 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 12 | 1 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 11 | 1 | - |
| | MMA | Muiron Islands | 12 | 1 | - |
| Winter | AMP | Gascoyne | 12 | 1 | - |
| | | Ningaloo | 13 | 2 | - |
| | IBRA | Cape Range | 16 | 3 | - |
| | IMCRA | Ningaloo | 15 | 3 | - |
| | KEF | Ancient coastline at 125 m depth contour | 26 | 6 | - |
| | | Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) | 20 | 3 | - |
| | | Commonwealth waters adjacent to Ningaloo Reef | 12 | 1 | - |
| | MMA | Muiron Islands | 14 | 3 | - |
| | MP | Ningaloo | 11 | 1 | - |
| | Nearshore Waters | Murion Islands | 10 | 1 | - |
| | | Peak Island | 16 | 3 | - |

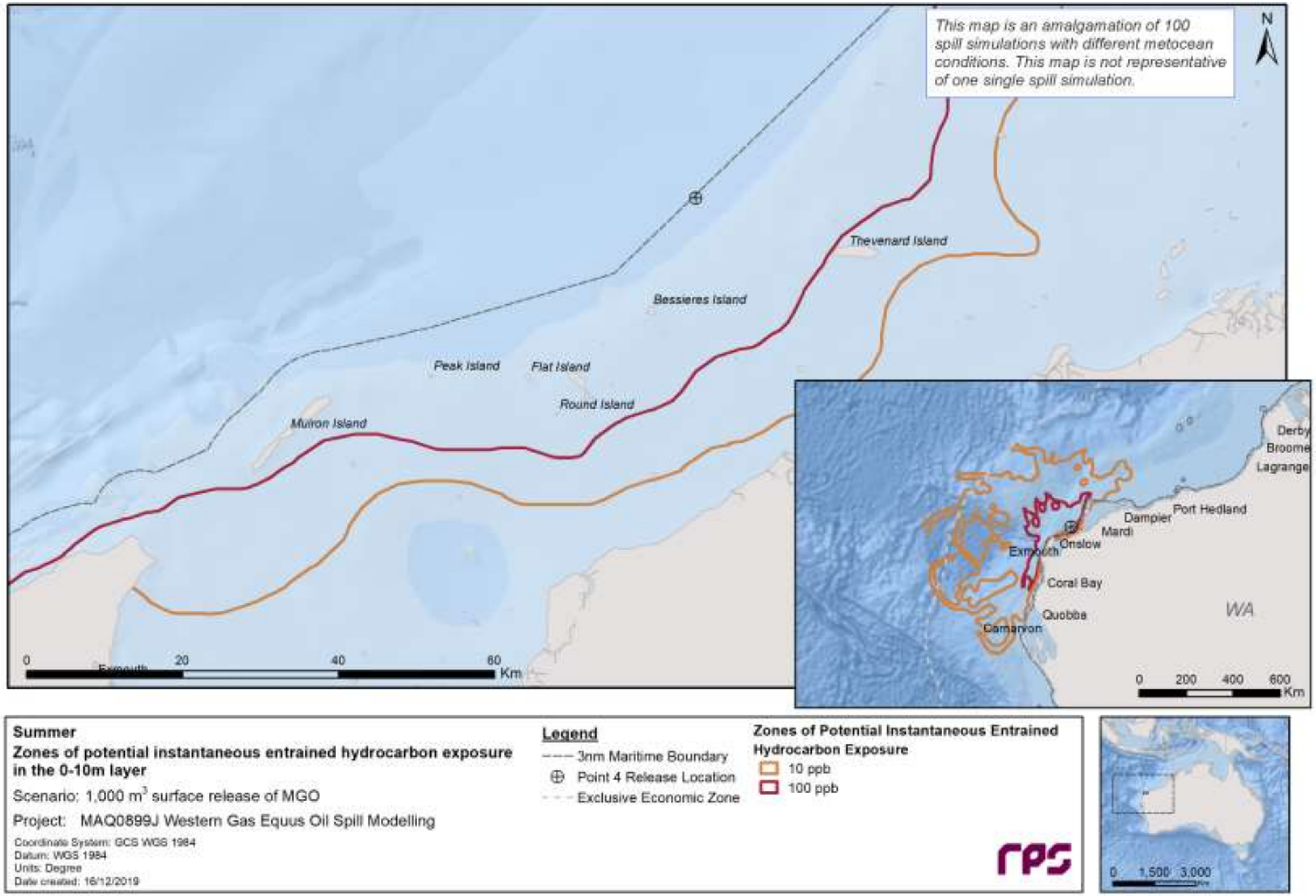


**Figure 12.34 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

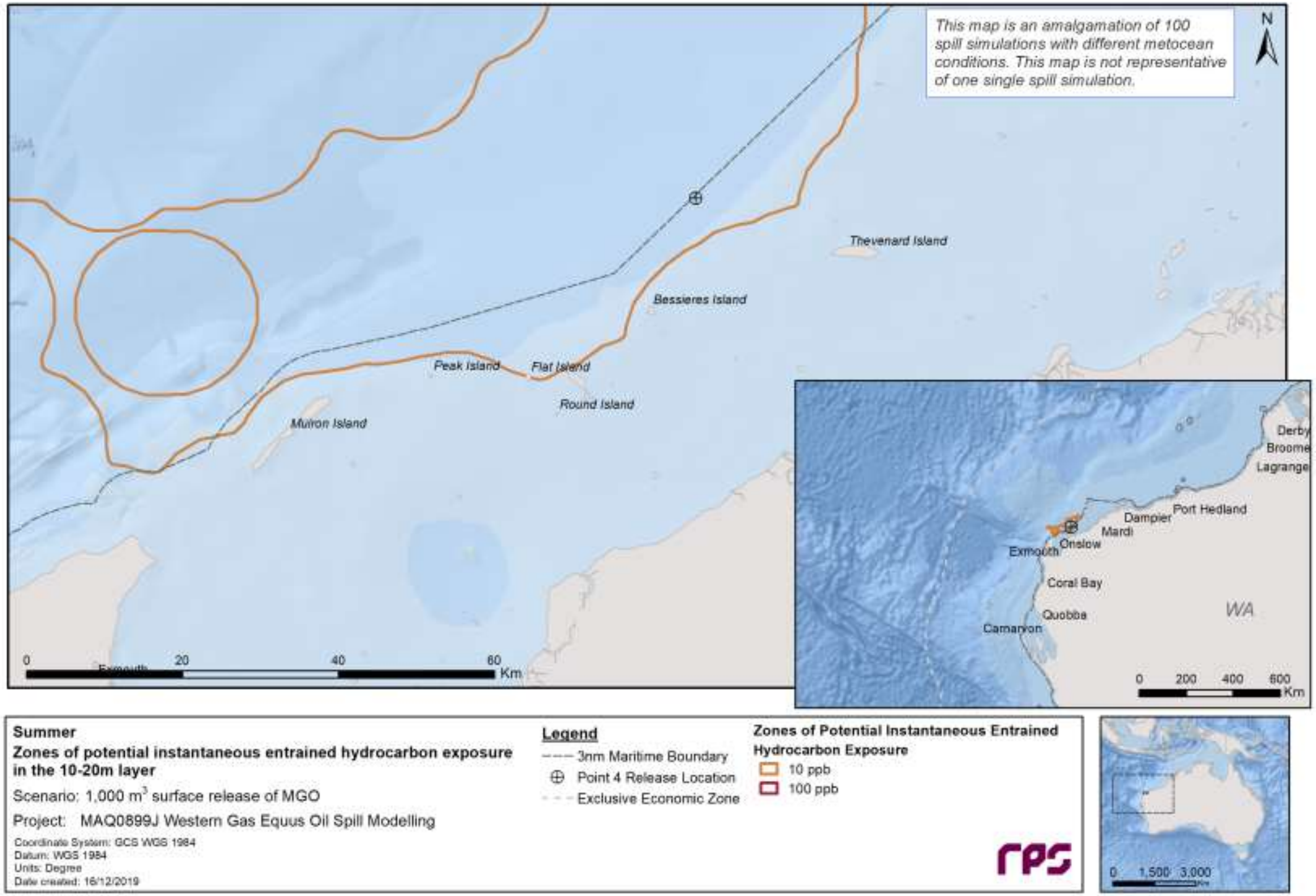


**Figure 12.35 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.**

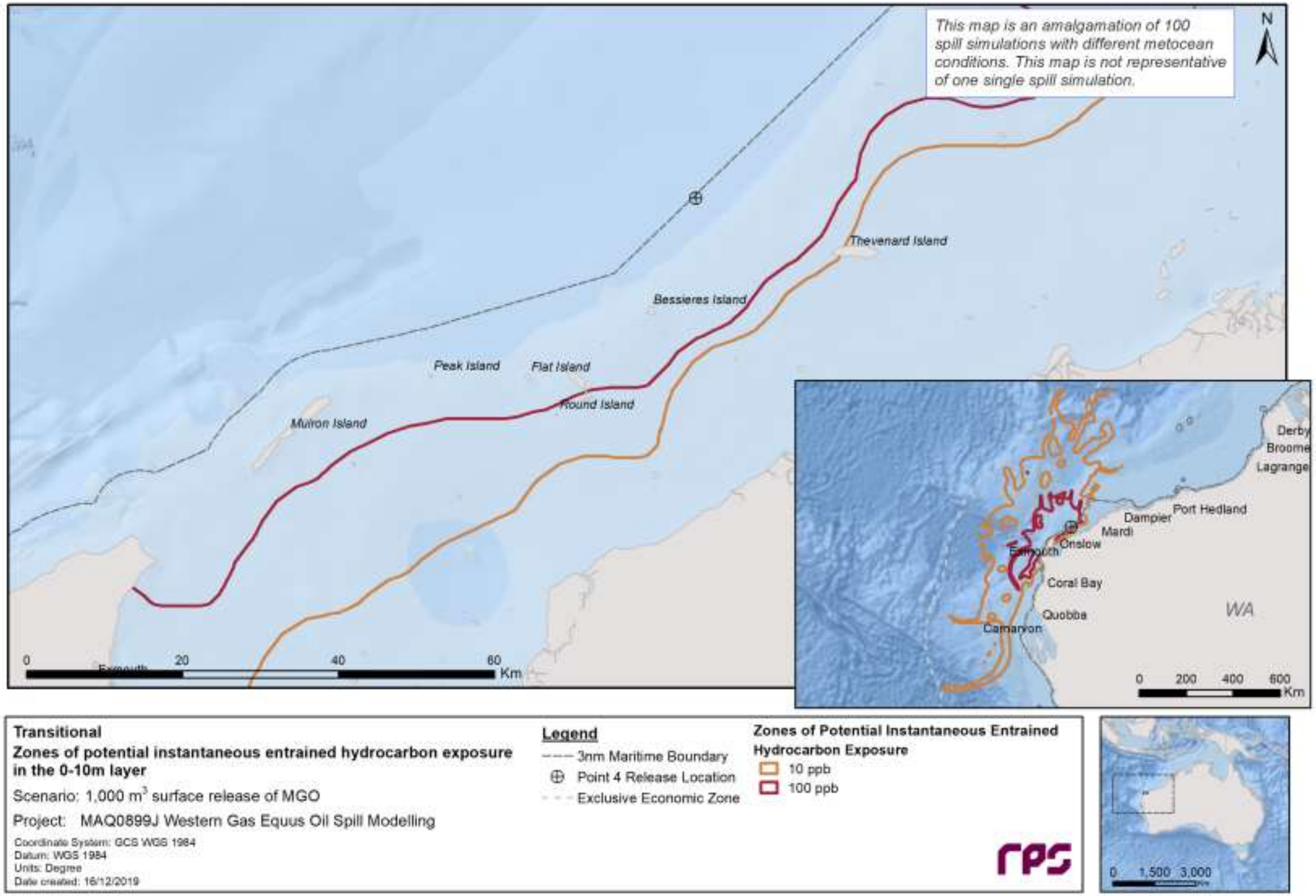


**Figure 12.36 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

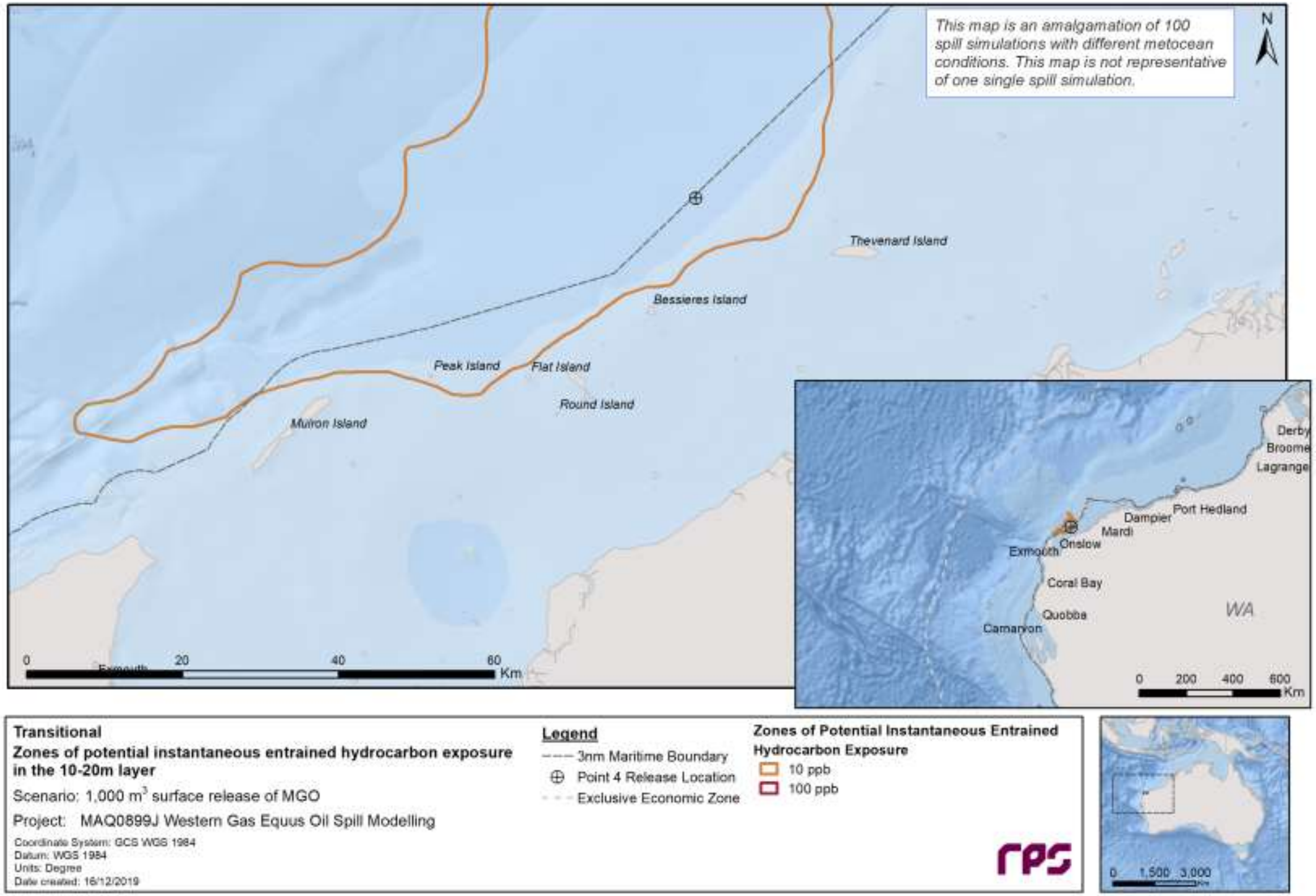


**Figure 12.37 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.**

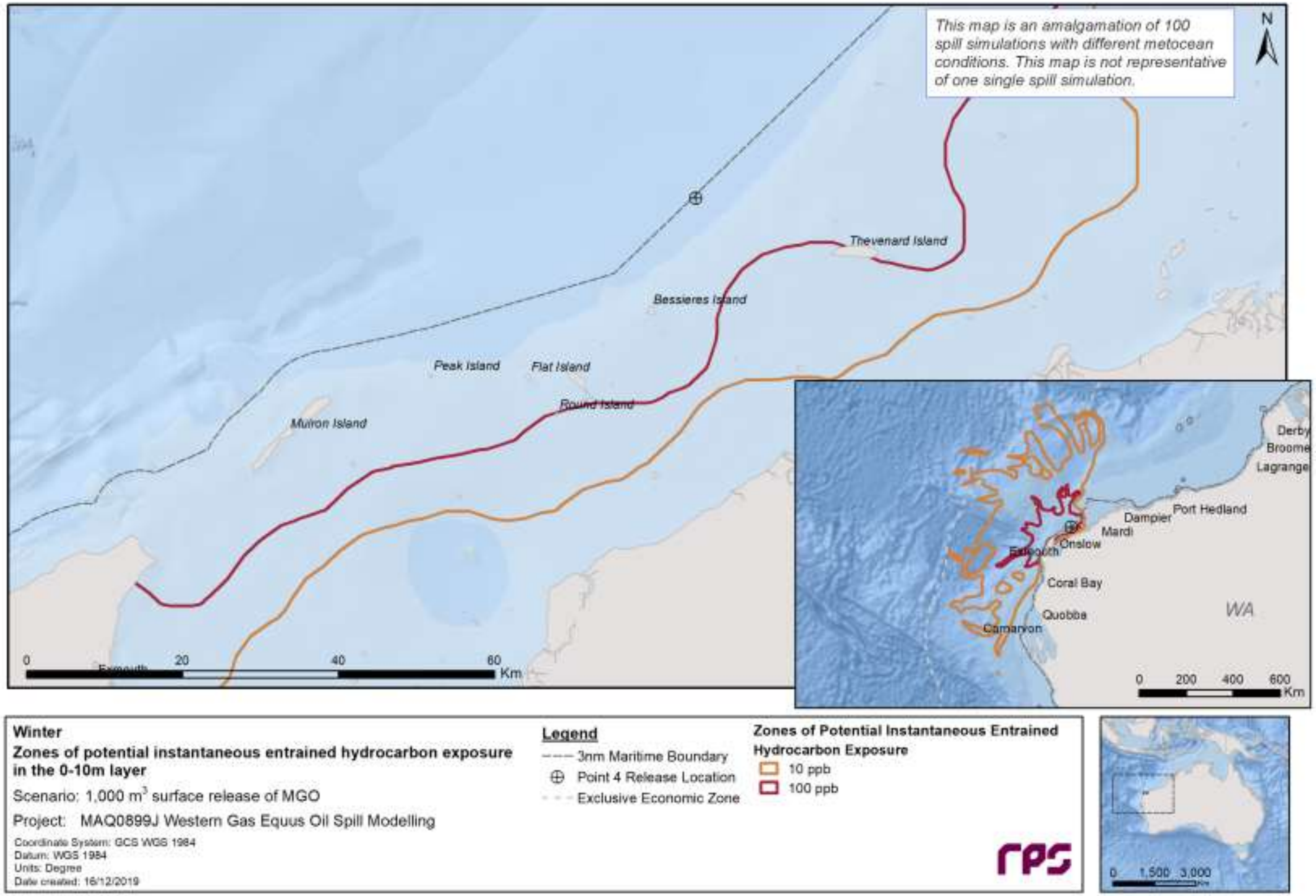


**Figure 12.38 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

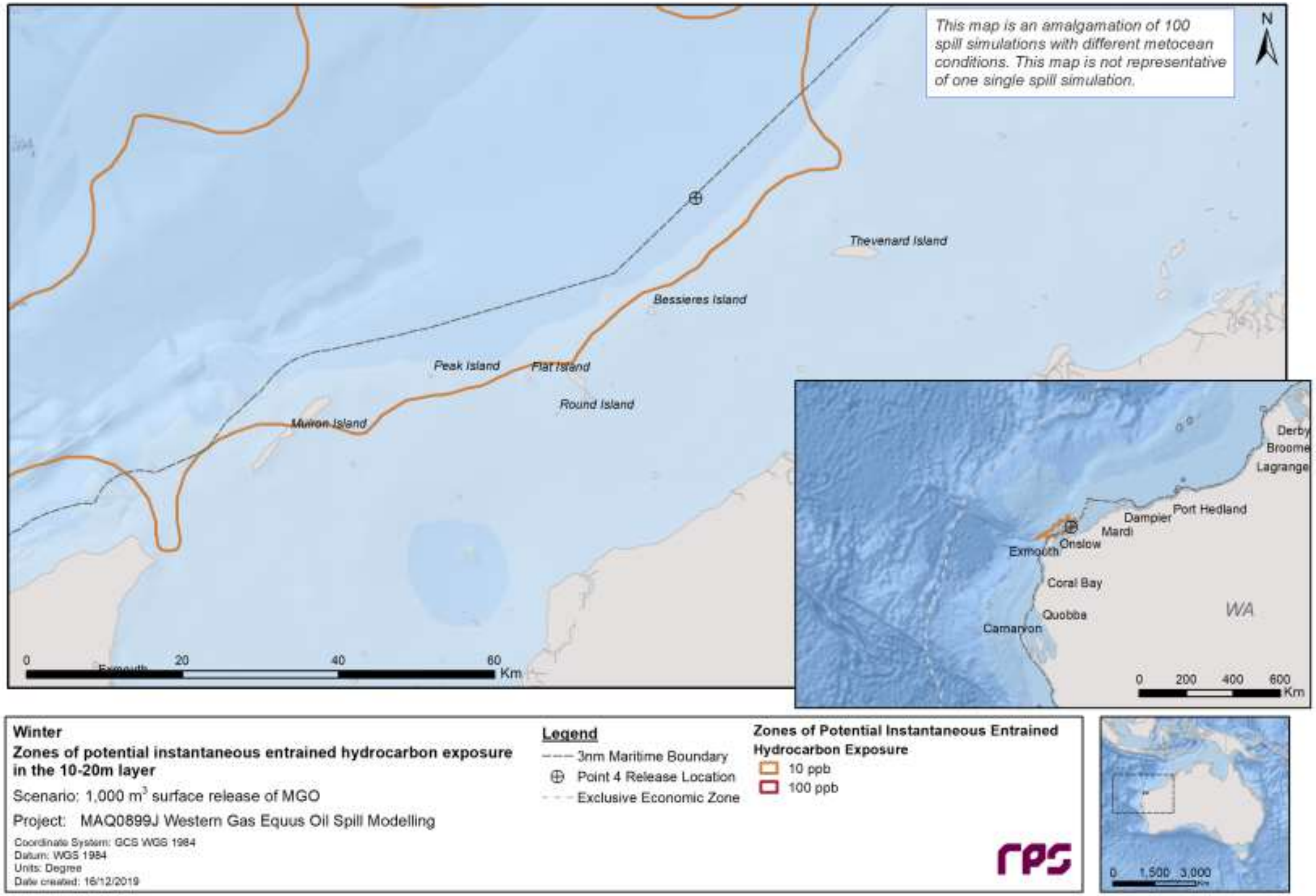


**Figure 12.39 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.**

## 12.2.2 Deterministic Trajectory

### 12.2.2.1 Deterministic Cases: Largest volume of oil ashore

The simulation that resulted in the largest volume of oil ashore was identified in winter, as run number 24, which commenced at 4 am on the 4th of May 2012.

Zones of oil exposure from sea surface oil (swept area) and shoreline loading over the entire simulation (40-days) is presented in Figure 12.40. The spill was predicted to travel southwest from the release location towards Bessieres Island.

Figure 12.41 displays the area of exposure at low (1 g/m$^2$) and actionable (10 g/m$^2$) surface oil thresholds, and length of oil contact to shorelines at the actionable threshold (100 g/m$^2$). The maximum area of coverage of visible oil on the sea surface was predicted to occur 6 hours after the spill commenced and covered approximately 16 km$^2$. The maximum length of shoreline above the actionable threshold (>100 g/m$^2$) was 2 km and had occurred 1.5 days (36 hours) after the spill commenced. Figure 12.42 is a time series of the mass on shore at the low (10 g/m$^2$), moderate (100 g/m$^2$) and high (1,000 g/m$^2$) thresholds.

Figure 12.43 presents the fates and weathering graph for the corresponding single spill trajectory. At the conclusion of the simulation period (day-40), approximately 677 m$^3$ (67%) spilled oil was lost to the atmosphere through evaporation. Approximately, 235 m$^3$ (24%) of the oil was predicted to have decayed, while approximately 86 m$^3$ (8%) was predicted to remain within the water column and 2 m$^3$ (0.2%) was predicted to arrive ashore.

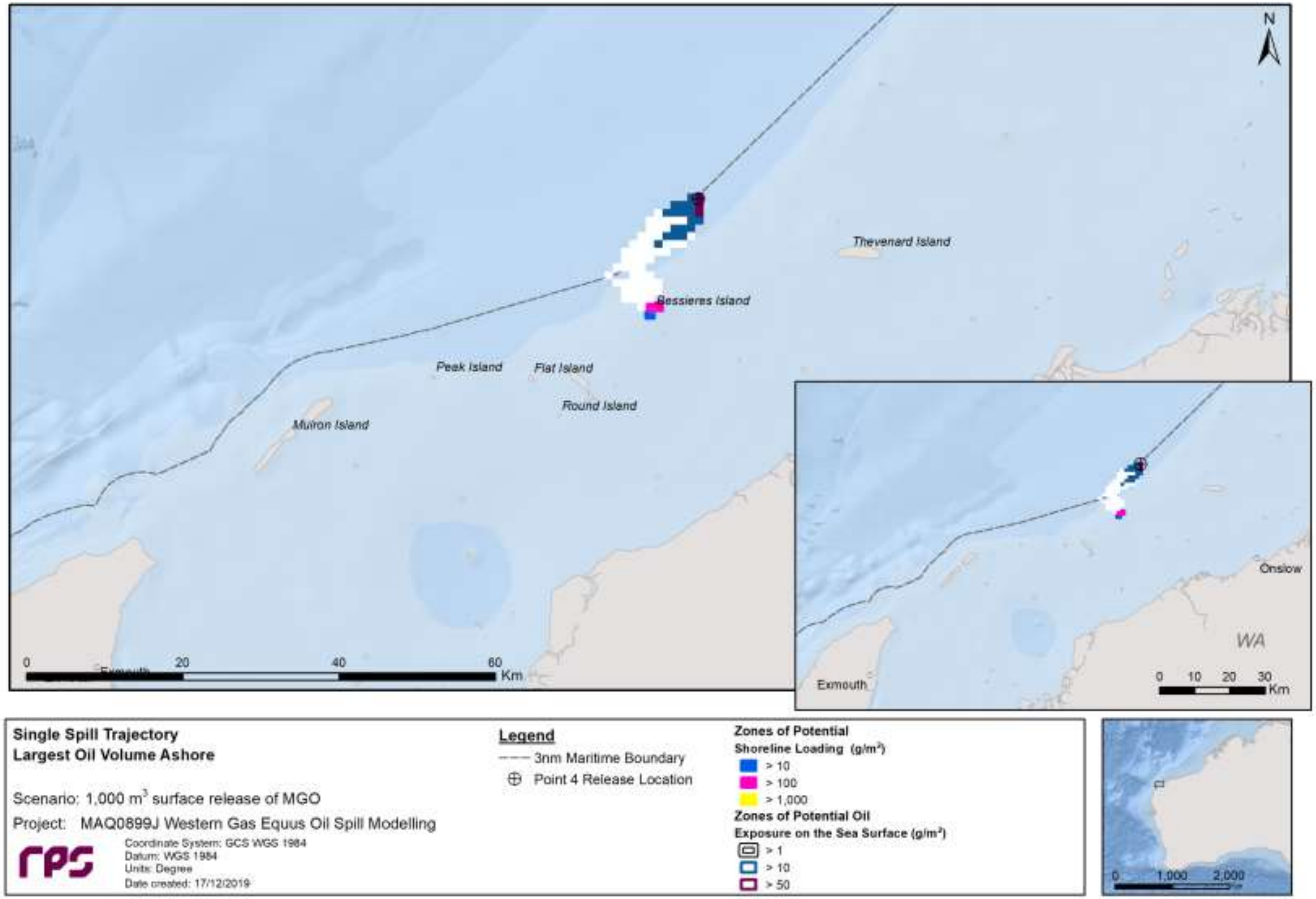


**Figure 12.40 Zones of oil exposure on the sea surface (swept area) and shoreline loading over the entire simulation (40 days), for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days, commencing at 4 am on the 4$^{th}$ of May 2012.**

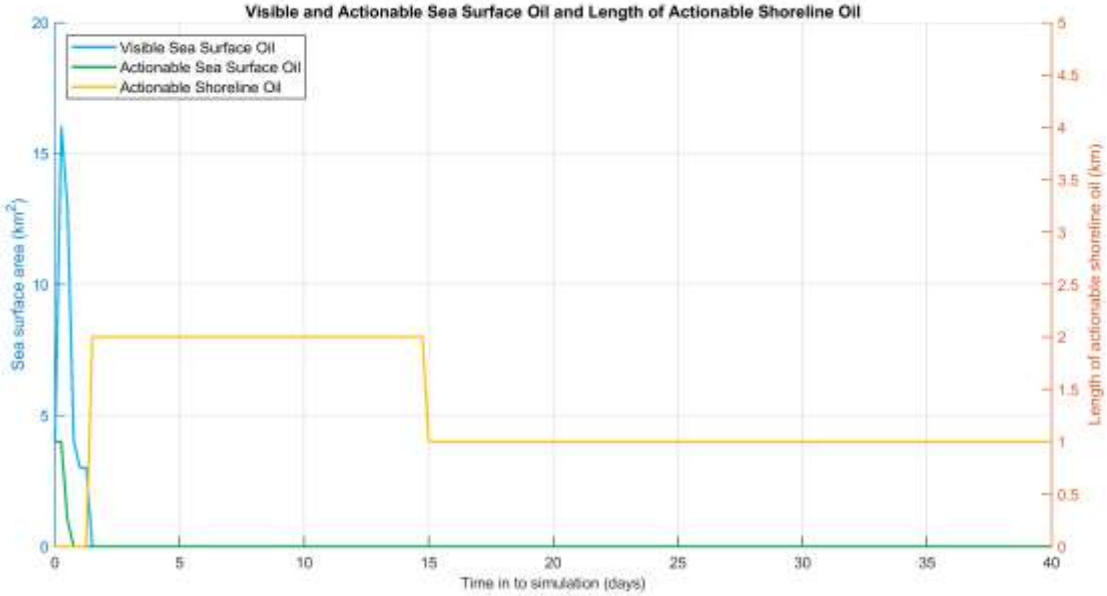


**Figure 12.41 Area of exposure at low (1 g/m$^2$) and actionable (10 g/m$^2$) surface oil thresholds and length of oil contact to shorelines at the actionable threshold (100 g/m$^2$); for the simulation identified to result in the largest volume of oil ashore from Point 4. Results are based on 1,000 m$^3$ surface release of MGO from Point 1 over 6 hours, tracked for 40 days, 4 am on the 4$^{th}$ of May 2012.**

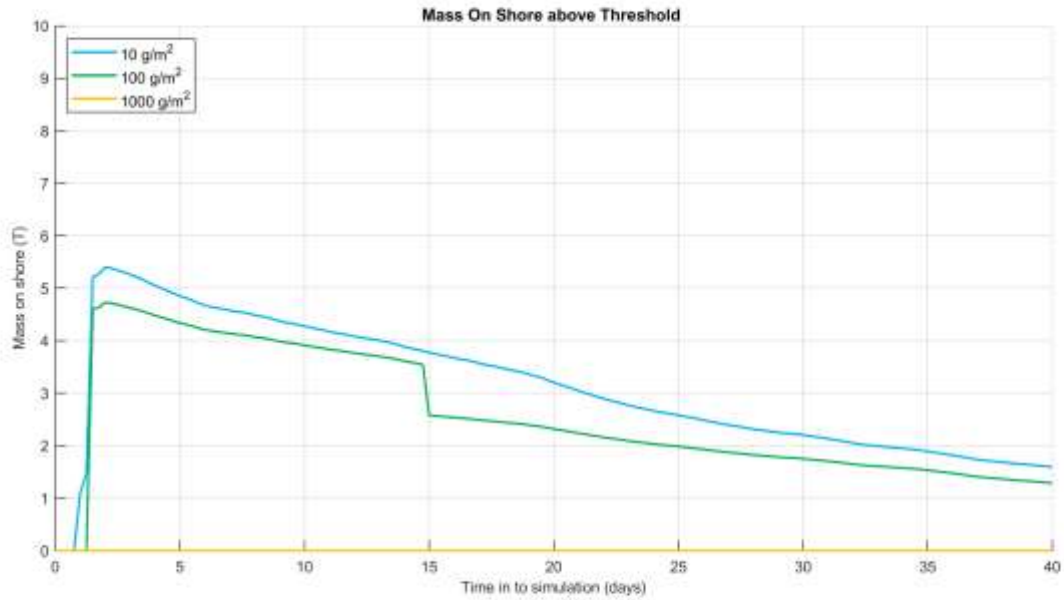


**Figure 12.42 Time series of the mass ashore at each threshold for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days, 4 am on the 4$^{th}$ of May 2012.**

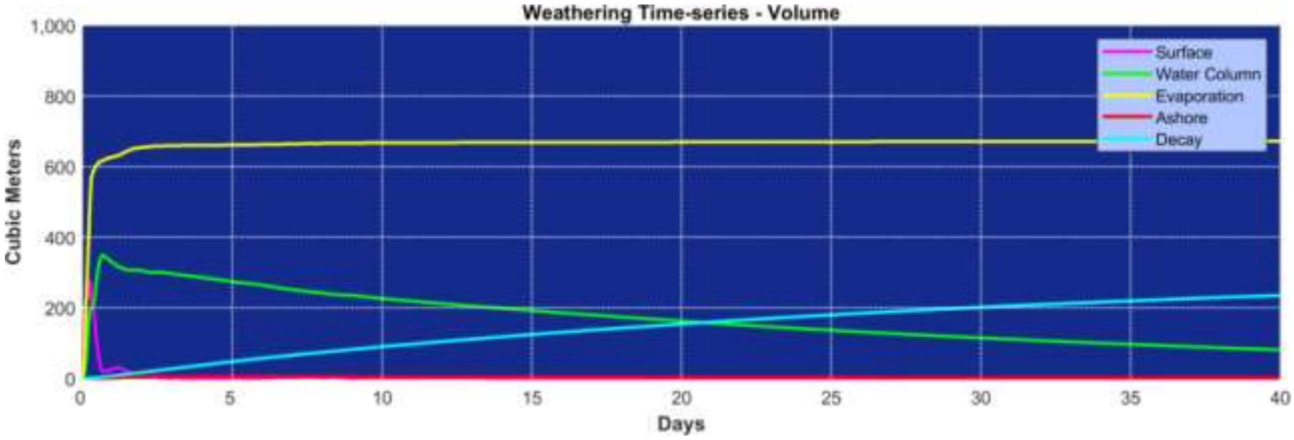


**Figure 12.43 Predicted weathering and fates graph for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m$^3$ surface release of MGO from Point 4 over 6 hours, tracked for 40 days, 4 am on the 4th of May 2012.**

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# APPENDIX D: STAKEHOLDER CONSULTATION RECORD

**Consultation Information Sheet sent to all stakeholders**

STAKEHOLDER CONSULTATION INFORMATION SHEET

WESTERN GAS

## SASANOF-1 EXPLORATION WELL ENVIRONMENT PLAN

MAY 2021

**Western Gas is planning to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth Waters in the Carnarvon Basin offshore Western Australia, starting at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.**

An Environment Plan for the proposed activities will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) and will be made available for public comment following a completeness check by NOPSEMA. NOPSEMA acceptance of this plan is required before any petroleum activity can commence.

The Environment Plan will cover well design and drilling operations, installation and testing of well safety equipment, well evaluation and plugging activities prior to the abandonment of the well.

Western Gas is Operator and 100% owner of WA-519-P and the adjacent Equus Gas Project.


*Figure 1: Sasanof-1 well location*

**ACTIVITY OVERVIEW**

**Earliest start date:**
Q1 2022, subject to approvals, vessel availability and weather constraints

**Approximate Location:**
- ~207 km northwest of Onslow
- Latitude: 20.4871°S
- Longitude: 113.544°E

**Approximate estimated duration:**
- ~25 days, excluding weather and operational delays

**Water depth:**
- ~1071 m

**Project vessels:**
- Semi-submersible mobile offshore drilling unit (MODU)
- Activity support vessels, including general supply/support vessels and anchor handling vessel(s)

**Distance to nearest marine park:**
- ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone)

**Exclusion zones:**
- A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.
- A temporary Cautionary Area with a radius of 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.

WESTERN GAS Accelerating development of Western Australia's gas resources

WESTERN GAS

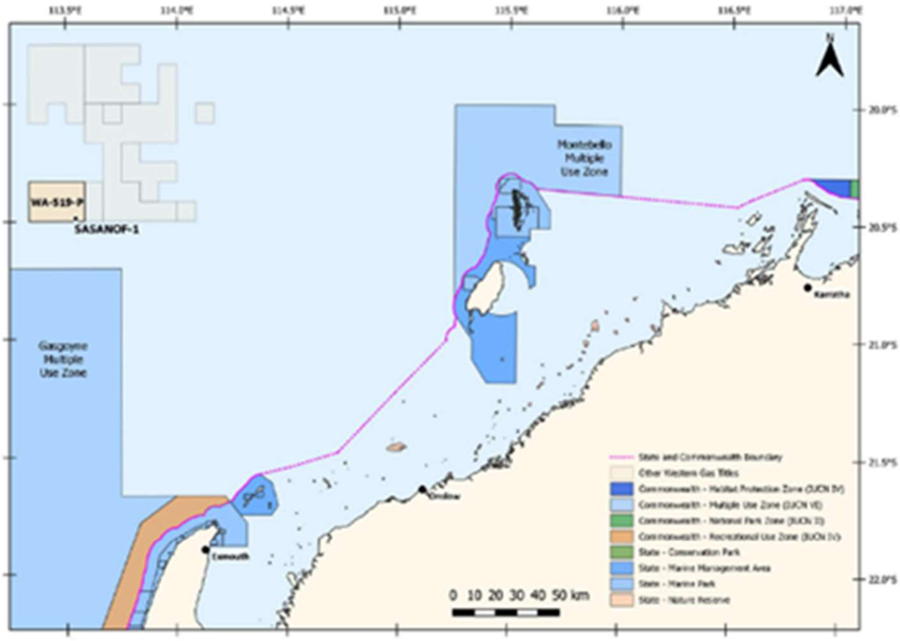


*Figure 2: Sasanof well location*

## PROPOSED ACTIVITY

Western Gas is planning to drill the Sasanof-1 exploration well in WA-519-P. Results from drilling activities will be used to confirm the presence of undiscovered oil and gas reservoirs, as well as to help inform Western Gas' understanding of its known discoveries in the area.

The Environment Plan for the activity will cover well design and drilling operations, installation and testing of well safety equipment, and well evaluation activities.

Best endeavours will be made to remove the wellhead. If the structure cannot be retrieved, it will be left in situ and the well location will be marked on nautical charts.

Drilling and support activities will typically be conducted on a 24-hour basis. The duration of these activities is subject to change due to project schedule requirements, drill rig and vessel availability, weather, and unforeseen circumstances.

Listed below is a summary of key activities for the drilling of the well.

- Pre-drilling survey
- MODU positioning and anchoring
- Installation and testing of the blow out preventers
- Drilling of the well
- Cementing of the well
- Well evaluation
- Well plugging and abandonment
- Post-drilling survey
- Support operations, including vessel and helicopter movements

## PROJECT VESSELS

Western Gas is currently considering vessel options, with the drilling rig likely to be a moored semi-submersible mobile offshore drilling unit (MODU). Typically, two or three vessels will support drilling activities, with at least one vessel in the vicinity to complete standby duties, if required. Supply vessels from either Onslow or Dampier will visit the selected MODU at regular intervals.

## STAKEHOLDER NOTIFICATIONS

Notifications will be issued prior to the start of the activity to alert other marine users who may be operating in nearby waters. A temporary Petroleum Safety Zone and Cautionary Area will be in place during the drilling of the well. Drilling activities will be deemed complete following the MODU moving off station.

## ASSESSMENT OF IMPACTS AND RISKS

Western Gas has assessed potential risks and impacts to the marine environment and relevant stakeholders, considering the timing, duration, location and the nature and scale of the proposed activity. Table 1 summarises key potential impacts resulting from planned and unplanned activities. Western Gas is consulting relevant stakeholders to help inform its management of these impacts and risks, and planning for the Environment Plan.

WESTERN GAS **Accelerating development of Western Australia's gas resources**

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*Table 1. Risk and impact assessment, and associated management measures.*

| POTENTIAL RISKS/ IMPACTS | MANAGEMENT MEASURES |
|---|---|
| **PLANNED ACTIVITIES** | |
| Interactions with other marine users | ▪ Establishment of a temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>▪ Establishment of a temporary Cautionary Area with a radius of up to number km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.<br>▪ Consultation with relevant stakeholders, including adjacent petroleum titleholders, commercial fishers and their representative organisations, and government departments and agencies to inform decision making for the proposed activity and the development of the Environment Plan.<br>▪ Western Gas will notify maritime safety agencies and other identified stakeholders of the MODU location and start and end dates for the activity. |
| Light emissions | ▪ Lighting is minimised to that required for safety and navigational purposes. |
| Seabed disturbance | ▪ Well location and site appraisal to identify and address well-specific hazards and drilling constraints.<br>▪ MODU mooring analysis and anchor deployment in accordance with drilling contractor standards.<br>▪ No anchoring of support vessels during drilling. |
| Planned discharges to the marine environment | ▪ All routine marine discharges will be managed according to legislative and regulatory requirements and Western Gas' HSE Corporate Management System where applicable.<br>▪ Chemical use will be managed in accordance with contractor chemical selection and approval procedures. |
| Underwater noise | ▪ Measures will be in place for interacting with protected marine fauna as per Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 should vertical seismic profiling be undertaken. |
| Waste generation | ▪ Waste generated on the MODU and support vessels will be managed in accordance with legislative requirements and a Waste Management Plan.<br>▪ Wastes will be managed and disposed of in a safe and environmental responsible manner that prevents accidental loss to the marine environment.<br>▪ Wastes transported onshore will be sent to appropriate recycling or disposal facilities by a licenced waste contractor. |
| **UNPLANNED ACTIVITIES** | |
| Hydrocarbon release | ▪ Oil Pollution Emergency Plan and Operational and Scientific Monitoring Plan will be in place.<br>▪ Appropriate vessel spill response plans, equipment and materials will be in place and maintained. |
| Invasive marine species | ▪ Contracted vessels will comply with Australian biosecurity requirements and guidance, and Australian ballast water requirements.<br>▪ Vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. |
| Marine fauna interaction | ▪ Compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000. |

## PROVIDING FEEDBACK

Please contact Western Gas before **25 June 2021** if you would like to comment on the proposed activities outlined in this information sheet or would like additional information.

Your feedback will be included in the Environment Plan for the proposed activity, which will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).*

Please let us know if wish your personal/organisation details or any part of your feedback to remain confidential as a summary of your feedback and our response in the Environment Plan for this activity will be published on NOPSEMA's web site.

This Environment Plan for this activity will also be open to public review and comment and will be published **here** following submission by Western Gas and a completeness check by NOPSEMA.

Please contact Western Gas at: **feedback@westerngas.com.au**

WESTERN GAS **Accelerating development of Western Australia's gas resources**

**Ref. 1.1 - Email to Australian Border Force (ABF) – 26 May 2021**

Dear Australian Border Force

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.
Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.
Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.
An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

## Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information. We are also open to receiving any information you think may be relevant to our consideration of managing environmental impacts and risks of the activity, including contact details for relevant others who may be affected.
A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).
The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.
Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref. 1.2 - Email to the Australian Fisheries Management Authority (AFMA) – 26 May 2021**

Dear AFMA

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

Our assessment indicates that licence holders in the Western Deepwater Trawl Fishery may be relevant to the proposed activities in WA-519-P, based on fishing licence overlap with the proposed Sasanof-1 well location and consideration of government fishing effort data from recent years, fishing methods and water depth. Licence holders in this fishery, as well as their representative fishing organisations are being consulted for the proposed Activity. A map is attached showing the proposed Sasanof-1 well location relative to the Western Deepwater Trawl Fishery.

Whilst not being identified as relevant to the proposed activity, Western Gas is engaging the Australian Southern Bluefin Tuna Industry Association given stakeholder advice from previous consultation activities for the organisation to be kept informed about proposed oil and gas activities.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

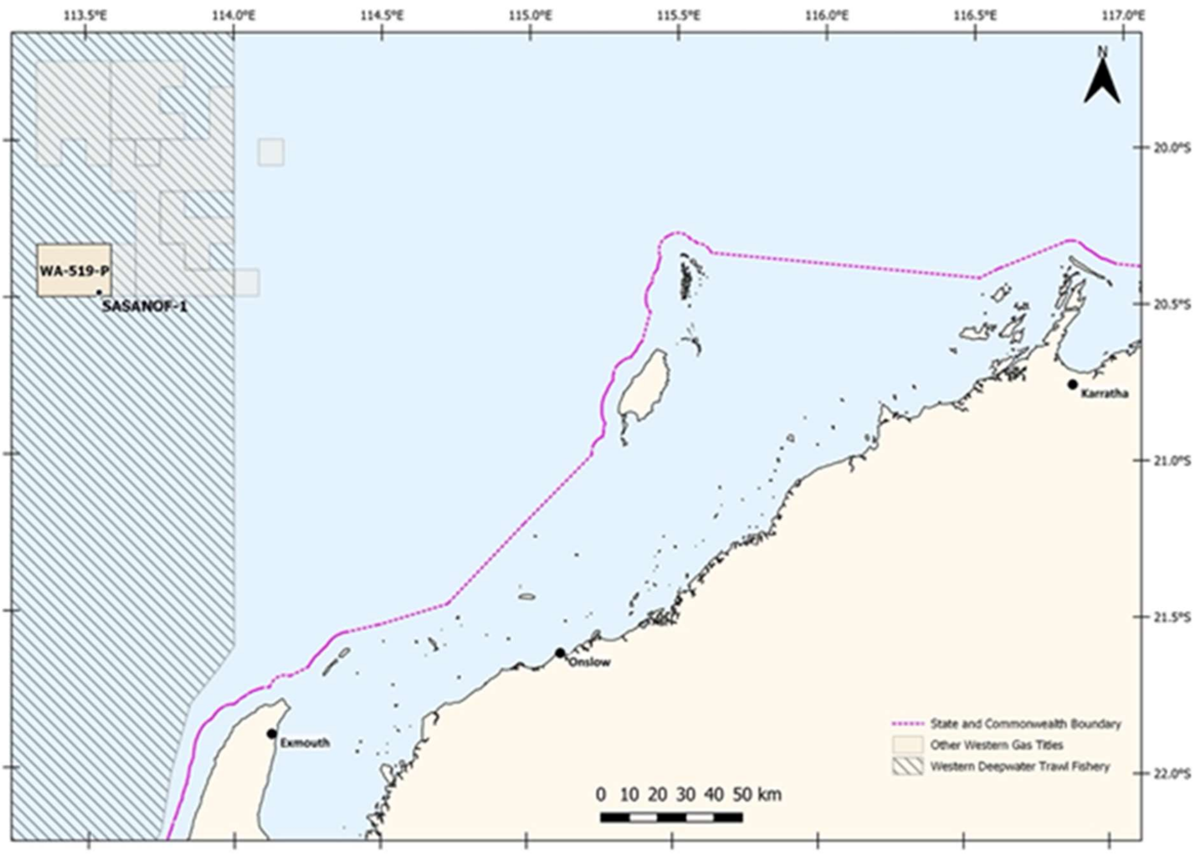
Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards




**Ref. 1.3 - Email to Australian Hydrographic Office (AHO) and Australian Maritime Safety Authority (AMSA) (maritime safety) – 26 May 2021**

Dear AHO and AMSA

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

A map is also attached showing the proposed Sasanof-1 well location relative to AMSA shipping fairways.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |

| | |
|---|---|
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

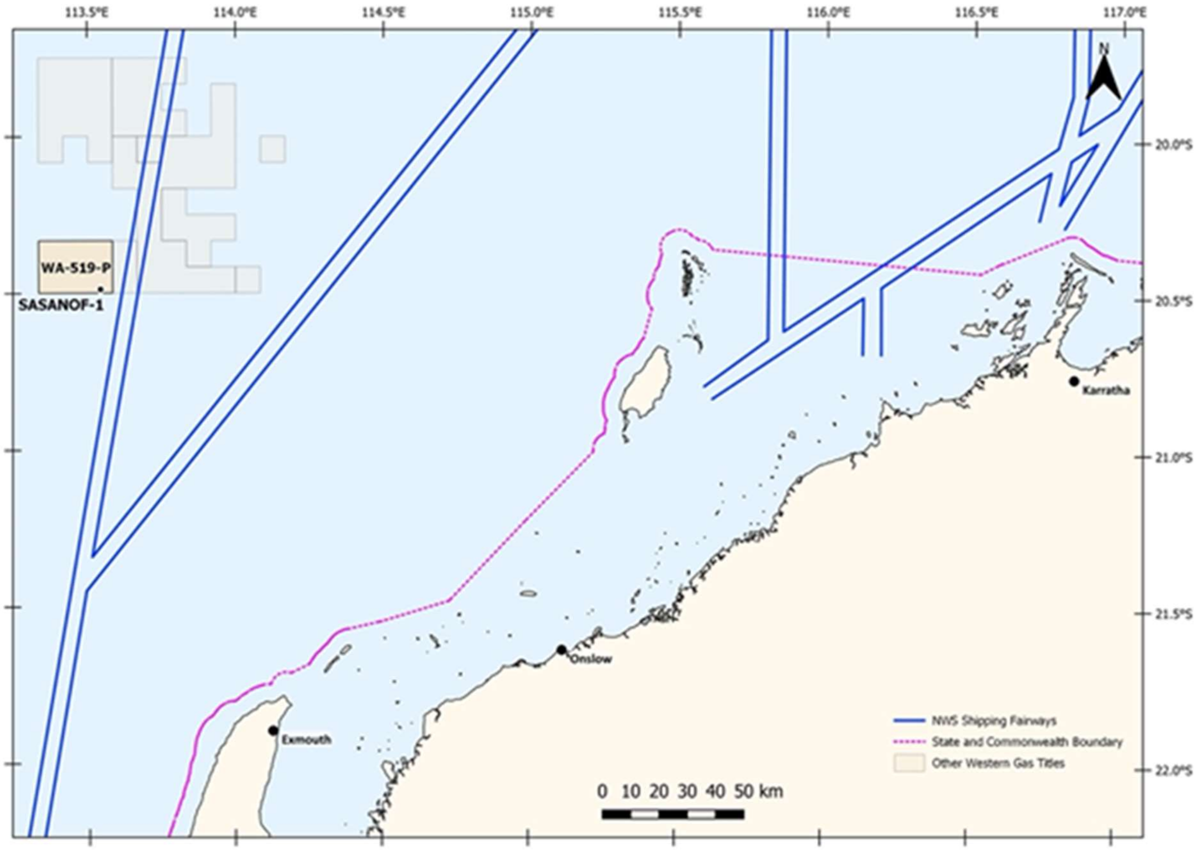
Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards




**Ref. 1.4 - Email to Australian Maritime Safety Authority (AMSA) (marine pollution) – 26 May 2021**

Dear AMSA

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

An activity overview is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

A First Strike Response Plan is currently being developed and will be provided to AMSA once finalised and for comment if requested.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref. 1.5 - Email to Department of Agriculture, Water and the Environment (DAWE) (fisheries and biosecurity) – 26 May 2021**

Dear Stakeholder

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS |

| | |
|---|---|
| | Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Implications for DAWE's interests**

We have identified and assessed potential risks and impacts to active Commonwealth commercial fishers, biosecurity matters and the marine environment that overlap in proposed activity in the Environment Plan for this activity. Western Gas has endeavoured to reduce these risks and impacts to an as low as reasonably practicable (ALARP) level.

**Commercial fishing implications:**

Our assessment indicates that licence holders in the Western Deepwater Trawl Fishery may be relevant to the proposed activities in WA-519-P, based on fishing licence overlap with the proposed Sasanof-1 well location and consideration of government fishing effort data from recent years, fishing methods and water depth. Licence holders in this fishery, as well as their representative fishing organisations are being consulted for the proposed Activity. A map is attached showing the proposed Sasanof-1 well location relative to the Western Deepwater Trawl Fishery.

Whilst not being identified as relevant to the proposed activity, Western Gas is engaging the Australian Southern Bluefin Tuna Industry Association given stakeholder advice from previous consultation activities for the organisation to be kept informed about proposed oil and gas activities.

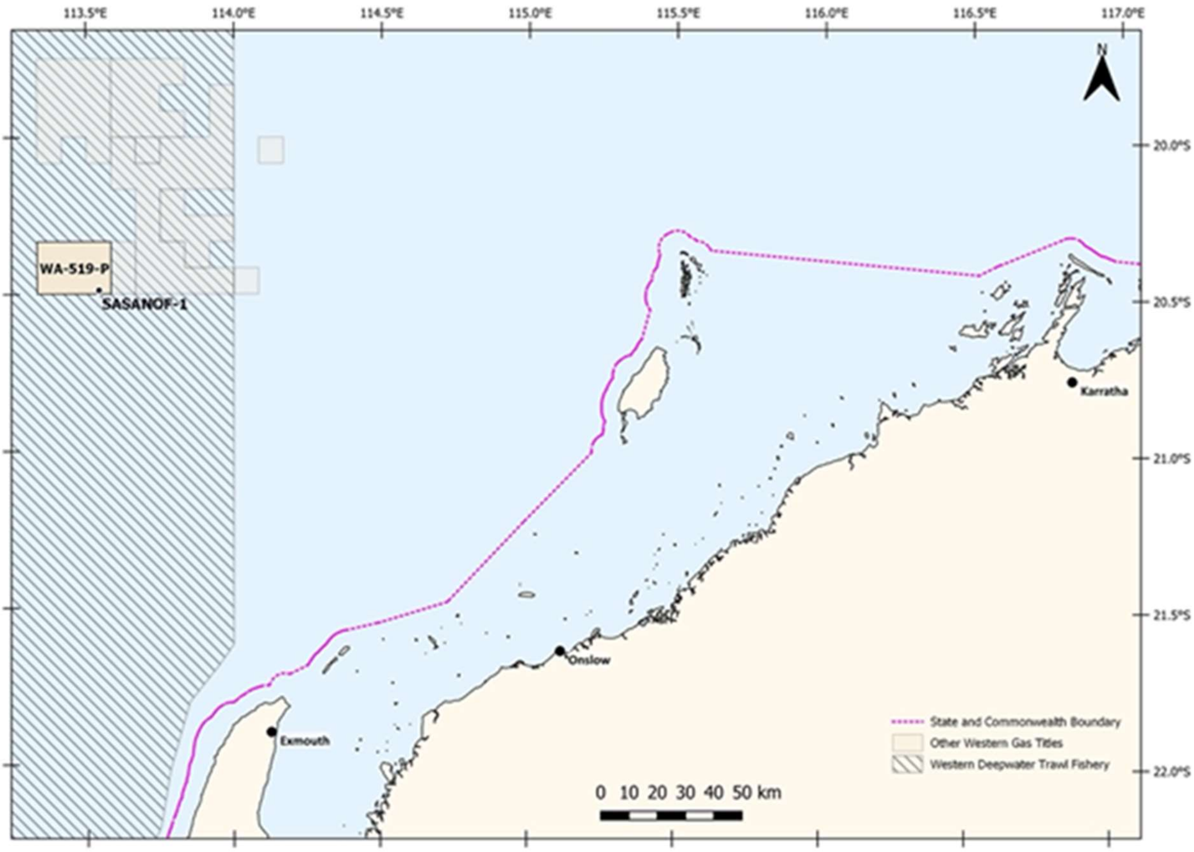
**Biosecurity implications:**

Western Gas provides the following information with respect to the surround environment at the well location and management measures to prevent the introduction and establishment of Invasive Marine Species (IMS).

| Aspect | Details |
|---|---|
| **Environment description** | The seabed in WA-519-P is a relatively flat and featureless sandy habitat. |
| **Legislation and other requirements that apply** | Biosecurity Act (2015) (Cth)<br>Biosecurity (Ballast Water and Sediment) Determination 2017 and the Ballast Water Management Requirements Version 8<br>National biofouling management guidelines for the petroleum production and exploration industry (DAFF 2009)<br>Marine Order 98 |
| **IMS mitigation measures** | Submersible equipment will be cleaned prior to initial use in the activity area<br>Support vessels will fulfil requirements of the Australian Ballast Water Management Requirements<br>DAWE will be advised immediately in the event of non-compliant discharges of domestic ballast water |

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.
A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).
The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.
Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.
Regards




**Ref. 1.6 - Email to Department of Defence (DoD) – 26 May 2021**

Dear Stakeholder

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

A map is also attached showing the proposed Sasanof-1 well location relative to Defence interests.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

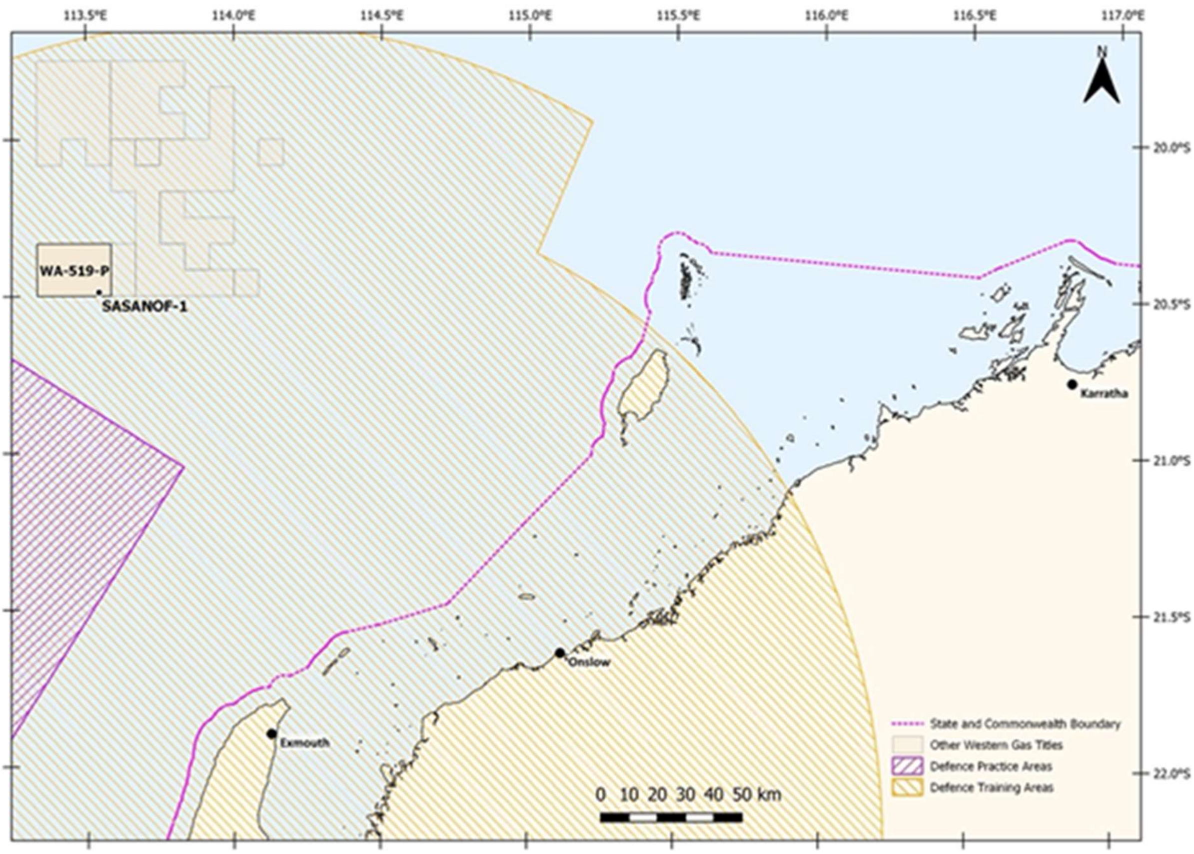
Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards




**Ref. 1.7 - Email to Department of Industry, Science, Energy and Resources (DISER) – 26 May 2021**

Dear DISER

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

## Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref. 1.8 - Email to Director of National Parks (DNP) – 26 May 2021**

Dear Director National Parks

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | 3.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

## Implications for the interests of Parks Australia

We note Australian Government Guidance on consultation activities with respect to the proposed activities and confirm that:

- We have assessed potential risks and impacts to Australian Marine Parks (AMPs) in the development of the Environment Plan for this activity, with the nearest AMP being the Gascoyne Marine Park (Multiple Use Zone) approximately 23.6 km to the south of the proposed Sasanof-1 well location.
- We have not identified impacts associated with planned activities that have potential to impact the values of this AMP.
- In the unlikely event of a hydrocarbon release from the Sasanof-1 exploration well there is a risk of hydrocarbons contacting the Gascoyne Marine Park.
- A NOPSEMA approved oil spill response plan will be in place for the duration of the activities. A stakeholder notification matrix is included in the plan. The Director of National Parks will be advised as part of this communications escalation if an environmental incident occurs that may impact the values of an AMP.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref. 1.9 - Email to Department of Biodiversity, Conservation and Attractions (DBCA) – 26 May 2021**

Dear DBCA

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone. |

| | |
|---|---|
| | A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Implications for the DBCA interests**

We provide the following information with respect to DBCA's interests:

- We have assessed potential risks and impacts to DBCA managed assets in the development of the Environment Plan for this activity, with the nearest Marine Park being the Ningaloo Marine Park approximately 150 km (State Boundary) to the south of the proposed Sasanof-1 exploration well location.
- We have not identified impacts associated with planned activities that have potential to impact the values of this marine park.
- Oil spill modelling for this activity does not show any surface contact with DBCA managed assets in the unlikely event of a hydrocarbon release from the Sasanof-1 exploration well location.
- A NOPSEMA approved oil spill response plan will be in place for the duration of the activities. A stakeholder notification matrix is included in the plan. DBCA will be advised if an environmental incident occurs that may impact the values of a DBCA managed asset.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref. 1.10 - Email to Department of Mines, Industry Regulation and Safety (DMIRS) – 26 May 2021**

Dear DMIRS

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our [website](website).

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |

| | |
|---|---|
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref 1.11 - Email to Department of Primary Industries and Regional Development (DPIRD) – 26 May 2021**

Dear Stakeholder

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

This previous consultation included engagement with WAFIC, which at the time indicated that no State-managed commercial fishing activities occur at water depths greater than 1000 m. Western Gas will reconfirm with WAFIC this previous advice remains current. Similarly, we seek confirmation from DPIRD on this previously provided advice.

We have provided details below on the proposed activity should you wish to provide feedback.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU) |

| | |
|---|---|
| | Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref. 1.12 - Email to Department of Transport (DoT) – 26 May 2021**

Dear Stakeholder

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Please note that oil spill modelling for this activity does not show any surface contact with State waters in the unlikely event of a hydrocarbon release.

Western Gas recognises DoT's guidance on consultation for the development of appropriate oil spill response plans and seeks advice from DoT and its expectation to be involved in reviewing the First Strike Response Plan being developed for this activity.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

| |
|---|

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Industry associations**

**Ref 1.13 - Email to licence the Australian Petroleum Production and Exploration Association (APPEA) – 26 May 2021**

Dear APPEA

Western Gas provides for information purposes the following details on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

| Activity | Details |
|---|---|
| **Approximate location*** | ~ 207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).
The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.
Please let us know if wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.
Regards

**Ref 1.14 - Email to Australian Southern Bluefin Tuna Industry Association (ASBTIA) – 26 May 2021**

Dear Stakeholder

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

This previous consultation included engagement with WAFIC, which at the time indicated that
the Australian Southern Bluefin Tuna Industry Association should be kept informed of planned oil and gas exploration and development activities with respect to key species migration.

We have provided details below on the proposed activity should you wish to provide feedback, as well as a map (attached) showing the proposed Sasanof-1 exploration well location relative to the Australian Southern Bluefin Tuna Fishery.

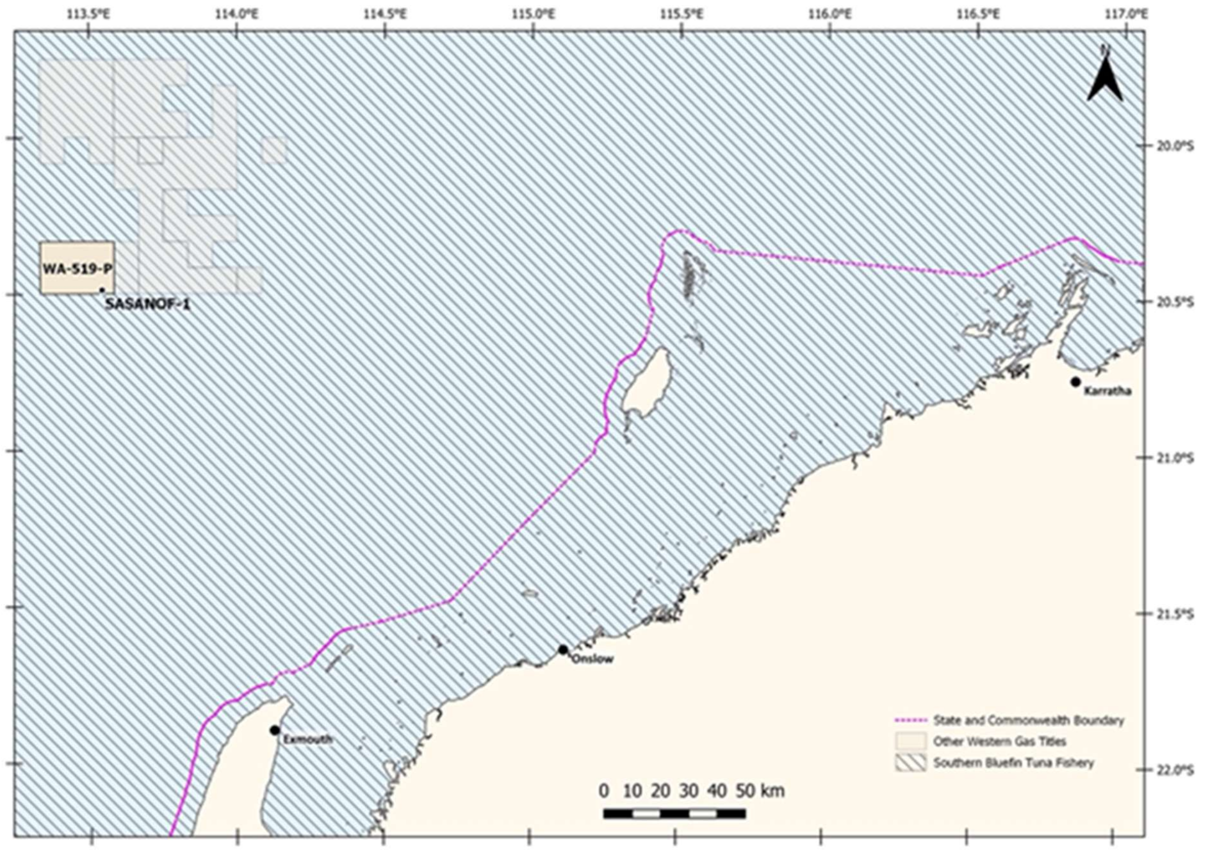
| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.
A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA. Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.
Regards




**Ref 1.15 - Email to the Commonwealth Fisheries Association (CFA) – 26 May 2021**

Dear Commonwealth Fisheries Association

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

Our assessment indicates that licence holders in the Western Deepwater Trawl Fishery may be relevant to the proposed activities in WA-519-P, based on fishing licence overlap with the proposed Sasanof-1 well location and consideration of government fishing effort data from recent years, fishing methods and water depth. Licence holders in this fishery, as well as their representative fishing organisations are being consulted for the proposed Activity. A map is attached showing the proposed Sasanof-1 well location relative to the Western Deepwater Trawl Fishery.

Whilst not identified as being relevant to the proposed activity, Western Gas is engaging the Australian Southern Bluefin Tuna Industry Association given stakeholder advice from previous consultation activities for the organisation to be kept informed about proposed oil and gas activities.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our [website](website).

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude:  113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

## Providing feedback

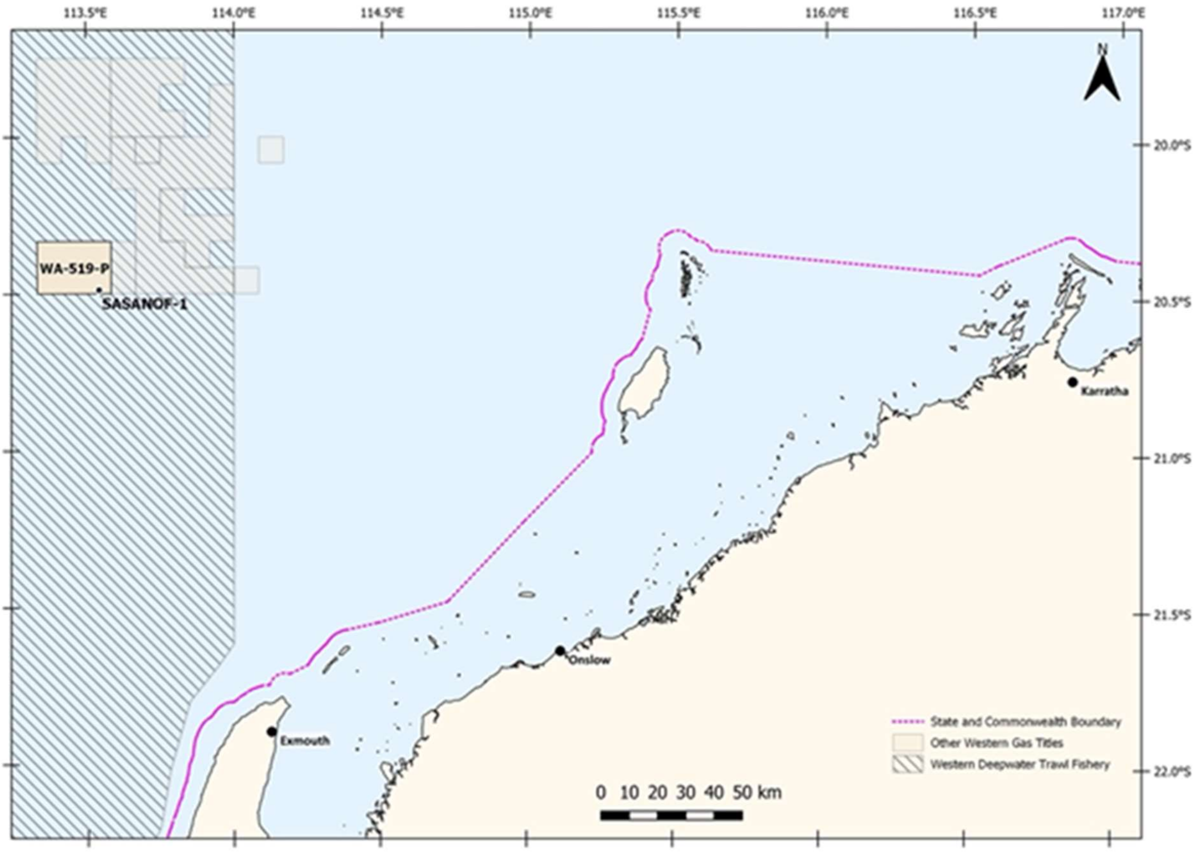
Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards




**Ref 1.16 - Email to the Pearl Producers Association (PPA) – 26 May 2021**

Dear Pearl Producers Association

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

This previous consultation included engagement with WAFIC, which at the time indicated that the PPA should be kept informed of planned oil and gas exploration and development activities.

We have provided details below on the proposed activity should you wish to provide feedback.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone. |

| | |
|---|---|
| | A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**Ref 1.17 - Email to WAFIC – 26 May 2021**

Dear WAFIC

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

This previous consultation included engagement with WAFIC, which at the time provided the following advice with respect to Commonwealth and State-managed commercial fisheries.

- Southern Bluefin Tuna – no active fishing, it is the migratory route, you must engage with the Australian Southern Bluefin Tuna Industry Association.
- Western Tuna and Billfish – one active fisher in WA, our agreed engagement is for seismic activities only.
- Can't 100% see if there is an overlap with the Northwest Slope Trawl fishery (200m depth contour to the outer limit of the Australian Fishing Zone), confirm commercial fishing is between 200 and 750 metres water depth)
- Western Skipjack Tuna – no active fishing.

Can you please confirm the above advice remains current as it is our intent not to engage licence holders in State-managed fisheries for this activity?

Also, for noting, we have identified that licence holders in the Western Deepwater Trawl Fishery may be relevant to the proposed activities and we will be consulting licence holders in this fishery, as well as their representative fishing organisations.

We have provided details below on the proposed activity should you wish to provide feedback.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |

| | |
|---|---|
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

## Commonwealth managed fisheries

### Ref 1.18 - Email to licence holders in the Western Deepwater Trawl Fishery – 26 May 2021

Dear Licence Holder

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

Our assessment indicates that licence holders in the Western Deepwater Trawl Fishery may be relevant to the proposed activities in WA-519-P, based on fishing licence overlap with the proposed Sasanof-1 well location and consideration of government fishing effort data from recent years, fishing methods and water depth. Licence holders in this fishery, as well as their representative fishing organisations are being consulted for the proposed Activity.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

A map showing the Sasanof-1 exploration well location relevant to the Western Deepwater Trawl fishery is also attached.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS |

| | |
|---|---|
| | Longitude: 113.544°E |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

**WA State managed fisheries**

Nil

**Adjacent titleholders**

**Ref 1.19 - Email to Chevron (WA-383-P) and Kufpec (WA-538-P) – 26 May 2021**

Dear Title Holder

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

A map is also attached showing the proposed Sasanof-1 well location relative to adjacent titles, these being held by:

- Chevron (WA-383-P)
- Kufpec (WA-538-P)

| Activity | Details |
|---|---|

| | |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871ºS<br>Longitude: 113.544ºE |
| **Earliest possible start date** | Q1 2022 |
| **Approximate duration** | ~25 days, excluding weather and operational delays |
| **Approximate water depth** | ~1071 m |
| **Approximate distance to nearest marine park** | ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone) |
| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
| **Exclusion zones** | A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.<br>A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. |

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

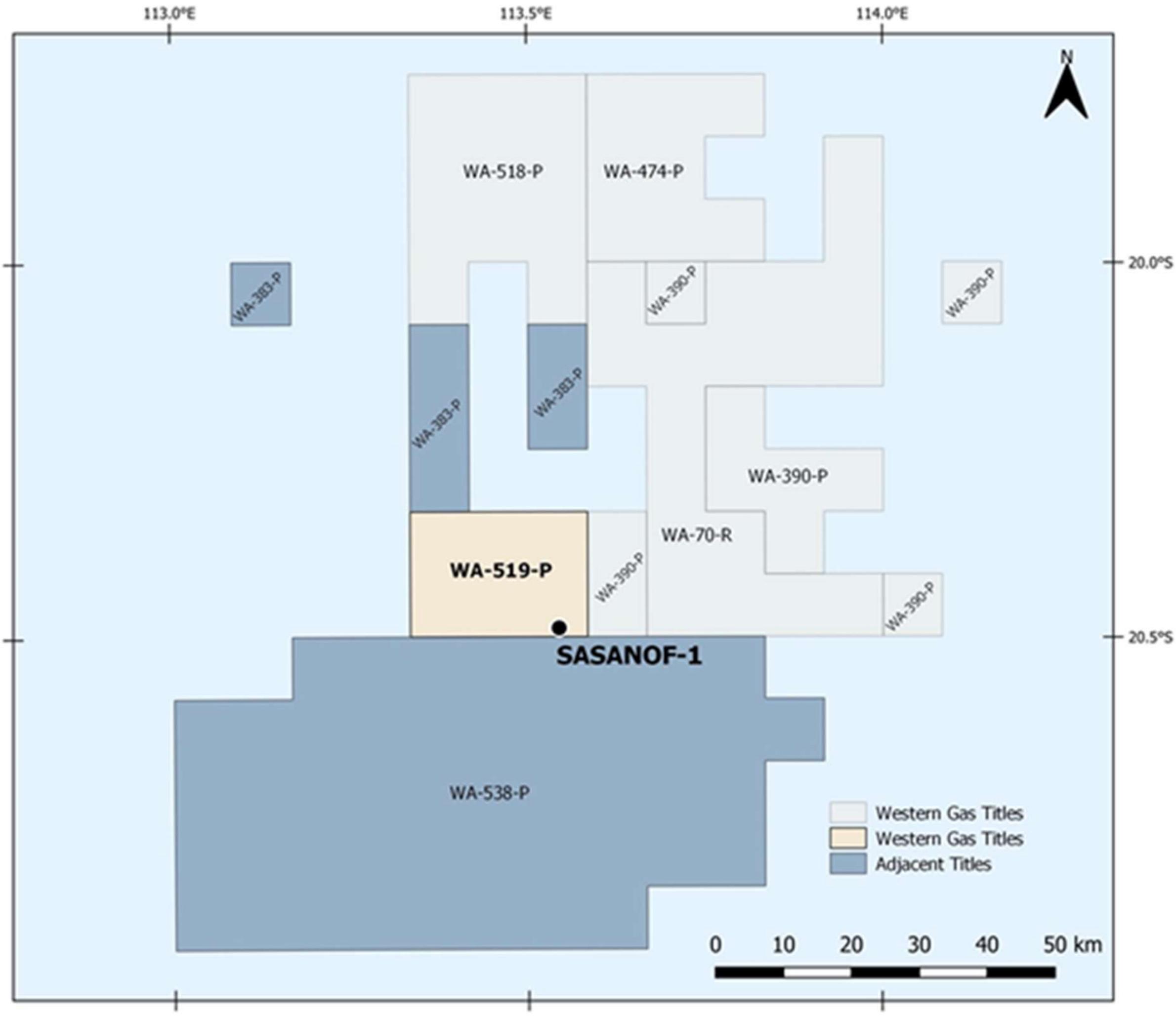
Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards




## Community stakeholders

**Ref 1.20 - Email to Agility, Buurabalayji Thalanyji Aboriginal Corporation, Mackerel Islands, Onslow Chamber of Commerce and Industry, Pilbara Development Commission, Pilbara Ports and Shire of Ashburton – 26 May 2021**

Dear Stakeholder

As part of our ongoing regional engagement program, Western Gas advises it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.
Whilst this planned activity may not impact your organisation's activities or interests, we feel it important to keep you informed, given the proximity of the Sasanof well location to our adjacent Equus Gas Project, which is subject to separate government approvals.

Consultation for the planned Sasanof-1 exploration well builds on engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

| Activity | Details |
|---|---|
| **Approximate location*** | ~207 km northwest of Onslow<br>Latitude: 20.4871°S<br>Longitude: 113.544°E |

WESTERN GAS

| | |
|---|---|
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| **Vessels** | Semi-submersible mobile offshore drilling unit (MODU)<br>Activity support vessels, including general supply/support vessels and anchor handling vessel(s) |
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* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

**Providing feedback**

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

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Regards